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THE ENGLISH MECHANIC

AND WORLD OF SCIENCE.

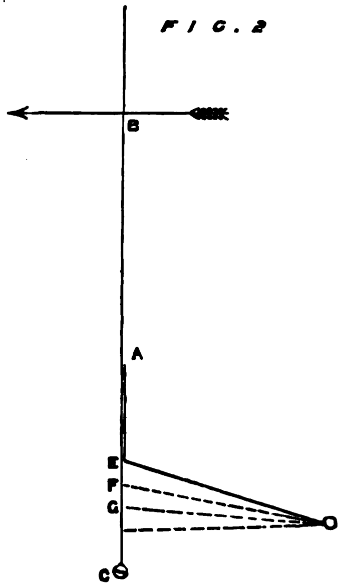
ARTICLES.

SCREWMANIA.—II.

HAVING laid down in a rough way the principle of the screw-tracing apparatus, inclusive in a great measure of the mode in which it may be worked out, the next step is to consider the latter point, with the view of alterations and emendations, if such are possible. For I need not inform the readers of the ENGLISH MECHANIC that there are generally divers and sundry ways in which the various parts of a machine may be made, some preferable under certain given circumstances, and others under conditions dissimilar from the first. Thus, a beam engine, excellent for pumping water, may give place for other purposes to a horizontal engine, an oscillating engine, a steeple engine, or any other form which circumstances may suggest as preferable.

On looking into the back vols. of the ENGLISH MECHANIC I see a *reference* to the plan of Cooke and Sons,* but not anything like a detailed description; so, in all probability, it appeared elsewhere, and, with equal probability, some other pen may have illustrated it. I can only say it is well worth a place in these pages, as it has stood the test of long practical experience. At present I wish to point out the essential differences it exhibits to that of my last paper. The tail-end of the lever in Cooke's apparatus stands out horizontally behind over the back-board, and very close to it, and the pulleys and cords take the same position. Thus nothing stands out in front, but all parts are kept out of the way as much as possible. It is evident that, if the attachment of the cord to the lever is to be at variable distances, the guide pulley will in some way need to be adjustable, that the cord may pass directly to it in a direction parallel to the lathe bed. Now, although in Cooke's apparatus the cord is attached to a pin on the long end of a lever, this lever does not vary in length, but the cord always goes to the same pin. But this lever is not the one which directly moves the sliding top of the base, but it is linked to another which effects this sliding motion, the latter making a variable angle with it, and the exact point at which, for a given pitch, the second lever is attached to the main one, is determined by a vernier attached to it, and sliding on the long one, the pitches that will be cut being marked upon the latter. In a tracing which I have of the arrangement (but which is, of course, somewhat obliterated at the very spot that I want a clear definition), A B, Fig. 2, may represent the main lever hinged at C, and D a second lever, the pin of which is attached to the under side of the sliding cover. This second lever may, of course, occupy such positions as E F G, and when the main lever is moved in the direction of the arrow the rate at which the slide will move will depend on the relative positions alluded to. In the drawing the connection between the second and first lever appears to be by a slide or sleeve, that can be slipped up or down on the latter, and fixed by a key at any given point. The pith of the arrangement is, at any rate, as stated here. Any error of rate is not of much importance, because the chief object is, I believe, to chase screws on the fittings of microscopes, telescopes, and instruments of that kind, and it was never meant to apply to the production of long screws. So far as this plan of getting variety of pitches from levers united at various angles is concerned, I have another entirely novel arrangement, contributed to my scrap-book by Mr. Gilray, of Greenock, which, however, I do not feel justified in giving to the reader without special permission. Experiment proved its capabilities, but I think it is proposed to alter it a little in detail.

FIG. 2



Now, as compared with my own arrangement, there is this advantage certainly in Messrs. Cooke's—viz., that the lever and cords are kept out of the way of the turner, and that, as the base of the rest is the movable part which traverses to and fro, the rest itself becomes as independent as an ordinary one. The theoretical disadvantage is, the error of pitch resulting from the mode of working the levers; and I think it were as well not to trust so wholly to the grip of the hand upon the tool and rest to steady the former for its cut. Then comes that terrible item, the cost, which is £5 (or *was* £5, for I am not certain that the firm now make lathes for amateurs at all). Since writing my first article I have tried to determine the possibility of securing the above advantages, and also retaining the rack, and also the possibility of keeping the levers and component parts more out of the way. With regard to the latter, two courses appear open: one is, to place the lever behind, as in Cooke's; the other to place it over the sliding bar, which here forms the rest, but which might be made to support a small rest like that of the former. The drawing, Fig. 3, represents the apparatus with the lever arranged to stand above, instead of below, and so hinged as now to give a right-hand thread by the direct action of the mandrel. Provision is also made in this (which may be considered a practical appliance of the principle) for the drawing out the sole of the rest, P, to any desired extent, according to the varying character of the works required to be chased with a screw thread. The parts O, P, M, L, remain as before, but the hinge of the lever is a boss attached inside the frame, MM. The axis of the lever is, however, now extended to stand out behind, as will be more clearly understood from the enlarged view, R, T, U, and Q, which is an end view and section through the vertical dotted line, H O. R is the semi-circular cog-wheel, N, of the first figure, U the lever H, sliding by a boss, V, on the horizontal axle, T, which moves the wheel, N, to and fro. It can be clamped at any point on this axle by the screw, W. The necessity for this is caused by the fact that the lever, H, must always be in the same vertical plane with the axis of the mandrel, but at the same time it will be necessary to draw forward the sole, F, and frame, M N, in order to clear the work whatever may be its diameter. This is first to be done so as to bring the rest, S, in the right position. The arm, H or U, is then drawn along the axle, T, until it is in the same plane as the centre of the mandrel, and this will bring all parts

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* Since writing the above I have received the kind permission of Messrs. Cooke to describe their apparatus, and a paper thereon is in the hands of our editor, and will shortly appear in these pages.

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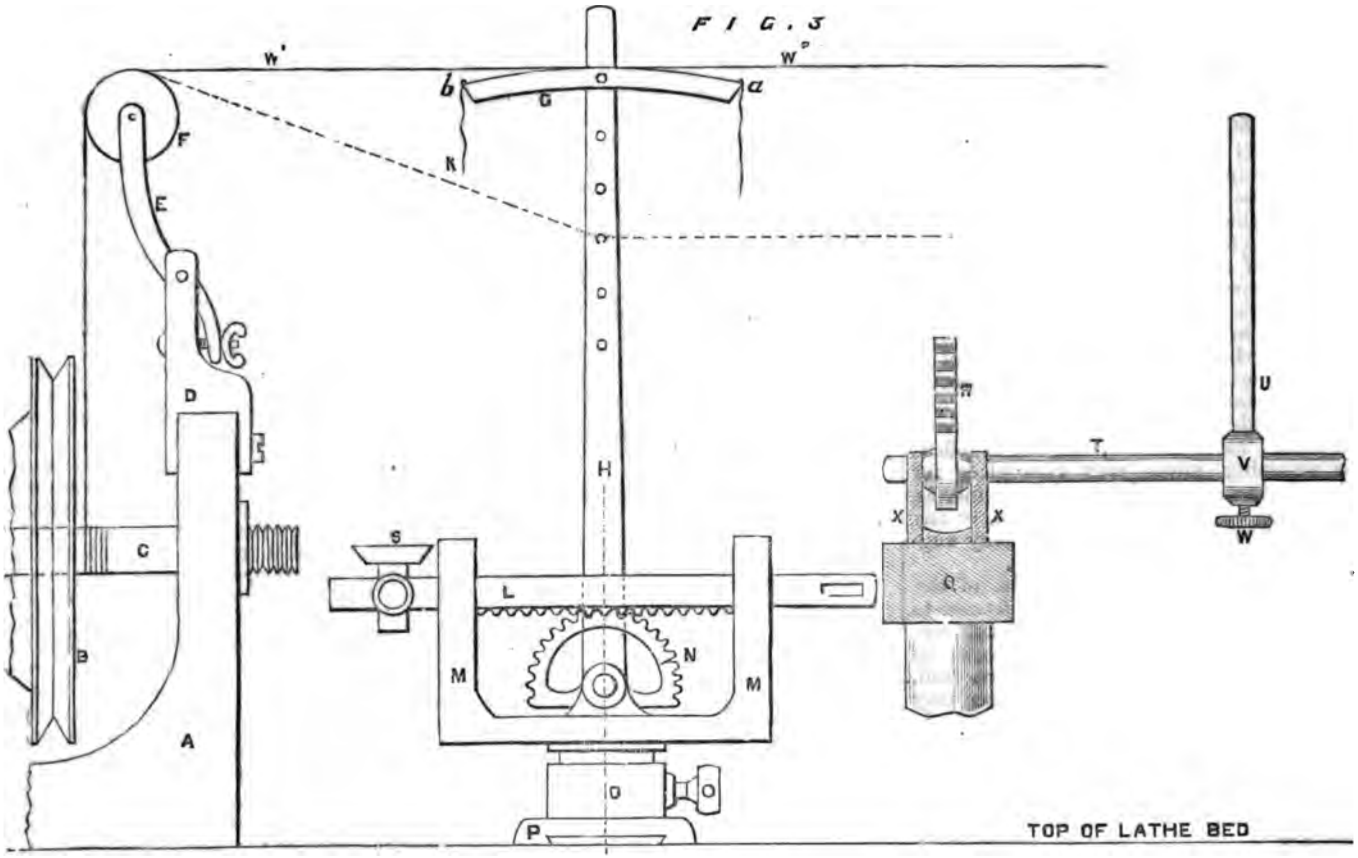
into position for work. The pitch will depend on the difference between the length of H and the diameter of the wheel, N, and the pitch will be uniform for the length of traverse. But I would also call attention to the fact that, *disregarding this uniformity*, alteration of pitch would also be made by bringing down the cord at an angle, K, as shown by the dotted line. The cord from the mandrel, W, is knotted to the peg, *a*, and W², which passes to a weight, is knotted to *b*, the ends being allowed to hang down. They will, of course, vary in length according to the position of the apparatus on the lathe-bed. At D I have shown a simple method of attaching the guide pulley, over which the cord passes, to the mandrel. The casting or forging, D, is made to fit over the head of the poppet, and is fixed thereto by a screw. A swinging arm, working in a slot in this casting, carries the pulley at its upper end, marked F, and a screw and thumb nut working in the end which is forked, allows the pulley to be raised or lowered to suit the position of the cord when the arc, G, is moved to different points on the arm of the lever. This cord should always pass horizontally from the pulley to the arc, or nearly so; but this does not matter much as regards the second cord, which goes to the weight—the latter, with its pulley, I have not shown. It is a simple matter to arrange a suitable plan, because it may go right away to the wall if necessary. Probably, I should fix against the wall at an intermediate height (about half that of the lever), a horizontal bar of half-inch iron, the length of the axle, T, or thereabout. The ends would be bent, and punched for screw-holes, so that the bar itself might stand out about a couple of inches. On this I should hang a pulley by a hook so that I could shift it along to any desired point, to suit the position of the cord, W². Nothing more elaborate appears to be necessary, and a pulley so slung adapts itself at once to the strain brought upon it by the cord and weight. As a means of further adapting the apparatus to a multiplicity of screw pitches, I have thought that if the under side of the square bar, L, was slotted, so as to allow the rack to imbed itself to about half its depth, a number of short lengths of different pitches might be kept and a selection made, each rack having, of course, a suitable segment to work into it. I have not shown any special way of attaching these segments—which, of course, must not slip round upon their axle, but the probable way would be by means of a little pin or feather inserted at that spot—this would be better than a clamping screw. To remove it the axle would then be simply pulled straight out of the boss and the bearings, X X,—a fresh segment (if more than one are to be used), held in position between X X and the axle re-inserted. The whole operation would hardly take a minute to accomplish. A flat may, with advantage, be filed underneath T for the set screw, W, to bed against. T should be turned down somewhat smaller where it passes through X X and the segment, so as to make a slight shoulder towards T. This arm should not be too slight so as to be liable to torsion, and all parts should be well fitted, and of sufficient strength. The actual size of the several pieces would depend on that of the lathe for which it is intended. I wish it to be distinctly understood that the apparatus is only designed for such light work in wood or brass as is generally done by means of the traversing mandrel, and not of screws in iron, which, nevertheless, may probably be lightly traced by its means sufficiently to give a start to the chasing tool.

FIG. 3



Before leaving the subject I may take one leaf out of Cooke's book with respect to the pulley, F, because it adds to the capabilities of the instrument. The cord from the mandrel may go to F, and take a few turns round it, being fastened to it, and then, from another part of it, a cord may go to the lever, H,—the pulley being made *stepped* as it is called, like the cone pulley of a power-lathe. This plan will, evidently, give other variations of pitch. Of course, every fishmonger cries up his own herrings, and this is, I think, fairly entitled to be called a "calla' herrin'," as it never, till now, has been planned in detail. So far as I can myself perceive, I think it has at least a claim to be tried and proven by some of your enthusiastic readers. If not, it may serve as a safety valve to the high-pressure screw-mania of theirs' faithfully, J. L.

TRANSATLANTIC STEAMERS.

AN interesting paper was read recently by Mr. Arthur J. Maginnis before the Liverpool Engineering Society, which, if expanded into a book, would undoubtedly have a considerable sale. It contained a brief history of the Transatlantic shipping lines and their steamships; and if, to the facts therein recorded, Mr. Maginnis would add the measurements of the vessels, and descriptions of their engines, his paper would be as valuable as it is interesting. The trade with the United States has prove to be the nursery of ocean steamships, an all the great improvements introduced int steam navigation since 1840 have been mad in connection with the Transatlantic liner Without attempting to settle the vexe question, as to the first steamer that crosse the Atlantic, we may point out that th Great Western was the first to demonstrat the possibility of employing steam vessel as regular traders. That ship left Brist at 10 a.m. on April 8, 1838, and arrived New York at 2 p.m. on April 23, with nearl 200 tons of coal still in her bunkers. Th voyage thus occupied, in round numbers, days, and it was considered that the quantit of fuel remaining left an ample margin for an delay that was likely to occur on the voyag Returning from New York on May 7, th run home occupied 14 days—the actual tim calculated by the work of the engines, bein only 13 days, as 24 hours were lost by sto page at sea. The Great Western was, w need scarcely say, a paddle-steamer (th screw propeller being in its infancy), and had a displacement of 2,300 tons; her length between perpendiculars was 212ft., with a breadth of 35ft. 4in., and a depth of 23ft. 2in. Including the paddle-boxes the breadth was nearly 60ft., for the floats alone were 10ft. wide. The Great Western continued running for some years, but it was in 1840 that what may be termed the first regular line was established by Mr. (afterwards Sir Samuel) Cunard. On July 4, 1840, the Britannia left Liverpool with the mails for Boston, which she reached on the 19th, the voyage occupying 14 days 8 hours. The Britannia was about the same size as the Great Western, and her success speedily led to the building of other vessels on the same lines. In 1843 the Great Britain, the first of the large steamers propelled by a screw, entered into the trade, and made some rapid passages; but it was not until the formation of the Collins' line that any remarkable advance in speed was made. That line commenced in 1849, and eclipsed all others in the magnificence of the fittings and the speed of their steamers—the Baltic in 1853, making the voyage from Queenstown to New York in 9 days 16½ hours. The first vessel of the line arrived at Liverpool on May 10, 1849, after a rapid passage, as it was considered, of 13 days. The rivalry between the Collins and the Cunard line led to the introduction of larger and more powerful vessels, and the duration of the voyage was gradually reduced until, in 1863, the Scotia, of the Cunard line, distanced all competitors by running home in 8 days 3 hours. Some years previous to that event, however, the Collins line had broken up, for in 1854 the Arctic was lost with 322 lives, and two years afterwards the Pacific sailed with 240 souls on board and was never heard of afterwards. The Cunard liners, either by the exercise of care and skill, or by good luck (a doubtful factor) had traversed the Atlantic with unfailing regularity—only one vessel, the Columbia, having been lost. That event took place on July 1st, 1844, at Nova Scotia, owing to a dense fog, but fortunately without any loss of life. It may be worth noting here, that since the commencement of the trade, the only vessels belonging to the Cunard line that have been lost were the Columbia and the Tripoli. The latter was stranded on the Tuskar rock, in 1873, but again fortune favoured the line, and passengers and mails were saved. Although the Collins line had a brief existence, the Cunarders were not left in possession of the trade, for in 1850 their largest and most powerful rival was established by Mr. Wm. Inman, the City of Glasgow being put on between Liverpool and Philadelphia. In 1854 that vessel sailed with 480 souls on board and was never heard of; but, notwithstanding this disaster, the Inman line continued to prosper, and in 1857, the Collins line having ceased to exist, they ran their steamers to New York instead of Philadelphia. Now commenced a rivalry that has continued to the present time—each new ship being expressly designed to beat the crack vessel of the other line, both in speed and in the comfort offered to the passengers. Up to 1867 the Scotia had made the most rapid voyages—at a large consumption of coal per ton of cargo, however,—but in that year the City of Paris beat the Scotia's best outward voyage by 33 minutes; and, two years afterwards, ran home in the then unprecedented time of 7 days 22 hours 3 minutes. Since then the Cunard Co. appear to have abandoned the struggle for the honour of making the most rapid passages, and are probably contented to rest their claims to public support on the unexampled security which passengers by their vessels have enjoyed during a period of more than 37 years. The average duration of the voyage during the first nine months of 1877 was, according to Mr. Maginnis, 10 days 58 minutes for the Cunard, and 8 days 21 hours 17 minutes for the Inman vessels on the outward voyage, and 9 days 7 hours 7 minutes as compared with 8 days 20 hours 36 minutes on the homeward voyage. The Inman line has, however, lost several vessels, the most memorable disaster being the supposed foundering of the City of Boston with 177 souls on board. In 1875 the Inman line, to eclipse the performances of the vessels of a rival company presently to be alluded to, constructed the City of Berlin, a vessel having the enormous length of 520ft. 6in., with a breadth of 44ft. 2in., and a depth of 37ft. 7in. With this vessel the fastest passages recorded up to 1875 were made, but after several voyages it was found that the hull required strengthening. Although the Scotia was a remarkably swift vessel, the results obtained by the use of the screw propeller in the Inman and other lines, led to the definite abandonment of the paddle, and large ocean steamers are now invariably propelled by the screw.

Passing over the smaller companies who made efforts to establish Transatlantic lines of steamships, we come to the Anchor line, which commenced by sending the Tempest from Glasgow to New York in 1856—a vessel that was lost the following year, presumably with all hands. Since 1863 the Anchor line has made steady progress, although six vessels have been lost, the recent additions to the fleet being amongst the largest in the Atlantic trade. The Allan line was established in 1854 to connect Liverpool with Canada direct, and since 1859 a weekly service has been maintained between this country and Quebec (or Portland). Owing, doubtless, to the dangerous nature of the voyage when nearing the American coast, the Allan line has had many disasters, in several instances happily unaccompanied by loss of life. The National line was established in 1864, and has carried on a regular traffic, so far, without the loss of life, although two vessels of the fleet have met with disaster. The steamers of this line have the credit of being well and strongly built, and, although Mr. Maginnis calls them slow, the outward and homeward voyages are accomplished, on the average, in 11 and 10 days respectively. In 1866 the Guion line was founded, and although so unfortunate as to lose three vessels and six lives, it is undoubtedly a successful line. We come now to what may be termed a new departure in the history of ocean steam navigation. Four years elapsed between the formation of the Guion line and the institution of the Oceanic Steam Navigation Company or White Star line, and people had begun to think that the Transatlantic trade was no longer a suitable field for enterprise. When, however, the Oceanic appeared in the Mersey, fresh from the hands of her builders, Messrs. Harland and Wolff, of Belfast, the older companies saw that they were threatened with the competition of a powerful rival. Instead of high bulwarks and narrow deck-houses, another iron deck was added with open railings for bulwarks, so that the water had free ingress and egress: the saloon was amidships, extending the full width of the vessel, while forward and aft, state-rooms were arranged along both sides, with extra large side-lights, giving so bright and airy an appearance to the cabins that intending passengers had little hesitation in taking up berths. The engines, too, were of a type then untried in the Atlantic trade, being inverted direct-acting surface-condensing compounds, so arranged that, in the event of a break-down, any one cylinder might be utilised to keep the propeller in motion. In 1872 the Adriatic made the passage out in 7 days 23 hours 17 minutes. and the next year the Baltic came home in 7 days 20 hours 9 minutes, the then fastest passages on record. In 1873 the Atlantic was lost near Halifax, and 545 human beings perished with her—the most serious wreck in the whole history of Transatlantic navigation, and one that gave rise to considerable discussion as to the safety of very long ships —or, what is more correct, vessels of narrow beam and shallow depth in proportion to their length. It must be confessed that to the enterprise of the White Star line passengers owe whatever recent improvements have been introduced into the vessels of other lines. The average duration of the voyage with the White Star steamers in the first nine months of 1877 was 8 days 13 hours 39 minutes on the outward voyage, and 8 days 10 hours 30 minutes on the homeward run—a result mainly due to the remarkable passages of the Germanic and Britannic, the latter of which has accomplished the outward run in 7 days 10 hours 53 minutes.

The Dominion line was established in 1872, to run between Liverpool and New Orleans, but it has had the misfortune to lose two vessels. About the same time the American Steamship Company was founded to ply between Philadelphia and Liverpool; and shortly afterwards the State line commenced to run between Glasgow and New York. In 1874 the old Great Western line between Bristol and New York was resuscitated, and the traffic is now regular but at long intervals; in 1875 the Warren line again commenced the trade to Boston, and soon afterwards the Wilson line between Hull and New York was founded. The latter, however, met with a heavy disaster in the loss of the Colombo, which has never been heard of since she sailed in 1877. The Beaver line also started in 1875 between Liverpool and Quebec, and the latest, but not least of the lines, the Leyland, commenced a regular trade between Liverpool and Boston in 1876. The vessels of this company are of the same type as those of the White Star line, and are fitted with four cylinder compound engines. The usefulness of the latter introduction is seen in the figures which represent the coal consumption of three typical vessels, the

	Duration of Voyage.			Coals consumed.	Coal per ton of Cargo.	Average speed.	Coal per i. h.p.
	d.	h.	m.	tons.	cwt.	knots.	lb.
Scotia (1866) ...	8	4	54	1,305	18·5	14·5	3·6
City of Paris (1867)	8	4	1	816·6	9·6	13·8	3·3
Britannic (1877) ...	7	10	53	745·6	4·5	15·6	1·9

The Scotia was a larger vessel than the City of Paris, and the Britannic is larger than the Scotia; but the consumption of coal per indicated-horse power, shows the advantage of the compound system as much as the superiority of the lines of the Britannic, for the indicated horse-power of the Scotia was 4,200, while that of the Britannic was 4,920, the engines of the City of Paris developing only 2,800.

Since 1840 56 vessels have been lost, and 29 involved the loss of life. At the present time the British fleet comprises 125 steamers, 18 of which, with a tonnage of 49,710, belong to the Cunard line; 18, with a tonnage of 52,650, to the Allan line; 12, with a tonnage of 50,382, to the National; 11, with a tonnage of 39,973, to the Inman; and 9, with a tonnage of 34,213, to the White Star. The Anchor line has 14 vessels. with 34,799 tons, and the Leyland line has 6 with a tonnage of 17,946; while amongst the foreign lines the Hamburg-American comes first, with 16 vessels and a tonnage of 51,034, closely followed by the N. German Lloyd's with 16 vessels and 46,361 tons. The French line has 10 vessels, with 39,325 tons; The two Dutch companies own 10 steamers, having a tonnage of 26,427, and the American line has 5 vessels, with a tonnage of 15,798. As some idea of the speed of the vessels, it may be mentioned that last April the Germanic, going west, made 410 knots in a day of 24 hours 55 minutes, and, coming east, in October last 394 knots were made in a day of 23 hours 26 minutes, at the rate respectively of 19¼ and 19¾ miles per hour.

Mr. Maginnis would, we imagine, earn the thanks of shipbuilders, engineers, and others, if, taking his paper as a nucleus, he gave to the world all the available data about ocean-going steamers, their style of build, and dimensions, with comparative diagrams, description of engines and boilers, and authentic figures as to coal consumption. These data should embrace those appertaining to the foreign lines if possible, and, for the sake of comparison, the figures relating to the P. and O. vessels, and the Cape and Australian lines should be added to those obtained from the Transatlantic companies. An important item in these details would be the amounts expended on repairs, for it is certain that long vessels driven at high speeds through rough seas must be severely strained, and cost more in repairs than shorter and perhaps slower ships. But such information, tending to show what is the best method of construction, would be of much value, and hasten the further improvement of the ocean-going steamer.

CANOES AND CANOEING.

By a Member of the Royal Canoe Club.

SEVERAL readers of this journal having written me in reference to the above subject, I have decided to write a short series of articles on the matter, which will assist those who intend going in for this most pleasant mode of travelling, in building or procuring a good useful canoe suitable for general use.

We are indebted to Mr. MacGregor for the first useful canoe introduced into this country, his type of boat being well known to most canoeing men under the name of a "Rob Roy." His travels and adventures are fully described in his three well-known works, "Rob on the Baltic," "Rob Roy on the Jordan," and "1,000 Miles in a Rob Roy Canoe." The publication of these works gave an impulse to canoeing, and in 1866 a few gentlemen combined together and formed the Canoe Club, which has now 500 members on its list, H.R.H. the Prince of Wales being commodore, and Mr. MacGregor captain. There are also clubs established on the Clyde, Humber, Mersey, Trent, and other places, the members having made cruises on nearly every river and lake in this country as well as many of those on the Continent. There are several classes of canoes—light racing, travelling, and sailing or cruising canoes. The first I shall dismiss with a few words. They are generally built of thin cedar, with canvas decks, having a length of from 18ft. to 24ft., and a depth of 7in. to 9in., with a beam of 15in. to 24in. Several of these may be seen at Cambridge. Under the second we may class the Rob Roy and Ringleader, and under the third we place the best type of canoe extant—the Nautilus—with its various modifications, as now used by the majority of the members of the various clubs.

Canoes must be strong, to bear the various knocks and shocks inevitable in loading on railway trucks, steamboats, carts, &c., and more especially the rocks and shallow places met with on many rivers and parts of the coast. They must be light, to enable the paddler to drag them over obstacles often encountered during a voyage. Handy to manage on a rapid stream, or when paddling to windward, or sailing before a stiff breeze, and at the same time of a convenient size, to carry its owner and a supply of food, stores, and luggage when on a journey, and not longer than will go on a railway carriage if required. One great advantage of a canoe over a yacht is its moderate expense. A good oak cruising canoe, with all fittings of the most luxurious kind, may be bought for £15, complete in every detail; while one for paddling only may be had for £7 or £8. The latter kind will be found very useful for paddling about on inland rivers and streams.

I would advise all would-be canoeists to learn to swim before going in for canoeing, as a capsize may occur at any time, although in a well-constructed canoe, and with moderate care, such a thing need not take place. To derive the greatest amount of pleasure from a cruise the canoeist should possess a muscular body, presence of mind, an aptitude for cruising and camping out, and—what is more necessary than these—a perfect canoe, complete with all its sails, gear, stores, and fittings.

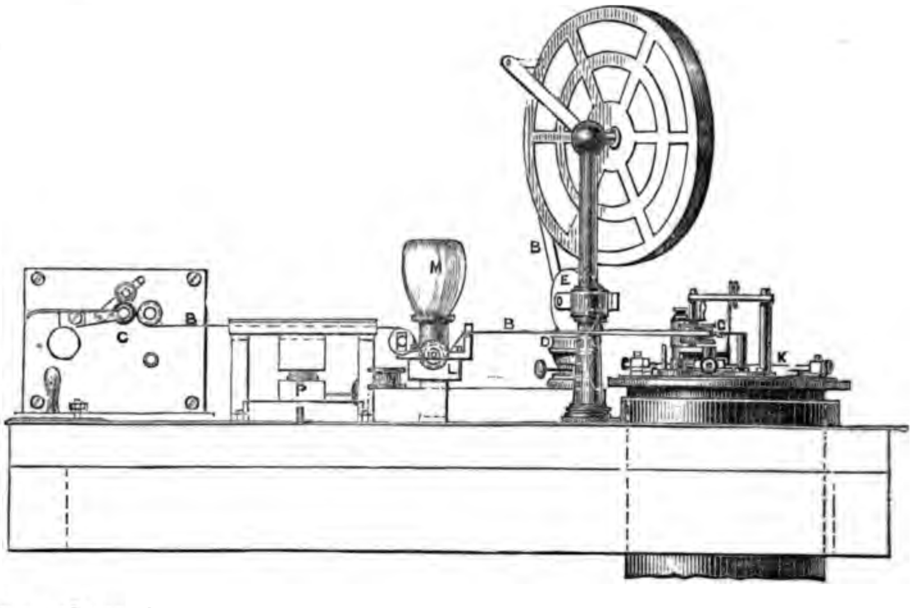
Every one should carefully consider—1. What he requires his canoe for before he commences to build. 2. The different kinds of wood. Many kinds may be selected for the purpose, bearing in mind that the shape, size, use, and weight of each must be considered in connection with the different qualities required in a travelling canoe. 3. Sailing powers, in bad as well as fine weather, good shear, water-tight compartments, and ballast forming a life-boat. 4. Sails—that may be set, reefed, or taken in without leaving the seat. 5. Strength—to bear lifting in all parts, bumping on rocks, and sleeping in her. 6. Weight—as light as possible, light draught of water for shallows, &c. For hard work and knocking about oak is by far the best; but if weight is a consideration some other wood may be used. The relative weight of woods used in canoe-building are as follows, cubes of each kind exactly equal in size being weighed:—Oak, 12lb.; yellow deal, 11lb.; cedar, 7lb.; and mahogany, 10lb. So that a canoe built of oak would weigh nearly double that of a cedar one.

(*To be continued.*)

RECORDING TELEGRAPHIC SIGNALS.

A METHOD of recording telegraphic signals, the invention of Dr. E. W. Siemens, of Berlin, has been recently patented in this country. The improvements consist in the utilisation of the principle on which an otherwise straight line traced upon paper is made to deviate from side to side when the current is passed, according to the signals sent. According to the present invention the paper strip has its surface on which the style acts, blackened with finely divided carbonaceous matter, such as that deposited from smoke, so that as it is passed under the style the point of the latter, by removing the carbon along its line of contact, produces a white line (that is, a line of the same colour as the paper) on the blackened surface. For the purpose of blacking the paper it is passed over a smoking flame, and to prevent it from being ignited or charred during its passage over the flame, it is kept in close contact with a cylinder of metal or other good conductor of heat. In order to fix the carbon coating on the paper strip after the line or signal has been traced thereon, so as to render the record permanent, the paper strip is treated with alcohol, ether, or other liquid, it being for this purpose passed under a cylinder which dips into a bath of such liquid. It is preferred to dissolve some resinous or glutinous substance in the said liquid in order more effectually to fix the carbon coating; and in order to accelerate the drying of the paper strip after it has been so treated, it may be passed over a wire gauze or other surface heated by a flame. The movements of the style may be produced in any known manner.

It may, for example, be attached to the tongue of a relay, or to a coil suspended in a circular magnetic field. When the style is moved by a coil in a circular magnetic field, it is preferred, for the sake of lightness, to make the coil of aluminium, which is suspended by a spiral spring, and in order to bring the coil rapidly back to the position of rest, and to prevent its lateral oscillations, elastic strings are stretched horizontally through the point at which the coil is attached to the spring, these strings serving as conductors for the coil.



The figure represents a side view of a telegraphic receiving instrument, showing the course of the paper strip through the apparatus. The continuous paper strip, B, is drawn from the reel and through the instrument by the ordinary clockwork, C. In its course from the reel it first passes over the smoking flame of a lamp, D, above which is mounted the metal roller, E, to prevent the over heating and scorching of the paper. The paper then is led over a roller, F, between it and the tracing style, G, which is attached to a bobbin preferably of aluminium wire, suspended in an annular magnetic field by a helical spring. (That part of the coil which is beneath the table is not shown.) In order to centre and steady the bobbin, two cross wires, K K, stretched by adjusting screws, are attached to it, and these wires serve as conductors. When electric impulses are transmitted through them and the coil of the bobbin, the latter is caused to move upwards or downwards in the magnetic field, and the tracing point, G, attached to it marks on the blackened paper, B, a wave-line. From the roller, E, the paper is led under a roller through a vessel, L, containing fixing liquid, which vessel is kept charged by a fountain glass, M. The paper having thus been moistened is dried by being passed over the flame, P, of a lamp, between which and the paper there is a screen of wire gauze. Although the movement of the tracing style, G, has been described to be effected by the action of a bobbin in an annular magnetic field, it is obvious that, the apparatus generally remaining as described, other known means of giving the tracing style up-and-down movement in obedience to electric impulses might be employed.

The sense of smell has long been acknowledged as an aid in diagnosis. Dr. Dupuy, of New York, remarks that patients having tubercular meningitis emit an odour closely resembling wet linen. The odour in tetanus is like that of a wet cloth.

THE WATCH, AND HOW TO REPAIR IT.

By Seconds' Practical Watchmaker.

(Continued from page 501, *Vol. XXV.)*

SINCE the last contribution to the English Mechanic on the above-named subject, several circumstances have occurred through which a continuance of the subject has been unavoidably deferred; and, although it was stated that the subject to follow would be the "Lever Escapement," I beg the indulgence of our readers until a few more general points have been introduced.

Hour-hand Traverses Irregularly.

Occasionally the hour-hand gets wrong, and although the fault generally is it being too easy on the hour wheel socket, other causes occasionally occur—namely, a tooth having been broken from the hour or minute wheel, and also a leaf of the cannon-pinion may be broken out. But there are instances in which, although a tooth may be broken out of the minute-wheel or the cannon-pinion, the hands will travel correctly. If a cannon-pinion of *twelve* leaves has one of them broken out the action in the minute-wheel will carry the hands without it being known; whereas, a pinion of *ten* leaves will not act, whereby the hour-hand will not point as it should.

Again, a cannon-pinion with *ten* leaves will act in a minute-wheel if that wheel has one of its teeth broken out. But when a minute-wheel is perfect, and its cannon-pinion (of *ten*) has one of its leaves broken out, the hands may continue to move, but they will not point correctly (the hour-hand will be in error). But, although *damaged* wheels are apparently defended, all wheels to watches should be sound and perfect.

Geneva watches occasionally err in the matter of the hands not corresponding, which sometimes is caused by one of the "motion wheels" having been applied of a wrong number of teeth in it. The following table of numbers suitable to various circumstances may be useful to workmen generally.

Trains of Motion Works.

Cannon Pinion.	8	10	10	10	10	12	12	12	12	14	14	14	16	16
Minute-wheel Pinion.	6	8	12	14	16	12	14	16	18	14	16	18	16	18
Minute-wheel.	24	30	40	42	48	48	48	48	54	56	56	56	64	64
Hour-wheel.	24	32	36	40	40	36	42	48	48	42	48	54	48	54

These trains are worked in the following manner. Take the first series, and multiply the cannon-pinion by *three*—twenty-four being the number of teeth suitable for the minute-wheel; next multiply the minute-wheel pinion of six by *four*, which, being equal to twenty-four also (because four times three are twelve, the number of hours to complete the circle of twelve), produces the number suitable for the teeth of the hour-wheel. It may be added that the nearer the numbers of the teeth in the two wheels approximate the better. Now examine the third series, and multiply the cannon-pinion of ten by four, which is equal to 40, as the number suitable for the teeth of the minute-wheel; and then, as the minute-wheel pinion has twelve leaves, multiply them by three, which is equal to 36, being the number necessary for the hour-wheel teeth—because, as in the previous case, four times three are twelve.

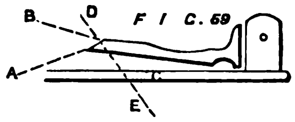
The hour-hand of a watch may be in error as regards pointing correspondingly with the minute-hand through other defects in addition to the preceding—such as excess of end-shake of the hour-wheel—the hour-wheel out of flat—a minute-wheel pinion having one leaf below the rest, whereby the hour-wheel in its revolutions passes over it; hence the disagreement of the regularity of the hour and minute-hands of a watch.

Verge Watch Catch on the Lower Pallet.

If balance-wheel teeth catch on the lower pallet, and that pallet be wider than the upper one, at the same time the balance-wheel teeth drop more on the lower than they do on the upper pallet, it becomes necessary to press the dovetail further through; but if the end of it is within the wheel, and cannot be reached by any tool so as to press it as required, the lower pallet may be made a trifle narrower, by doing which the defect will be remedied, the drop of the teeth from the lower to the upper pallet will be effected earlier, more drop upon the upper pallet, and hence a more equal escapement. But, in the event of the lower pallet being the same breadth as the upper one, the watch should be taken to pieces, and the dovetail pressed further through to make the wheel's teeth drop more equally on each pallet. If a difference in the amount of "drop" be recognised, it should be more *from* the upper *to* the lower pallet.

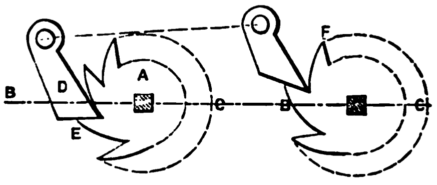
Verge Pivots, Putting In.

Pivots to verges are worked in in various ways by different workmen; but, whatever method is employed, one point in the manipulation is important to keep in view—viz., that the truth of the circular character of the balance be insured, for, if not, a deal of time is frequently expended in completing the watch to "keep time," inasmuch, if the balance be "thrown out of round," through the new pivot not being central and perpendicular to the verge body, the balance will be "out of weight" at one part, and necessarily has to be filed away in order that it be in equilibrium, which reduces it in weight; and hence the "pendulum spring," if little or no excess of length remains, necessitates a new one, whereas, if workmen insure centring the steel plug so that the *ball* of the balance is quite *flat*, its equilibrium—sufficient for practical purposes—will be insured. Some workmen "centre" the steel plug so that the balance *rim* revolves somewhat flat, giving no attention to the *ball* or centre of the balance; such method ends in producing unsightly as well as unprofitable work.



F I C. 59

F I C. 60



Winding-stop and Spring Action.

The winding "stop work" which is generally applied to English watches in many instances is made and fitted so carelessly as to be the cause of the chain—and occasionally the mainspring—breaking. How often has the jobber to wish that the stop and its spring were supplanted by some other arrangement, because of its frequent failure? It often fails to act from having excessive shake or freedom of its blade in the notch of its stud, the blade having been filed too thin; the result being that when the point of the fusee-cap is—by the act of winding—presented to the end of the stop, instead of the cap abutting against it only slight contact is made, and in consequence of defective form of the end of the stop, the fusee cap presses it on one side, allowing the further winding up of the fusee, breaking of the chain, and not unfrequently the balance-staff also. The proper shape of the end of a stop is seldom, if ever, thought of. It should be so shaped that when the fusee cap end is in contact with it, that it should be drawn by the cap towards the fusee; at the same time, when the pressure by the act of winding is at its greatest, such pressure should cause the stop to go nearer to the upper plate, irrespective of the means resulting from the chain. Fig. 59 represents a side view of a stop in relative position to the upper plate, C, when the chain has no action upon it. The end, A B, of the stop being sloped downward towards the left hand it may be assumed that when the point of the fusee cap comes in contact with the end at A, by continued pressure (as is the case in the act of winding) there will be a tendency for the stop to be forced towards the upper plate, thereby insuring a safe abutment of the cap; whereas, if the end of the stop were formed as represented by the dotted line, D E—all conditions being similar—the stop would be pressed from the plate, and thereby the fusee cap would pass it—the result being overwinding and breaking of the chain.

There is yet another important adjunct to the stop—namely, its spring—which serves an important part in the safety action of winding up a watch. Such spring requires little explanation to the general workman. It should have attention directed to it so that its action insures the perfect uplifting of the stop. If this spring be close to the stud, failure of the stop rising may ensue; it should be clear of it, well curved upward, passing under the stop, but not projecting beyond it so far that its end is close to the pillar-hole of the plate. Should it be much beyond the breadth of the stop there will be danger of the pillar-seat pressing it when the plate is pinned on, and thereby the spring action destroyed.

There is another fault in the form of the stop which workmen frequently have to alter—namely, the omission of forming a hollow, or bevel, on that side of it which the fusee cap in its unwinding action should be aided in passing under, for it occasionally happens that when the hollow or bevel is not formed at the side referred to, the edge of the fusee cap abuts against its side instead of freely passing under it; in some instances the watch will stop, and in others an impediment is presented which prevents the free action of the fusee.

Another fault to be pointed out as a defective "stop work" is a twofold one. When the channel or hollow in the upper plate is so formed that the stop does not freely get pressed into it by the act of winding, and has to be bent more towards the fusee to enable it to go close to the bottom of it, there is danger of the chain in unwinding pressing against the edge of the stop, and there being bound; because the stop, having been forced into the channel at the time of winding, is prevented being released by reason of its opposite side (opposite to the chain) being pressed against the wall—if the term may be used—of the channel from which it had been previously bent to allow of its depression by means of the chain. Watches having this last-cited fault have proved troublesome to young practitioners, occasioned chiefly from the fact that they omitted to try the stop-work—more especially the adjustment of the mainspring; had such been tested the defect might have then been detected.

Mainspring Breaking.

Various are the causes assigned for the breaking of mainsprings. Among the number there is one which every workman should prevent, because it is through his negligence if it occurs. The cause here referred to is connected with the barrel ratchet and click (Fig. 60). This figure is intended to show the barrel ratchet, A, with its click, D, in such a position as should be to insure a sound setting up of the mainspring, inasmuch that the bottom of the click, D (being secured by its screw), presents resistance to the advance of the ratchet, A, beyond the base of the click. It very often occurs that the click—although planted properly when first applied (as at D)—by occasional repairing becomes shorter, whereby, instead of its base, E, being in position to resist the advance of the ratchet, becomes formed as the dotted line click F, and thereby the mainspring power has the tendency of forcing the ratchet so that the shortened click is turned over, which results in the mainspring suddenly releasing itself from tension, by which, in most instances, the spring becomes broken. Again, it is no uncommon occurrence that a mainspring becomes broken by it suddenly being released from tension in consequence of the click, D, being thrown out of action by the click screw, through "overturning," giving way. Therefore, the click screw should be left sound and screwed down, so as to secure the click in its final position, and thus insure the security of the barrel ratchet and the mainspring from breaking.

"Falling-off" of "Crossing on the Foot."

Such defect is common to all kinds of watches where a dovetailed piece is employed to form the surface on which the end of the lower pivot of the balance-staff acts. There are several causes of which there are three which require pointing out to the general workman. It will not be sufficient to know that the pivot fits the hole properly, and that it projects beyond its surface. Neither will the free vibratory motion of the balance be insured because the jewel of the dovetail is smooth and central; the perfectly *close fitting of the dovetail* to the jewel-hole must be insured, else the end of the pivot may not act on the surface of the dovetail, and in such a case the shoulder of the pivot would be acting on the chamfer of the hole—thereby the diminution of force vibration of the balance.

The next defect to be noticed is one of very frequent occurrence among young hands—namely, applying too much oil to the sinks (or chamfers) of the pivot-holes—especially the centre-wheel, when the balance is very near to the upper plate—in which case a bar of the balance may become oiled, or the balance-rims may also take oil from the fourth wheel chamfer. Under such conditions instances occur that very minute particles of fibrous matter adhere to the oil, and in some positions of the watch catch or rub the sharp edges of the barrel-hollow or the surface of the upper plate; the defect being augmented by the jewel-hole, or both, being too large for their respective pivots. Remedy.—Raise the balance, and, if necessary, put new hole.

The last of the three defects is that referring more particularly to half and three-quarter plate arrangements, which have circular end-pieces instead of the dovetail slip. The circular end-piece has one disadvantage connected with it—namely, that the bearing and action of the pivot end is always on the same place; consequently the smooth surface is more quickly worn; whereas, the dovetail slip, when replaced after cleaning, seldom has the same surface for the pivot end to act upon. Therefore, the indent, or worn end-piece, is often a cause of the falling off of the crossing. These remarks apply equally to the opposite end-piece. An end-stone that is cracked or deeply scratched must be considered more worthless than the preceding.

Depth of Verge and Follower Holes.

These holes should never be left deep—*i.e.*, long—as such add greatly to the loss of power and freedom of action in the escapement; they should be half as deep as the pivots are in length, and the length of such pivots should be rather more than half the thickness of an ordinary upper plate.

Pendulum Spring a Cause of "Falling Off of Crossing."

If the mainspring is the life of a watch the pendulum spring may be considered the soul of it, and hence any imperfection in the latter materially impedes the regularity of its timekeeping. The want of freedom of the inner coil round its colet, the coil rubbing the pendulum-spring stud, coils in contact with each other, the spring cut of flat and slightly touching an arm of the balance or the cock—are faults all of which are fatal to even "fair" timekeeping, and more or less prevent the free action of the balance; yet there are two other points connected with this spring which deserve special recognition—namely, in the verge watch when its spring is a little out of flat and the balance near the slide, at the same time the slide is a thin one, it generally occurs that the *inside* piece of the index is nearly as thick as its slide. It occasionally happens that workmen, in striving to free the pendulum spring of the balance, keep it as low down in the slide as possible, whereby, while the balance is in a state of rest, the spring is free of the curb-pins piece, but when in action the distorted coil will rub upon that piece, and, although but slightly, prevent the free vibrations of the balance; and when the watch is reversed in position—*i.e.*, the dial upward—in consequence of the verge end-shake, full and free vibrations result. Some of the preceding remarks equally apply to the lever watch. There is one analogous case—namely, the pendulum-spring, under similar conditions to such as the last-named one, becomes foul of that portion of the over-sprung index which is over the spring, from the curb-pins towards the ring of it—*i.e.*, towards the cock. Although this latter defect may not be noticed when the watch is held with its dial downward, the falling off will be evident when the position is reversed. Remedy.—Remove the pendulum-spring, place the colet with its spring upon an arbor, place it in the turns, and make it circular and flat by means of a small rigid pointer.

THE ORGAN: A COMPREHENSIVE TREATISE ON ITS MANUFACTURE, PROCURAL, AND LODGMENT.*

By John Watson Warman,

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PART I.—GENERAL TREATMENT IN MANUFACTURE.

s. A SIMPLE illustration will make this perfectly clear; take an ordinary Compound Horizontal Bellows, its Feeder 3 × 6, and by its side two of the old Diagonal species *each* 3 × 6, the *drop* in the former and the *sink* in the latter being the same, say 6in. Now give a stroke with the Feeder, and at same time raise one of the Diagonals, the wind admitted will be same in both cases, but more power will be required with the former, because there is the dead-weight of the Feeder-board to raise *in addition* to that giving the actual pressure. The Feeder must now, before it can give a second stroke, be allowed to drop, and during this the second Diagonal can easily be raised, thus at once bringing the amount in the Diagonals up to double that in the Receiver; by the time the Feeder is ready for its second stroke the first Diagonal can be again raised, and so on continually, the Diagonals being thus able to supply, so far as time is concerned, *double* the amount given by the Feeder; it must, therefore, follow logically that, so far as the mere obtaining of a certain amount of wind in a given time, and with a given expenditure of constructive labour, the Compound Bellows is *a long way behind* the old Diagonals.

t. But this, bear in mind, is not a fair comparison; the element of blowing labour must be taken into account, and in this view the Diagonals, of course, lose much of their advantage, for it is clear that in example just given nearly double driving *power* will be required. But many organs are so small that the labour of blowing is very light indeed, and practically the Blowist will feel no more inconvenience or fatigue if his up-stroke be converted into one of the same resistance as the down (the latter remaining unlightened); this advantage, of course, ceases as organ *enlarges*. And, in addition, with a single Feeder uncounterpoised, a palpable advantage will remain to the Diagonals, for the dead-weight of the entire Feeder, with its necessary bracings, is inevitably a serious item; in the Diagonal every particle of this assists in the actual pressure produced. Besides this there is some labour involved even in the descent of the single Feeder, for obviously the hand cannot even remain grasping a moving handle without some wear of the muscles going on. These two points are instanced as matters of information; both, of course, lose their force when the Feeder is cut into two, as the dead-weight of one assists in the actuation of the other, and there is also no "blank" stroke. Still, remember the friction is greater (either with two Feeders or one Counterpoised) than with the Diagonals.

u. Practically it comes to this, *at least* as large an amount of wind can be supplied—with a given *area, time, power,* and *expenditure* of construction and *material*—with two Diagonals as with a single Compound Bellows, and this undoubtedly accounts for the former design lingering so long among the Germans (*see* Hopkins, Para. 26), who are generally supposed to know what they are about in organ matters; and, considering the very strong admiration—to use no stronger term—expressed for these builders by this writer throughout the whole of his volume, it is rather surprising he did not pause before making a statement so extraordinary.

v. An exemplification of the truth of this comparison of the relative merits of the two forms is furnished in the case of the alterations made in the Chichester Cathedral organ, which Mr. Hopkins himself narrates at page 545 (1st edition). This instrument had originally two Diagonal Bellows. Their size is not given; but "in 1829 Pilcher . . . . put in new Horizontal Bellows, using the old Diagonals as the two Feeders;" and, although the organ had, since its original construction, received the additions of a Trumpet, a second Open Diapason, a II-rank Mixture to the Great, a Pedal Clavier, Great and Choir made "long octaves," besides a set of Unison Pedal Pipes by Pilcher himself (I do not include the new Choir by Byfield, as it was not capable of uniting to Great or Swell—for the same reason the Swell of 8 Stops is not reckoned, the Coupler Swell to Great not at that time existing), yet we hear nothing of shortness of wind; and it was not until 1844, when a Swell to Great and a set of *Double* Open Pedal Pipes to FFFF was added by Gray and Davison, that a second Bellows was provided; and this would then be desirable under any circumstances.

w. It will thus be seen, as already said, that two Diagonal Bellows of *given area* and use are equal to Compound Bellows having a Feeder of *equivalent area* and drop to the *united Diagonals*; and as there is, as in the preceding case, the *entire work of the Receiver* extra, the reason why some builders have refused to abandon the earlier type is at once apparent.

x. It will now be asked, What, then, if any, is the real superiority of the Compound? The answer is very simple—viz., in its *compactness, facility of actuation,* and *compensating qualities.* A few words on each will be sufficient.

y. As regards *compactness,* the old Diagonals were generally placed side by side, thus taking up a great deal of room; and although the wind supplied was, as we have seen, quite equivalent to a Compound Bellows of same area, and the total of room occupied considerably less, yet it would obviously be generally better to occupy a little more room on elevation with less on plan; besides, the *Double-action Feeder,* impracticable with Diagonals, furnishes an excellent means of economising area; then, again, two Trunks are of course always required. It is true that one Diagonal could be placed over the other, but this does not much mend matters: a considerable space, only *half* of which can be made use of, must be left between Bellows, and their convenience for Blowing is also impaired. This latter brings us to next.

z. The Diagonals in all cases require for their *actuation* a Blowing-beam and two Tugs or Connecting Rods; in addition to this, care must be taken that the Levers, &c., are perfectly free during the descent of the corresponding Bellows; if the latter be placed one over the other the complication of the Blowing is further increased by the necessity for additional arms, &c. With the Compound Bellows—even with two Feeders if of the Cuckoo kind—a simple Lever and Rod are all required, and under no circumstances whatever is the relinquishing of the Actuator demanded. (*See* 5, d. on.)

[5. a] But it is in *compensation,* or evenness of supply, that the Compound possesses its great advantage. It will be evident that the inward folding of the Ribs of the Diagonals will produce a stronger wind as the Board descends; this could, of course, be partially remedied by making one or half of the Diagonals with inverted rib; but it is clear the compensation secured by this would be in suspension during the raising of a Bellows, and the expedient of two *folds, one* of them inverted, does not seem to have been thought of, though quite practicable. A rough kind of compensation was, therefore, attempted by giving the middle board such a *slant* that the upper board in descending became *deflected* to such an amount that the *departure* from true Verticity (and consequent *diminution* of direct downward pressure) would *make up* for the increased density caused by the intrusion of the folds. But it is manifest that such an arrangement would demand an accurate adjustment of deflection to width of rib, such as is by no means practically easy even to calculate, and then structural difficulties might arise to prevent the carrying out. The expedient of a spring (*see* Hopkins, par. 39) is manifestly an imperfect and, to some extent, variable and treacherous one.

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b. Now arose the Horizontal Receiver figured by Dr. Rimbault on page 34 of his "History" (first edition): still, the inequality by rib entry was as great, or, rather, greater than before; and a second fold, with inverted rib, would be necessary to each Reservoir to render supply absolutely uniform.

c. A pair of Receivers so constructed would, in fact, give a very excellent supply, occupy *less* room on *elevation* and *no more* on plan than a Compound Bellows, and undoubtedly be lighter to actuate, as (as already pointed out) *either* the friction or dead weight of the entire Feeder is saved.

d. Seeing this, therefore, and considering that the Receiver will require little if any bracing, the *entire* cost of the Feeder thus saved (to say nothing of the Escape Valve ditto, this now being considered fully balanced by the extra Ribbing involved in having two Reservoirs), it would seem that the Compound is the inferior form; but there remain three disadvantages with the Simple—viz., the chance of non-agreement or disturbance in *identity* of pressure of the different Bellows; the impracticability (satisfactorily) of the expedient of *Double-action*; and the *elaboration* and necessity of *relinquishment*—either in Action or Blowist—in the *Feeding*. The elaboration is practically serious, as, in place of a simple Rod and protruding Lug either very strong double-armed Trundels must be constructed or a Lever *over* the Receiver must be permitted; either of these is in practice often extremely inconvenient. The *relinquishment* is also a point of practical importance. The chance of *non-agreement* may, perhaps, be considered of less moment.

e. I have gone at such length into the question of the relative merits of the Simple and Compound forms—first, because very erroneous ideas are entertained as to the amount of the superiority of the latter; second, because it affords an opportunity of clearly exhibiting the real state of Mr. Hopkins's knowledge with respect to this very important portion of the instrument; third, because of the necessity of starting with a correct type.

f. I have said what I have, notwithstanding, or rather *in consequence of*, the high position Mr. Hopkins deservedly enjoys as an organist, musician, and composer; error is never so mischievous as when propagated by one who is entitled to authority on other grounds, and it cannot be otherwise than harmful, and exceedingly harmful, to the highest interests of the art of organ-building that a person even *capable* of falling into so gross a blunder (it is not as though it stood alone) as estimating the supplying power of a Compound Bellows by the cubical capacity of its Receiver should be received and quoted as an authority on organ structure; and for no better reason apparently than that he has found time to put forth a work of some 581 pages, of the accuracy of which (so far as the structural portion is concerned) the foregoing may be considered a fair specimen.

g. A few examples will show how the *sound* and *bulk* of Mr. Hopkins's work have, apparently, impressed some constituents of the Organ-loving world. Thus, in Rimbault's *preface* to the "History," we have "Mr. Hopkins's . . . intimate acquaintance with his subject." Shepherdson says (page 30), "Mr. E. J. Hopkins . . . displays that acquaintance with the construction of the Instrument which constitutes him a great authority." These are amateurs. Mr. Bishop, jun., unable truthfully, to speak of the book in such terms as these, yet calls it (page 22) a "comprehensive work," and then proceeds to quote verbatim the greater portion of page 73 (first edition), in which Mr. Hopkins dilates—quite unnecessarily by the way—on the superiority of the metal Tin. I request the reader to notice that Mr. Bishop, on page 20, states that the firm to which he belongs never uses a lower standard than 25 per cent., or one quarter, of Tin. It is only just to Messrs. Bishop to observe that such a standard, though considerably lower than the minimum of some English builders, is yet *as* a minimum (and, indeed, preferably for some Registers) an exceedingly good one, and, so far as I can learn, higher than the English *average* at the present time (commencement of 1877); but one cannot help admiring the dexterity with which Mr. Charles Kenwrick Kenelm Bishop lays hold of a Name, the Organ-knowledge of the possessor of which he must (speaking generally) often smile at.

h. Mr. Lewis has, on page 10 (stated to be a fifth edition) of his little work, gone—though with considerable caution—somewhat farther. We there read: "The foregoing extract is long; yet the authority of the writer justifies it, since no one is better able than Mr. Hopkins to speak from personal knowledge of the common practice of the day in the treatment of Organs." The extract in question is that of the whole of page 290 and about a third of page 291 (first edition), in which Mr. Hopkins enlarges—not without some exaggeration—on the expedients resorted to by ingenious Organ-builders to keep an instrument of a certain number of stops within a given money figure. Note that Mr. Lewis's productions are, according to his own admission (see page 19), higher in actual price than those of many Organ-builders; and that on pages 41 and 46 are given extracts "from Rimbault and Hopkins's 2nd edition" of notices of two Instruments recently constructed by this firm, such notices being, to say the least of it, rather peculiarly worded for a work professedly written in the best and most abstract interests of Organ-building art. On page 52 a Mr. Rea quotes portions of pages 288 and 289, where Mr. Hopkins again somewhat loosely inveighs against cheap work.

i. As a wind-up of what I have here to say with reference to the *critical* qualifications of the average English Organist, let us imagine one of these gentlemen, whose only knowledge of the Bellows is derived from their description in Mr. Hopkins's work, acting as referee of some instrument just completed. We will suppose two Organs side by side, both containing compound Bellows of like quality 5 by 8ft. (a very common size), but the Receiver rising in one case 9in., in the other 12in. The "judge" seats himself at the Instrument, and if he do what he ought, draws every Stop and Coupler that increases the Sounding-size of the Instrument, then puts down the fullest chord legitimately possible, and while holding on, watches not the Tell-tale alone, but the Blowist, and the *rate* of the strokes giving the feed. After this striking exhibition of sagacity (so admiringly instanced by Forkel, Seidel, Lewis, and Hopkins himself), the referee enters the Instrument, and has the Bellows fully inflated to measure its rise; the cubical capacity is at once seen to be in one case 25 per cent. greater than in the other. Both Organs may be "passed" as satisfactory with reference to their wind, but if any detail is gone into, one (to be consistent with Mr. Hopkins' teaching) will be reported as possessing *one quarter* supplying power *in excess* of the other.

•**j.** Now what a humiliating spectacle of the blind leading the blind is here presented. What are the real facts of the case? Simply that the Bellows of the less cubical capacity is not only *absolutely the cheaper*, but *absolutely the better* of the two; the diminution in the width of the 16 ribs, besides consuming less material, will slightly *enlarge* the Receiver, consequently rendering it a little *steadier*; at the same time the 3in. of vertical space gained will assuredly be valuable in most cases, sometimes of *very great value indeed*. It is not, of course, for one moment insinuated that the "Judge" is here pronouncing otherwise than according to his honest conviction: but the injustice—palpable and real injustice—done to the maker of one of the Instruments is none the less wrong and deplorable.

(*To be continued.*)

Impurities of the Rhine. — Dr. Vohl, of Cologne, has adopted an ingenious method of determining the impurities in waters of the Rhine. By analysing the boiler incrustations of the river steamers he has detected a large percentage of arsenious acid and phosphoric acid.

CERAMIC ENAMELS.—III.*

THE enamel glaze is bought, as prepared for photographic work, from Worcester, where it is made in large quantities. About a thimbleful of the glaze (which is a fine powder like flour) is placed in a small narrow bottle—say, a two-ounce medicine bottle—and the bottle filled up about three parts with alcohol. This is marked "Glaze in alcohol." To make up the glazing mixture take a two ounce medicine bottle, and put in it half an ounce of un-iodised collodion, such as would be used for negatives; add to this a quarter of an ounce of methylated ether and half an ounce of alcohol; now add as much water as it will take without throwing the gun cotton down; to do this set the tap to drip very slowly, and get one drop into the bottle, shake violently, and then get another drop in, and repeat the shaking; so go on till six or eight drops are added, which is about enough. Shake up the bottle of "Glaze in alcohol," and let it rest about two minutes for the coarser particles to subside, then carefully add some of the upper part of the mixture to the diluted collodion—enough to make it rather opaque and milky-looking will do. This is the glaze ready for use; it must be well shaken up each time it is used.

When the enamel is quite cold balance it on the top of one finger if small, or near the edge of a piece of flat wood if large, and pour the glaze mixture over it; then immediately tilt the enamel up to the vertical position, letting the glaze run off on to soft blotting-paper, rocking the tablet in the meantime to prevent the formation of lines. When the collodion is set, place the tablet in a muffle on a piece of fire-clay, and gradually introduce it to the full heat; keep a careful watch now to see that the burning does not proceed too far. The glaze should only just melt; as soon as this is the case, which will be seen by looking at the reflection of the bent wire held just above the tablet, pull the enamel out, and when a little cool remove to a block of wood to get cold again.

The image is now indelibly fixed, and it may be treated roughly with impunity. The picture is not, however, at its full beauty as yet, as, if all the baths, &c., have been in good order, one glazing will not be sufficient. The whites will be glazed, or have a polished appearance, but the darks will be still of a matt surface, and not transparent in effect as they should be. This is overcome by repeated glazings. No enamel is perfect that has not been glazed at least five times. The number of separate burnings (say, five or six), as here recommended, give a totally different effect to what would be obtained by one great burn with the glaze applied thicker. Those who wish to save themselves trouble will work in this way, but any one who wants to get the best results will not mind the trouble of five or six, or even a dozen glazes.

When the glazing comes nearly to an end there will be found some little points where improvement is needed in the way of retouching. This point is very easily gained. Collect all the trimmings of films after they have been through the toning and ammonia baths, and all waste or torn films as well; place them a few moments in the muffle on a piece of fire-clay—they will instantly burn, and the ash is to be carefully collected, and kept in a small bottle. A little of this may be placed out on a palette, with a minute atom of the glaze powder, and one drop of some essential oil, and then well rubbed down with a muller. The paint so obtained may be used with fine brushes dipped in turpentine, and, the work being burnt into the enamel, will take the same colour and surface as the rest of the picture.

Ceramic colours may be applied to enamels, and burnt in with considerable success, but I have found much difficulty hitherto in getting the red shades wanted about the lips and cheeks right. I have used the colours made by Lacroix, of Paris.

When an enamel has failed it may be put on one side, and when there is a sufficient of them the images may be dissolved off with fluoric acid, applied with a rag at the end of a stick, and then, after washing, the tablet may be fired in the muffle till it melts to a good bright surface. If this be carefully done the tablet so renewed will be as good as a new one. In this firing after cleaning the image will often appear again when in the heat. If this be the case the heat should be continued till a full glaze has been obtained, when the tablet, after cooling, may be again treated with the acid, and again fired.

When the successful enamel is finished up to the last heating the name and address of the artist and other matter may be written on the back with a fine brush dipped in the same paint as used for retouching, but a little more thinned with turpentine. As, however, the enamel is to last for thousands of years—or, at any rate, hundreds—and, as the name and position of the person photographed will, probably, be of more interest in a hundred years' time than the knowledge of the name and address of the photographer who produced the work, I generally print on the back in small lettering the name and other particulars of the person whose portrait is represented on the obverse. This remark, however, applies more to persons of great social distinction than to ordinary people.

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* BY NELSON K. CHERRILL, in *Photographic News*.

I have now gone over the whole process of making ceramic enamels as I am now doing them, with, in my own practice, unvarying success. I have, as I said at the beginning, tried thousands of experiments to find out material improvements in the process, but each line in which I have attempted deviation from the process given above has ended in such deterioration of the work as to lead to its abandonment. If the failures I have encountered and found out the cause of were detailed in full, they would fill the *News* for a month.

I will, however, condense into a paragraph the main causes of failure, which should, however, never be met with by any one who will follow my instructions accurately.

Failures in enamels are of four distinct classes, which may be thus enumerated:—Class I. Failures in development. Class II. Failures in the direction of getting poor slaty bluish colours, which glaze all at once when put in the muffle. Class III. Failures in the direction of excessive blackness just the opposite to the last. And class IV. Failures in the glazing operation itself.

With regard to the first class of failure, I would suggest that it is imperative that the development proceed slowly—this seems to me the only condition of success. The photographer's knowledge of his business will enable him so to manage the light, lens, exposure, &c., of the film as to secure this necessary condition. I do not think the developer I have given is by any means the only one that will do, though, as in my hands it succeeds the best, I never use any other.

The second class of failures arises from there being too much gold in the toning bath, or rather, perhaps, too much in proportion.

The third class arises from there being too much iridium, or too much in proportion. Both these may be avoided by a strict adherence to the formula I have given.

The fourth class of failure, the only one to be really feared, is the most difficult to deal with. It is much more difficult to describe than to show. I might say, as old Artemus Ward, "If any of your readers will come to me in New Zealand," I will give them every information. The chief thing to avoid in glazing is the getting an unequal layer of glaze on the tablet the *first time. Until the first glaze is burnt in the picture will rub very easily*, therefore a badly-laid glaze will be its ruin, as it cannot be removed. After the first glaze is burnt the enamel is safe, and any further error in the matter of pouring on the glaze, &c., can be rectified by simply washing it off again under the tap. Then, again, there is a possibility that when too much glaze is used the enamel will spoil by what I have, till recently, looked at as "burning out," but which I have since found out to be simply a sinking in of the image. The best remedies for all errors in glazing are to use plenty of alcohol in the collodion and plenty of water, and at the same time, the smallest workable quantity of glaze, making more burns of it, but doing less work at each burn.

In concluding this paper I wish distinctly to disclaim having made any invention or discovery connected with the enamel process. I obtained my information in the first instance, as stated, from Mr. Watson, of Hull, and his process has been the substantial basis of all I have done with enamels.

RIVET'S MICROTOME AND ITS USE.

By Dr. Johannes Grönland.*

SINCE man has been engaged in microscopical observations, he has endeavoured to contrive cutting instruments suited to the preparation of microscopical objects, and therefore it is long since he first contrived apparatus by means of which very thin but uniform sections of the object to be observed can be made.

By means of the simple knife, and the different constructions of the double knife, it was only possible to obtain very thin uniform cuts of comparatively small area. An attempt was therefore made to contrive instruments, which, by means of suitable mechanism, would give greater firmness to the knife, and secure a more uniform section. Such instruments are known as microtomes or section-cutters. That the endeavours to construct a microtome are already of ancient date is a well-known fact. One of the oldest instruments of this kind appears to be that in the Utrecht physical cabinet. Since that time a great many different microtomes have been constructed, which have more or less completely satisfied the demands made upon them. The objection, however, which has been made, not entirely without reason, to most of these instruments is this, that although very complex, their performance in many cases has not been equal to the requirements of rigorous science, and consequently they have not received much favour from specialists in natural science.

Nevertheless, it seems to us that those who regard the microtome as a *pons asinorum*, damaging to true science, and only furthering superficiality and so-called scientific dilettantism, take a one-sided and prejudiced view of the matter.

It is not the object of these lines to give a review and critical discussion of all known microtomes. The writer of these lines has not had occasion to learn, from practical experience, their advantages or defects, and he does not consider himself competent, without such experience, to pass judgment upon them. But having used the instrument described below exclusively for making plant preparations, he may be permitted to express in a few words his opinion in regard to the demands required of such an instrument, and to give a somewhat more exhaustive account of a microtome which he has already used for a number of years with good results, and make known its advantages.

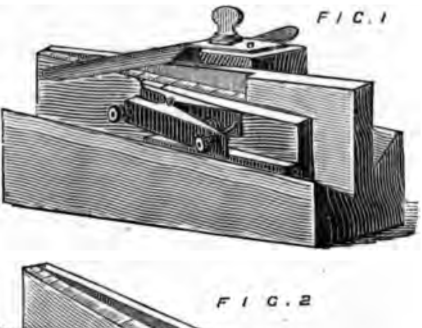
FIG. 1

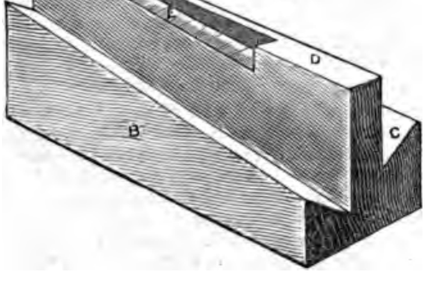
FIG. 2

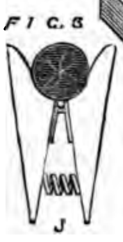
FIG. 3

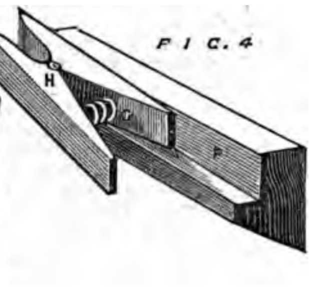
FIG. 4

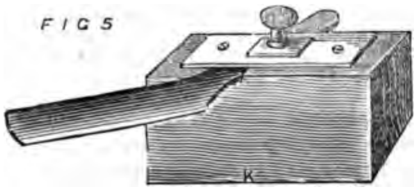
FIG. 5

As regards the features essential to a good microtome, I agree in the main with the views of P. Schiefferdecker. In how far the instrument devised by him corresponds with these I cannot judge, for I have not had an opportunity to see such a one, or to work with it. The most important feature of a microtome appears to me to be the simplicity of its construction and at the same time its cheapness, and in these respects an instrument used by me for years, and in no wise new, but, as it appears to me, again and again mistaken for another, and with injustice defamed, may stand at the head. It has not profited, in my opinion, by any of the supposed improvements which have been attempted upon it. I refer to the microtome, made of wood, devised in the year 1868 by my friend Rivet, of Paris. The number of sections I have made with it since it has been in my possession, and of which not a small portion have come into the hands of expert specialists, amounts now to thousands, and this circumstance suffices to show that the statement of Herr Alexander Brandt, that, in Leucard's zoological laboratory, wood had proved to be a poor material for such an instrument, is unfounded. It is certainly necessary that the wood be selected to suit the instrument, but if this is done the microtome always retains its original value, presuming that it is carefully protected.

The apparent improvement, by making it o
instead of wood, which probably was first
Leyser, in Leipzig, gives it greater pr
While it cannot be denied that the material
better suited for such precision, it should
overlooked that thereby comes a greater clu
in managing the knife, which is shown irre
by comparative work with a wooden and
microtome. One errs greatly if he believes
skill of the cutter has little or no regard
management of the knife. P. Schiefferde
also of the opinion that the sliding of the
the human hand by a microtome is more
tageous and judicious than the complete
pendence of the instrument from the individu
of the operator. If, then, with Rivet's mic
the movement is not by the free hand, but by
of slides, it appears that the working of the
built wooden machine is more satisfactory th
of the one of brass. Moreover, an instru
the latter kind is much more costly than a
one, and from this fact alone its use will
less general.

A circumstance which in particular effe
machine is the position and fastening of th
In Leyser's instrument the position and fa
of the knife appear to be same as in the Rive
tome, made by the mechanic Verick, in Pari

Imitations of the Rivet microtome ha
been made in Breslau after the design of Dr.
which differ in many points from the origi
struction.

As such an instrument lies before me, wh
Leyser's, is entirely of metal, and as I h
occasion to compare its performances with
Rivet's construction, I give here a detailed
tion of my instrument, and point out where i
from the one made in Breslau.

The microtome, as originally construc
Verick, after the plan of Rivet, consists, bes
knife, of three pieces—namely, a woode
(Fig. 2) 16 centimetres long, 6 centimetre
and 6 centimetres broad. On either side
block there is a wedge-shaped groove, B a
that the breadth of the upper middle port
only measures 13 millimetres. The groove
the left side (when the instrument is placed
one for work), lies in a sloping plane havin
clination of 1 in 100; the right-hand groov
the contrary, lies more in a horizontal plane.
on the middle portion to the left, there is to b
running parallel with the wedge-shaped cut
10 centimetres long, divided into millimetre

Each division corresponds to an elevation
millimetre.

Both the wedge-shaped cuts run parallel
side, so that the upper middle portion of t
is of uniform breadth from front to back.
wedge-shaped groove lying in the inclined p
accurately fitted wooden block, F, can be mo
and forth, upon which is a clip, H, provide
spiral spring, G, in order to confine the obj
cut directly, if it be large enough. If the
too small, however, to be held by the cli
clamped between two little pieces of elder
preferably with plants imbedded in stearine.

Fig. 3 shows the clip with the object h
seen from above. In the wedge-shaped
lying horizontal, is another wooden wedge
to and fro, which projects above the middle
the block about the thickness of the back
knife. In the upper part of this there is
into which the strong handle of the knife i
pressed, and which is made with greatest care
the knife may maintain the most advantage
tion for cutting. It can be clamped in this
by means of a brass screw, so that any ch
position is quite impossible.

The cutting is now a very simple operatio
places the wedge with the object clamp, a
to the thickness of the preparation whi
desired to obtain upon a whole or half divi
conducts the cutting by drawing the knif
short pull towards himself. With most ob
elevation of 1-10 millimetre gives cuts su
thin.

As regards the construction of the knife i
blade is 55 millimetres long, by 16 mi
broad, and makes an angle of 15° with the
which is 80 millimetres long by 12 mi
broad. The handle, and also the back of t
have the same thickness of 5 millimetres.
is very deeply hollowed above, but beneath
flat, and both sides are polished. The ve
construction of the knife is, as I know f
perience, of the greatest importance to its u

In the use of this instrument, which, I m
explicitly remark, is only suited for the c
objects not too hard,* I take care to pou
upon the surface of the object already prep
this purpose, and also place a few drops
upon the concave side of the knife. By th
the section is prevented from adhering to t
whereby it would be broken or torn.
knife-blade must be of the utmost possibl

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* Translated by the *American Journal of Microscopy*.

* For cutting harder woods, and such like
make use of a microtome of entirely different con
on Welker's principle.

of sharpness is a *conditio sine qua non*, hardly requires mention. I do not allow the labour to deter me from carefully stroking the blade upon the razor strop after every six or eight cuts of soft, or every three or four cuts of more difficult objects. In this manner I have been able to make rather hard preparations with this instrument, as, for example, through a cereal fruit (grain of barley) a longitudinal section which showed the bud axis and the layers of young leaves, together with the albuminous bodies. Such complete sections are obviously not to be made by the free hand.

If I now compare my instrument with the Breslau microtome, the differences are to be seen at a glance, in the more costly material, and the clumsiness in making sections, particularly in the following points. The object-clamp, which in Rivet's instrument is fastened immovably on the wedge of the inclined plane—which I regard decidedly as an advantage—can here turn upon a steel peg. The reason for such turning is not evident to me. Moreover, the clamp itself, which in my instrument simply closes by the strong spiral spring provided, here is worked with two screws, the use of which appears to me very problematic, and unnecessarily complicate the apparatus. The right and left wedge-shaped cuts are not, as with me, parallel, but diverge towards the front. Any presumed advantage in this for the cutting appears to me illusory. The greatest defects appear to me, however, to cling to the knife and its manner of fastening. The blade of the knife is disproportionately long; the thickness of the back measures 4 millimetres, the length 12 centimetres, the breadth 19 millimetres. The reason for the long knife I do not comprehend, since in cutting only half of the edge can be used. The blade is only slightly concave. The handle of the knife, which is 70 millimetres long, 15 millimetres broad, and 4 millimetres thick, is simply secured by means of a screw furnished with a cruciform plate, and hence lacks all firmness and immobility—features which, according to my experience, are indispensable. These special causes have rendered it impossible for me to obtain useful sections from the instrument as thus modified. Careful comparison shows indisputably that the Rivet microtome, in its original simple form, is capable of most excellent performance, and that the modifications undertaken upon it, without increasing its usefulness—indeed detracting from it—have made it considerably more costly.

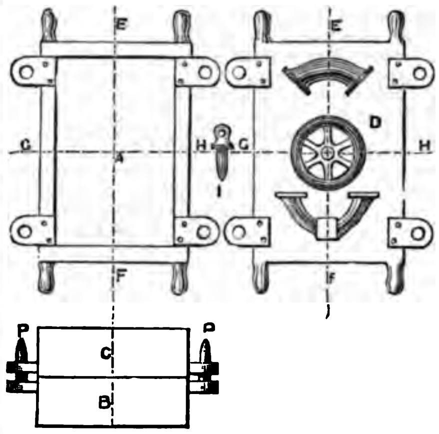
If I have permitted myself above to draw attention to the advantages of an already celebrated little instrument in its simplicity, this is because I foresee great results for the extension of microscopical observations from its more extended introduction, and because its undervaluation appeared to me truly not sufficiently justified. It is greatly to be desired that a skilful mechanic should prepare such instruments, and it is hardly to be doubted that he would find a good market for them. My judgment of the instrument is from almost daily use of it for about ten years, and I am in a position to call upon a great number of scientific men, in whose hands are to be found preparations made with it, to testify to its performance.

ECONOMY IN PATTERN WORK.*

IT is often a source of considerable dissatisfaction that a person cannot obtain a cheap casting without a costly pattern. Many shifts are made to avoid this expense and the attendant delay; for instance, if a casting breaks, the pieces are sometimes temporarily united and made to serve as a pattern. Sometimes what is termed a skeleton pattern is given to the moulder—a mere outline of the thing desired; or, perhaps, even only a portion of it. I do not wish to enter into details or offer examples of these shifts and contrivances, and only mention the practice to show that a want is felt for cheap patterns, especially when only a few castings are required. Let me now, therefore, call the reader's attention to a contrivance which may satisfy that want to a certain limited extent.

Let the iron or brass founder use one or more flasks of the kind shown in the engraving at A, B, and C. A is a plan of the flask; B and C are end views, showing the two parts, nowel and cope placed together. This flask does not differ from that ordinarily used except in one particular—namely, the centres of the pins, P, in the nowel, B, and the centres of the holes in the cope, C, must be equidistant from the centre lines, E F and G H. Let a strong board be made similar to that shown at D in the engraving, battened on one side to keep it straight, the other side being planed true and free from curve or twist. Let four iron lugs, with holes in them similar to those usually screwed to the cope part of a common flask, be fixed in like manner to this board, and let the centres of the holes be at equal distances from the centre lines, E F and G H, making these distances the same as those adopted for the flask. It is now evident that the board, D, may be so applied to the nowel, B, that the four pins in B shall fit into the four holes in D, and that it will be retained in position by them; in like manner the board may be applied to the cope, C, so that the four holes in the one shall exactly coincide with those of the other. When so applied it is only necessary to place two or more pins, such as shown at I in the engraving, in the holes, and the board will be retained in its position with reference to the cope.

Things being so arranged, we are prepared for business. Any article whose parts are symmetrically disposed about a centre line (and there are hosts of such) may be made from half a pattern. Herein is the economy, for it is presumed that half a pattern costs less than a whole one. Let the half patterns of any such articles be placed upon the board, D, so that the centre line drawn upon the pattern falls exactly upon that drawn upon the board. Our engraving shows three different kinds of half patterns so placed, a bend, a wheel, which has perhaps a rim round or oval in section, and a hanging bracket, sufficient to fill the flask, and all to be moulded at the same time. The half patterns having been placed as required, they must be retained in their respective positions by pegs passing through from the back of the board and fitting easily into holes made a short distance into the patterns. Place the nowel, B, upon the board with its pins in the holes, and clamp it there; ram it with sand and turn the whole over; lift off the board and draw the patterns. Replace the patterns on the board and apply the cope, C, to it, passing at least two pins through the holes to hold the board and cope in position; ram the cope and make provision for ventilation and the admission of metal, continuing the process as before directed for the nowel. The cope and nowel, when placed together, will now form a perfect mould.



The author has seen this arrangement carried out for a piece of work where hundreds of pieces were required. It gave perfect satisfaction. The half patterns, once placed upon the board correctly and pegged, are good for any number of pieces, and all the rest goes easily. It is immaterial whether close or snap flasks are used; the arrangement holds good for all machine framing which is symmetrical, such as brackets, bends, elbows, tees, straight pipes, wheels with an even number of straight arms or without any, &c. We may even go a step farther, for if the piece is in its main parts symmetrical, but has upon one side a hub or branch of some sort not required upon the other, then if such hubs or branches are attached by easily fitting pegs they may be retained when ramming the nowel and removed when ramming the cope, or vice versâ.

Unlike the makeshifts for economy's sake alluded to, the arrangement here recommended throws no extra labour upon the moulder. There is simply the expense of a few flasks—and let me ask the question: if four pins have to be attached, why may they not be placed in a certain position? So that it only amounts to this, that every flask of the same size should have its pins or holes in the same place, so as to accommodate if necessary the same board. It is not, however, imperative to proceed to this extreme.

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* From the *Scientific American*.

THE NEBULAR HYPOTHESIS.

IN the March number of *Science-Gossip*, Mr. H. P. Malet, speaking of the recent experiments in the liquefaction of the gases, says:—It has been discovered by M. Cailletet and M. Raoul Pictet that our air can produce water; they have also converted oxygen and nitrogen into liquids, and have produced a vapoury cloud from hydrogen under great pressure and excessive cold. Under the nebular hypothesis of Laplace the origin of water is nowhere satisfactorily accounted for. Mr. Proctor has told us that it is to all intents and purposes demonstrated that the nucleus of this earth was formed from a nebulous condition. The German astronomer, Gruithuisen, adopting the same primary condition, formed this earth by the slow aggregation of cold matter, leaving the water origin unaccounted for. By this new discovery, it seems that all the conditions for producing the water were present under the latter system. The light and heat had not penetrated the nebula; there was therefore intense cold, as there is now in the air above us and at the sea bottom. As the solids of the nebula slowly condensed they caused great pressure. As the gases are expressed now in water from the earth, so we may infer that they were at the beginning. In the *Mail* of January 9th, 1878, I find, "It is only a question of carrying these experiments further in order to reduce these liquid gases to the solid form." We have then a nebulous mass filling the whole space now occupied by the atmosphere, the water, and the solid earth. Under the universal law of gravitation the heaviest molecules of the mass subsided towards their centre—as these molecules condensed they produced pressure. Hence we have the result in our quasi-solid earth, the water resting on it, and the air enveloping the whole, the entire system resulting naturally from the nebulous mass, the sunlight and heat reducing or refining the atmosphere to its present condition by causes well known.

THE TECHNOLOGY OF PAPER-MAKING.—IX.*

The Chemicals used in the Paper-mill; their Nature, Economical Use, and Methods of Valuation. The Recovery and Re-use of Soda as an Economical Process, and in its Sanitary Bearings. The Disposal of Washing and Machine Waters, so as to Minimise the Pollution of Streams.

ALMOST as important as the introduction of machinery has been the application of chemicals in the manufacture of paper. We have already seen what important parts soda, chlorine, and alumina play in the various stages of the process, and now it falls to us to consider the nature of the commercial chemicals containing these active agents. First in point of time, if not also in importance, we have caustic soda. This substance consists essentially of the metal sodium combined with oxygen and hydrogen. When sodium is burned in oxygen gas, two equivalents of the metal combine with one of the gas, and sodium oxide (Na_2O) is the result. This substance has a powerful affinity for water, with which it combines, forming sodium hydrate ($NaHO$). The reaction may be symbolised thus:—$Na_2O + H_2O = 2\,NaHO$. This agent, contaminated with varying proportions of soda and other salts, is known in the arts as "caustic," or caustic soda. As its name implies, it is highly caustic, or burning in its nature. It is so very deliquescent that, if left exposed in the air for some little time, it will become liquefied by the water it absorbs. For all substances of an acid nature caustic soda has a strong affinity, and it is in virtue of this property that it is so eminently serviceable in the treatment of raw fibre-yielding vegetable substances. When exposed to the air it not only absorbs moisture, as already stated, but also carbonic acid, carbonate of soda being the result. The exact composition of this substance in the anhydrous condition is Na_2CO_3. When this is formed from sodium hydrate, a molecule of water is involved in the reaction, thus:—$2\,NaHO + CO_2 = Na_2CO_3 + H_2O$. Soda ash and soda crystals consist essentially of carbonate of soda, the former being anhydrous, and the latter combined with seven equivalents of water of crystallisation. The soda recovered by incineration from the waste soda leys is also a carbonate—indeed a crude soda ash often quite as rich in available soda as ordinary commercial ash. The impurities are, however, generally of a more objectionable nature.

The important part which caustic soda plays in the economy of the modern paper-mill is now well understood. I have already adverted to its action grease, oils, gluten, resin, and silica, as well as upon cellulose itself, and need only further remark that while the agent is indispensable it is also expensive—amounting to about 10 per cent. of the value of the product—and this being so, it is important that it should be used in the most economical manner, consistent with effective work. That there is in this respect room for improvement in very many mills, there can be no doubt. I have seen much accomplished where the boiling arrangements had been previously considered perfect. It is sometimes found economical to purchase soda ash instead of caustic soda, dissolving it, causticising the solution with quick lime. When the waste lime sludge can be readily got rid of, it is possible to make a profit of this; but at most mills it is a serious matter to get rid of the sludge, as well as the other refuse matters which so rapidly accumulate. For size-making, soda crystals are no doubt very suitable, being the purest form in which soda can be purchased commercially. From experiments made under my own direction, however, I am convinced that an equally good size can be made with soda ash, provided only it be quite free from colour and mechanical impurities, and it should not be difficult to secure a supply meeting these conditions. The result of the use of ash as against crystals is a saving in the sizing charges.

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* Being the substance of the Cantor Lectures delivered before the Society of Arts by Mr. W. Arnott, F.C.S.

Every paper-maker should know the strength of the chemicals he is using, and that not so much to satisfy themself as to the character of the goods which his merchants are sending to him—though this is not unimportant—but what is of more consequence, that he may be enabled to regulate their use in the mill so as to ensure uniform and satisfactory results. The determination of the soda in caustic, and in the various carbonated compounds, is one of the simplest of analytical processes. It would be a mistake, however, to suppose that even this simple operation can be done successfully and accurately without some manipulatory skill, and suitable and accurate weights and measures. First of all we must prepare a standard solution of sulphuric acid of such a strength that the contents of each division of the burette intended to be used will equal one grain of real soda. By operating upon 100 grains of the sample to be tested with such a solution, the divisions consumed will give the percentage of soda direct. There is some trouble connected with the preparation of a solution of this description, and, unless the mill staff includes a trained chemist, it is better to secure a supply of accurately adjusted standard acid from a professional chemist. Professional jealousy need not prevent any analytical chemist supplying this, as the work to which it is to be applied is such as can only be done in the mill, if it is to be of the practical utility I have indicated.

In addition to the standard acid, a solution of litmus must be at hand, and in some cases it will be found advantageous to have a supply of litmus papers as well. With these tests prepared, the appliances required for the actual operation are few and simple. A balance and weights, the former capable of turning with one-tenth of a grain; a burette and stand—the burette graduated to indicate quarter per cents. will be sufficient—a large porcelain basin, with a suitable tripod stand, and Bunsen burner, and a few glass stirring rods. Boiling water, from a clean kettle, will be quite suitable for dissolving the sample. The process may be conducted as follows:—The sample, which must, of course, be a fair representation of the drum or cask from which it is drawn, should, in the case of caustic soda, be quickly crushed into small fragments and returned to the stoppered bottle in which it was collected. There is no need for grinding up the sample, for, if time is occupied doing this, moisture will be absorbed and the results vitiated. The contents of each drum are usually pretty uniform, and the crushing recommended will give the operator a sample quite fit to work upon. Samples of soda ash and soda crystals will, of course, be fairly representative of the casks from which they are drawn. One hundred grains of the prepared sample must be weighed out upon a watch glass, or slip of glazed paper, and transferred to a porcelain basin, with at least half a pint of boiling water. The watch glass is preferable for caustic soda, and the weighing in the case of that agent must be done expeditiously. While the sample is dissolving, the burette will be charged with the standard acid. To the soda solution a few drops of solution of litmus sufficient to colour it distinctly will be added. The acid will then be run into the blue soda liquid; at first, and within reasonable limits this may be done rapidly, but towards the close of the operation the acid must be added cautiously, and the solution kept well stirred. In the case of caustic, when the blue has distinctly changed into red, the operation may be considered completed, and the measures consumed read off the burette; as I have already indicated, this is without calculation the result required. When the soda in the sample is a carbonate, the blue colour of the litmus will be changed to pink before all the soda is neutralised, owing to a portion of the liberated carbonic acid remaining in solution; this must be eliminated by placing the basin over the Bunsen and boiling the solution. The blue colour will thus be restored, and more acid must be added, repeating the boiling from time to time, until the red colour becomes permanent. It is sometimes necessary to filter the soda solution before testing; this applies specially to recovered soda, and, although in a less degree to soda ash.

In sampling soda, as in sampling everything else, great care must be taken to secure a fair average of the stock. Professional chemists, as well as buyers and sellers, are often much annoyed by the discrepancies in the results obtained on analysis, traceable alone to different samples having been supplied to the different analysts, under the assumption that they must be alike, while in reality they are often very different. This is especially the case with samples of recovered soda, and I cannot too strongly urge that in all cases where disputes are likely to arise between buyer and seller, samples should be most carefully drawn in duplicate, either mutually, or by an independent competent party.

When soda has done its work in the process of boiling, the spent alkaline liquors are highly charged with matters which, when allowed to flow into streams, produce an effect which is very offensive. This has led to the evaporation of these liquors, and it is satisfactory to know that in most cases the operation has not only greatly increased the purity of the streams, but has also proved remunerative to the mill-owners. That the process may be conducted profitably or otherwise, will depend upon the strength of the waste ley, the price of coal—taking quality into account—the efficiency of the apparatus employed, and the skill with which it is worked. There are many competitors in the field, each with the best recovery apparatus, occupying little or no room, costing little or nothing to erect, and recovering the soda in a high state of purity, at an infinitesimal cost, and, of course, free from the nuisance of smell. As I devote much attention to this branch of chemical engineering, I must be excused for not giving an opinion upon any of the competiting systems. I will, instead, try to point out some of the features which a good recovery furnace should possess. It should be constructed of the very best fire-bricks, not too silicious to their nature, and bound very strongly with iron plates and binders. The evaporating pans should be constructed of what are known as "best" plates, and the workmanship should be quite equal to that of a first-class steam boiler. Both upper and under sides should be exposed to the action of the hot gases as they pass onward from the furnace to the chimney. The structure, as a whole, should be neat and strong, well housed, and capable of being kept cleanly and worked easily. The furnace should be shallow, the fire bridge low, the hearth not too deep, the roof low, and the pans long and rather shallow. The draught should be capable of easy adjustment, and, in working, must be frequently altered. The quantity of soda recovered should be equal to from 70 to 75 per cent. of the soda used, and to secure this none of it must be drawn up the chimney, converted into slag, or run into the river. It should be possible to work the furnace with very little smell; but in my travels I have only seen one that completely prevented smell—a very expensive erection designed by a French engineer. It is an easy matter preventing smell in the recovery house, but the more objectionable smell from the chimney is not so readily overcome. All leys having an average strength of 5° T. and upward should be evaporated at least without loss; below that strength it will require very good working to make both ends meet. That the boilings of most raw materials should be kept out of our rivers there can scarcely be two opinions. Not to speak of the offensive appearance which they are calculated to give the stream, both on account of their colour and their frothing quality, the water must be rendered quite unfit for any of its primary purposes. I am far from being in favour harsh measures, and quite realise the importance of fostering rather than oppressing our manufactures; but, where it can be shown that a public good can be effected, not only without loss to the manufacturer, but at a positive gain, there is little reason why it should not be done. The papermakers on the Esk, near Edinburgh, who were first driven to evaporate their liquors, had, no doubt, many difficulties to overcome; efficient apparatus was yet to be designed; and, in some cases, four entirely different sets of apparatus were erected before a reliable working system was obtained. This involved much loss, which no papermaker resolving to recover his spent soda need now incur. Some of the earlier furnaces consumed as much as eight to ten tons of coal for every ton of soda recovered. Now, however, from one and a half to two tons should be sufficient to recover a ton of 48 per cent. ash from esparto liquors.

Before the soda is withdrawn from the furnace, the organic matter should be well burned off, so that the product may not smell offensively when exposed to the air. It should then be deposited on the recovery house floor in such a way that the carbon will be readily burned out without fusing the mass. The product should be spongy, friable, and easily dissolved. It is always more profitable to causticise and use up the recovered soda in the mill where it is produced then to pack and sell it. The causticising apparatus should, if possible, be so arranged as to avoid hoisting and pumping. It is seldom that the levels are such as to admit of both objects being attained, and in some cases neither of them are attainable. The agitating vessels should be capacious and well proportioned, provided with ample agitating and steaming power. A good size of pan is 6ft. deep, by 7ft. in diameter, and capable of taking a charge of 12 to 14cwt. of soda. The soda is sometimes, and with advantage, dissolved in a separate vessel, and the liquor, free from sedimentary matters, introduced into the causticising pan. There is thus no risk of destroying the agitators with hard lumps of fused soda, or pieces of brick, which sometimes get into the soda heap. The lime required to causticise a ton of soda will vary from 9 to 15cwt., depending upon its quality, the strength of the recovered soda, and whether it has been dissolved in clean water or coolings. It is scarcely possible to eliminate the carbonic acid entirely from solutions made with coolings, yet it is sometimes imperative that these be used for that purpose. The lime will, of course, be put into a cage hung over the side of the agitating vessel, and not into the vessel itself. From four to six hours' steaming and agitating should be sufficient to causticise the soda as thoroughly as the condition of the solution will allow. After from two to four hours' quiescence, the clear caustic liquor will be run off, and the lime sediment agitated for half an hour or so, with a further quantity of water, and again allowed to settle. The weak soda solution thus obtained will be added to the original strong liquor, and the lime washed into draining vessels, the drainings being used for dissolving the next batch of soda. It is very difficult to remove the last portions of the soda from the lime sediment, and there is, of course, a limit to the amount of water that can be used for that purpose. By a process of washing in the drainers, analogous to the process of claying sugars, most of the remaining soda liquor can be driven out or displaced by clean water. The causticised soda liquor will be measured into the boilers, the value of each inch in depth of the measuring cistern having been previously ascertained. There is always a certain loss of soda to be made up with fresh caustic or with causticised soda ash liquor, and it is better to use the new and recovered together in some definite proportion in each boiler, rather than to boil so much of the raw material with all fresh, and the remainder with all recovered soda. The strength of the recovered soda is thus kept uniform, and in every way better results are obtained.

The nature and valuation of bleaching powder must now receive our attention. The chemical composition of this substance is rather complex. If a sample of 35 per cent. powder be taken and agitated with water it will be found that about 85 per cent. has gone in solution, the remainder being insoluble. The soluble portion consists chiefly of hypochlorite of calcium represented by the formula $CaCl_2O_2$. This is the agent which yielding up its chlorine, performs the very important function of bleaching the half-stuff prepared in the breaking engine. The remainder of the soluble matter is the inactive chloride of calcium and sometimes also small quantities of chlorate o calcium. The insoluble portion consists of lime, 1 per cent.; carbonic acid, 4 per cent.; and silica, &c. 1 per cent. I have already stated that the chlorine is held in very feeble union with the other elements of the hypochlorite; it may indeed be considered a an almost free agent, its action upon colouring matter being energetic, and the destruction of th colour complete and permanent.

The destructive effect of the agent may readil extend to the fibre itself if too strong a solution o too much heat be employed. The temperature i hot bleaching should not exceed 90° F., or th cellulose will be sure to suffer in weight, colour, an strength. The only physical feature of bleachin powder which it may be well to note is the readines or otherwise with which the insoluble matter subside in the mixers, this being very muc dependent upon the nature of the limestone or chal used in the preparation of the powder. There is limit to the power of lime to take up chlorine, an in practice it is found difficult to get that portion of i which is in a condition available for bleaching muc above 35 per cent., and at that standard it is usuall sold in this country.

Prudential Assurance Company.—The repo of the Prudential Assurance Company, adopted the meeting last week, stated that in the ordinar branch the new business of the year consisted 3,883 policies, assuring the sum of £500,317, pr ducing a premium income of £17,144. The sum £1,300 had been paid for annuities granted, and th claims paid during the year amounted to £48,40 upon 329 policies, representing 310 lives. Of thi amount, however, £839 was upon endowment matured. The annual premium income of thi branch amounted to £93,352, received in respect 20,073 policies, assuring in the aggregate, £2,756,90 The assurance fund, which at the commencement the year was £471,437, stood at £511,221 on the 31s December last, showing an increase of £39.783. Th year's business in the industrial branch consisted the issue of 1,863,245 policies, representing a ne annual premium income of £752,507. The claim during the year amounted to £322,270. The tot annual premium income in this branch amounted t £1,227,803, being an increase in the year of £247,22 The assurance fund which at the beginning of th year was £373,492, stood on the 31st December las at £536,298, showing an increase of £162,80 Taking both branches together, the total premiu income of the company during the year wa £1,321,155, the total of claims paid £870,697, an the total of the assurance funds £1,047,520.

SCIENTIFIC SOCIETIES.

ROYAL ASTRONOMICAL SOCIETY.

THE first meeting of the new session was held at the Society's Rooms, Burlington House, on Friday, the 8th instant, Lord Lindsay, M.P., President, in the chair.

John Ellard Gore, Esq., Assistant-Engineer, D.P.W., India; the Rev. Frederick John Hall, Haileybury College, Hertford; William Hobson, Esq., Park View, Whalley Range, Manchester; Lieut. Robert Heggan, R.N., H.M. Dockyard, Sheerness; William Curtis Offer, Esq., 60, Grosvenor Park, Camberwell; and F. H. Stevens, Esq., B.A., Clifton College, Bristol, were balloted for, and duly elected fellows of the society.

Mr. Neison explained the substance of a paper upon "Hansen's Term of Long Periods in the Lunar Theory." He said it would be remembered that about three years ago the Astronomer Royal had announced, in a paper read before the society, that a certain term of long period in the motion of the moon, discovered by Hansen, ought to be omitted for the future, on the ground that the later investigations of Delaunay and Newcomb had shown that its value was insensible. A short time back Professor Newcomb published in the *American Journal of Science* an elaborate investigation of the corrections of Hansen's Tables of the Moon, and showed that, though Hansen was able, by means of certain artifices, to make his tables represent the motion of the moon for the period between 1750 and 1850, yet for periods before that Hansen's tables showed discordances which it was very difficult on any hypothesis of Hansen to explain. Mr. Neison suggested that some of these discordances might be accounted for by taking into consideration the action of the sun upon the orbit of the moon as affected by the action of Venus. Delaunay had shown that the action of Venus would cause the moon to move in a somewhat larger orbit for the space of about fifty years, and then in a smaller orbit for a similar period. It would be evident that, when the moon was moving in the larger orbit, the earth would have less effect upon it, and consequently the perturbing influence of the sun upon the motion of the moon would be greater. Delaunay, in considering the perturbing influence of the sun upon the motion of the moon, had omitted to take into account the variations of the moon's orbit caused by the action of Venus, and had assumed that the effects would destroy each other. Mr. Neison's paper was intended to show that it was possible that the action of the sun upon the alternately larger and smaller orbit of the moon might be sufficient to account for the term of long period for which Delaunay had been unable to find any explanation, when he considered the moon as moving in a fixed orbit and neglected the effect of Venus.

Mr Drach asked what was the alteration in size of the moon's orbit caused by the action of Venus.

Mr. Neison said he could not say, in feet or inches, how much the diameter of the moon's orbit would be changed, but the alteration would amount to very little, for though it goes on for 50 years its cumulative effect is only to make a difference of two seconds of time in the moon's place at the end of 50 years.

Mr. Proctor was called upon to read a paper "On the Determination of the Axial Position of Mars with respect to the Earth at any Epoch." Mr. Proctor said that he had intended to make use of the observations of Mr. Green to prepare a new chart of Mars to submit to the meeting, but that he had found that the work would be greater than he had expected, and he had therefore been obliged to defer the chart till another occasion. It seemed to him that Mr. Dawes, though one of the most acute of observers, was not very skilful in delineating upon paper what he saw. There was a great amount of work in going over and correcting a chart of Mars, and the paper that he was about to explain was intended to show that one might form projections of Mars, by making use of the right ascension and declination of the planet given in the *Nautical Almanac*, without making use of the tabulated results, on which Mr. Marth had expended so much labour. If α be the right ascension of Mars and δ the declination at any epoch, I (about $29\frac{1}{3}°$) being the inclination of the equator of Mars to the terrestrial equator, and N (about $47\frac{1}{4}°$) the right ascension of the rising node of the former plane to the latter. Let $P\,O\,P'$, $E'\,O\,E$ be diameters intersecting at right angles of the circle, $P\,E\,P'$. Take the area, $P\,p = I$, and draw the chord, $p\,c\,n$, perpendicular to $P\,P'$, cutting it in c. From p take arc, $p\,l$, of $\frac{1}{2}$ circle, $p\,l\,n$, about c as centre $= \alpha - N$, and draw $l\,q$ perpendicular to $p\,n$, cutting circle $P\,E$, in d, and produce $l\,q$ to meet $E\,E'$ in L. About L as centre, strike arc, $L\,h\,h'$, cutting $p\,n$ in h, and on this arc measure from h arc, $h\,D$, equal to δ. Then $D\,c$, perpendicular to $d\,q\,L$, gives r, the end of polar axis of Mars, regarding $P\,E\,P'$ as disc of Mars, and $P\,P'$ as the meridian, while the minor semi-axis of the Martian equator at epoch is equal to $D\,c$. The part of this construction, up to the point where the arc, $p\,l$ is taken equal to $\alpha - N$, is common to all cases, and the construction from that point takes less time than is required for writing the description of it.

Mr. Proctor also read a second paper on Mr. Stone's note in the January number of the *Monthly Notices*. Mr. Proctor had shown that when you have an object of any magnitude you cannot, by making use of a telescope, increase its brightness. No doubt you might appear to do so, and the details of the object might be rendered more distinct; but on investigation it would be found that they were not so bright. In illustration of the mistake which people make with regard to this, he drew attention to the fact that one may read in the dusk by means of a magnifying glass, and you may then see letters distinctly which you could not see without it, but on comparing the brightness of the magnified image with page seen directly, it would be recognised at once that the magnified image was not as bright as the unmagnified.

Mr. Stone seemed to think that Mr. Proctor had supposed that this law also referred to stellar points, but this was not the case. An object like the satellites of Mars would of course be rendered more easily visible with a large aperture than with a small one, for it did not subtend a sensible area, and consequently its brightness would not be decreased on increasing the magnifying power.

Mr. Neison thought that Mr. Stone intended to say that there was an additional reason for seeing small points of light with a large aperture over and above the mere increase in light collected by the object-glass, for with a large aperture you would have the light of the star collected into a small stellar disc, while with a smaller aperture it would be diffused over a larger disc, which would not be so easily seen in contrast with the illumination of the atmosphere.

Mr. Ranyard read a paper by Mr. Plummer, "On the Supposed Influence of a Mass of Brickwork upon the Errors of a Transit Instrument in its Neighbourhood." Mr. Plummer had found upon tabulating the azimuth errors of his instrument that they were positive in summer, and negative during the winter months, and he concluded that these errors were due to the radiation of heat from a great mass of brickwork in the neighbourhood of the transit instrument.

Lord Lindsay said, that he could quite understand that the heat radiated by a mass of brickwork might cause the unequal expansion of the piers of a transit instrument. In the course of a visit which he paid last year to the Royal Observatory, Edinburgh, Prof. Piazzi Smyth had shown him an experiment, in order to illustrate the extreme sensitiveness of the piers of his transit instrument to slight changes of temperature. The telescope was turned to the nadir, and the images of the wires reflected from the mercury were brought into coincidence with the wires in the eyepiece. The light of a lantern, at a distance of some six feet, was then turned upon one of the piers, and in the course of three or four minutes the heat of the lantern caused the piers to buckle, so that the images of the wires were carried distinctly away from coincidence.

Mr. Dunkin said that Mr. Plummer's discovery, with regard to the periodic changes of his transit instrument, was nothing extraordinary. Such changes occurred in all transit instruments. At the Royal Observatory the changes were so constant that he could tell from month to month what the level or azimuth error would be almost to the tenth of a second. The origin of these changes was still undiscovered: whether it was that Greenwich-hill shifted periodically, or whether it was a change due to the piers themselves, he did not know. He had looked over Mr. Plummer's paper rather hurriedly, but he did not think that Mr. Plummer had made out that the change was due to the mass of brickwork. It might be due to the shifting of the ground itself, or to the unequal action of the sun on different parts of the observatory in summer.

Mr. Penrose, the architect at St. Paul's, mentioned that there was a rail which slipped between two masses of stone near to the doorway of the west front of the cathedral. In hot weather the expansion of the stone was such that the rail was sometimes jammed. On making measurements he found that the parts of the wall were shifted by the expansion caused by heat as much as an eighth of an inch.

Mr. Gill mentioned that there was a regular daily change in the errors of the transit instrument at the Liverpool Observatory, which, he believed, had been traced as being coincident with the height of the tide, the observatory being close down by the water.

Mr. Christie mentioned that Mr. Stone, at the Cape of Good Hope, had established, or believed he had established, a connection between the changes of azimuth error and the amount of water in a river near the observatory.

Lord Lindsay suggested that such changes might be caused by the percolation of water into the soil.

Mr. Neison mentioned that a remarkable change had been noticed in the errors of the transit instrument at the observatory at Armagh. The errors appeared to depend upon the state of saturation of the soil. The observatory was built upon a hill, under which was a bed of clay, dipping at a considerable angle to the surface. It seemed that as the clayey strata became saturated with moisture it swelled up and caused a movement of the whole superincumbent mass of the hill.

Captain Noble mentioned that the variations of the level errors of his transit instrument were so regular that he believed he could tell the time of day from the level error, if he were taken into his observatory blindfold.

Mr. Christie remarked that it was much more difficult to understand the cause of the changes in azimuth than the cause of the changes in level error. It would easily be understood how the unequal action of the sun should make one pier expand more than the other, but it was more difficult to understand what could give rise to the torsion which corresponded to a change of azimuth error.

Mr. Ranyard read a paper by Mr. Stone on the telescopic observations of the transit of Venus. Mr. Stone had rediscussed the observations published in the parliamentary report upon the observations of the transit of Venus, and had deduced a solar parallax of 8″ 89—equivalent to a sun's distance of 91,940,000 miles.

A discussion followed as to what phase of the phenomena of contact between the limbs of Venus and the sun observers had usually described, and as to the sources of error in interpreting their descriptions. The meeting adjourned at a quarter to ten o'clock.

ROYAL MICROSCOPICAL SOCIETY.

AT the meeting on March 6th (Mr. H. J. Slack, President, in the chair) a list of donations was read and acknowledged, and four gentlemen were elected fellows of the Society. Mr. Charles Steward described a new species of coral, said to have been obtained from an island in the vicinity of Tahiti, and which was referred to the genus Stylaster. The characteristics of the genus and the distinctive features of the new species were explained and illustrated by black-board drawings, and specimens of the coral were exhibited under the microscope. A paper "On a New Operculated Infusorian from New Zealand," by Mr. Hutton, of Otago, was read by the President. A paper by Mr. Adolf Schulze, of Glasgow, "On a New and Simple Method of Resolving the Finest Balsam-mounted Diatom Tests," was read by the Secretary, and described the success which had attended the examination of this class of objects by means of the reflex illuminator and the immersion paraboloid moistened with castor oil in place of water. The lines on *Amphipleura pellucida* were shown in this manner by Dr. Dickson in illustration of the paper. Lissajou's curves, drawn microscopically upon glass by Mr. West, were exhibited by Mr. Thomas Curties.

Fireworks Brakes.—Mr. Smith, the inventor of the vacuum brake, is, says the *Engineer*, a man not easily deterred by difficulties. It has long been evident that an automatic brake possesses an enormous superiority over one which is not automatic. That, in fact, it is almost certain that the brake of the future must be automatic. To endow the vacuum brake with this useful or even necessary qualification was a matter of no small difficulty, but the inventor has risen with the occasion, and has patented an arrangement for rendering his brake automatic, which will commend itself for its simplicity. The device is known as an "Automatic Attachment." It consists of an ejector of much the usual construction, but instead of being worked with steam, a rocket case is attached to it. This case is fitted with a fulminating igniting arrangement, which may be described as a gun-lock. To the trigger is attached a string, which runs along the train. The automatic attachment is placed in the guard's van, let us say, and is cocked and capped before the train starts. Should a coupling break the string is tightened and pulls the trigger; the rocket composition is ignited, the gas rushes through the ejector and creates a vacuum, like steam, and the brakes are applied. An automatic attachment may be fitted to every carriage. We do not know how the ends of the broken tubes between the carriages are to be stopped, nor have we received any information as to the efficiency of the device. Air and water have already been pressed into their service by inventors of brakes. It has remained for Mr. Smith to enlist fire in his cause, unless it be true that one ingenious individual proposed years ago to fix a Congreve rocket on the top of every carriage in a train, all the rockets to point astern; when the train had to be stopped in a hurry, all the rockets were fired at once by electricity, and the retarding influence of the rockets brought the train to a stand, as Artemus Ward might say, "in a blaze of glory." This invention would not invalidate Mr. Smith's patent. Whether railway companies will look with favour on a scheme which includes the carriage of fireworks as an essential feature is quite another point, on which we need pronounce no opinion.

SCIENTIFIC NEWS.

SO great is the desire for admission to the Royal Society, amongst certain classes of scientific men, that, although only 15 will be elected, more than 50 candidates have either directly or indirectly entered into competition for the honour. The list of foreign members was made complete (50) at the close of last year by the election of seven members; but since then, so great has been the mortality amongst the savants, that there are already six vacancies in the foreign list.

Telephony is progressing apace. The Chinese, who, according to one account, refuse to have the telegraph, but whose language is in reality difficult to transmit by electric signals, are pleased with the telephone, and already messages have been sent over a wire 500 miles in length without much difficulty. Some of the employés of the Indo-European Telegraph Company have also been testing the telephone in Persia, with such instruments as could be made out of a scanty supply of materials by Mr. C. Taplin, at Tabreez. That place was connected telephonically with Tiflis, and at night, when there was little business passing over the wires, conversation was carried on between the offices, songs sung, and the usual tests applied in a very satisfactory manner, the distance being nearly 400 miles. The best results were obtained with vocal music.

An extraordinary statement with regard to the use of electricity in indicating the condition of a line of railway and the traffic is reported from France, where the apparatus is undergoing a trial at Marseilles. The invention consists of an electric mirror, in which all the movements on a line are presented simultaneously to the observer as clearly as if he were looking at a picture. The term "mirror" is probably misleading, as most likely all that is meant is that each train records its passage from station to station at the two termini and other important points.

According to the *Athenæum*, the Walter press is giving satisfaction to the newspaper proprietors who have adopted it. As an example, it is stated that the seven Walter presses used by the *Daily News* produce 1,500 perfect copies per minute, or 90,000 an hour. Another is to be erected, when the production will be equal to 103,000 copies per hour, a rate which enables papers of large circulation to give late news without changing the hour of publication. According to these figures each machine must run at the rate of nearly 13,000 an hour, a high speed, which involves nicely balanced movements and good ink rollers. The limit has been placed by practical men at 15,000, and that only at certain seasons when the rollers can be kept in order; but with an improved composition, capable of withstanding the wear and tear in all weathers, so far as the Walter press is concerned, there should be no difficulty in maintaining a rate of 20,000 an hour.

MM. André and Angot have started for Ogden, Utah State, for the purpose of observing the transit of Mercury on May 6. They represent the French expedition, the expense of which will be defrayed by a contribution of 30,000 francs from a well-known Parisian.

We understand that Dr. J. F. Schmidt, of Athens, has at last placed the whole of Lohrmann's work on lunar topography in the publisher's hands. The chart of the moon was, it will be remembered, to be divided into twenty-five sections, and four of those sections were published in 1824. Then the author's sight failed, and the work was suspended, until, several years after Lohrmann's death, Dr. Schmidt undertook the editorship, the labours of which he has now concluded.

On page 394, last volume, we alluded to the success that had attended the efforts to raise the steamer Edith in the fairway of Holyhead Harbour. The vessel was beached in a position where it was hoped the damaged plates could be repaired, but it was subsequently found impossible to render her water-tight, and accordingly the cradles were again brought into requisition. After several breaks-away, the vessel was beached in a more favourable spot, patched, pumped dry, and taken into the graving dock, A careful examination shows that the hull is perfectly sound, not a rivet having been started by the strain, while the engines, after 30 months' immersion, are practically uninjured.

The Alpheta, an iron vessel of 1,260 tons, was successfully raised from the Bembridge Ledge, Isle of Wight, last week, and towed safely into dock at Portsmouth.

Several torpedo boats have been recently tried on the Thames, some of which have surpassed the most sanguine expectations of their builders—if we may accept the figures as official. Twenty-seven knots, or more than 30 miles an hour, seems an extraordinary speed for even a high-powered steel-built torpedo boat.

The London School of Medicine for Women have purchased of Dr. Blundell's executors the valuable collection formerly attached to the chair of midwifery at Guy's Hospital.

The leaves of the castor-oil plant (Ricinus communis) are said by a California newspaper to act as poison upon grasshoppers, which, after eating a small portion, are unable to move, and speedily die. If the statement is true, the leaves may possibly be of utility in clearing kitchens of cockroaches.

Several unaccountable explosions having taken place in connection with specimens of toughened or hardened glass, a doubt has arisen whether, after all, the discovery is of much value for the construction of domestic and culinary vessels. Herr Lamek has been unpleasantly "peppered" about the face by fragments of a flask which, after being in use for fourteen days to catch a filtering solution of phosphate of lime, flew into pieces without any warning.

A portion of the Gilbert Elevated Railway in New York, about three miles in length, was opened for traffic on March 1.

Some experiments have been lately made by M. Boussingault on cementation of nickel, a metal which has several of the properties of iron. While it combines with carbon in the process it does not (he found) acquire, like iron, the properties of steel—viz., hardness, resistance to traction, elasticity, &c. From Berzelius' statement that meteoric iron, which is always nickeliferous, retains its metallic clearness in damp air, M. Boussingault supposed that by combining nickel with steel the latter would be preserved from rust; he accordingly prepared steel with 5, 10, and 15 per cent. of nickel, but the alloys, placed under a thin layer of water, all rusted like steel without nickel, and sometimes even more rapidly. In these latter experiments he found he had been anticipated by Faraday. But with a large proportion of nickel, as in the meteoric iron of Santa Catharina, Brazil, which has 34 per cent., there is no oxidation. The magnetic properties of cemented nickel are being examined by M. Becquerel.

Recent microscopical researches by MM. Meunier and Tissandier have revealed the fact that certain ancient rocks—Cretaceous, Liassic, Triassic, Permian, Carboniferous, and Devonian—contain magnetic spherules which are absolutely identical with those found in dust in the air, and may therefore be legitimately considered as of meteoritic origin. Should this view be accepted the fact of our globe having received materials of cosmic origin in such a far distant past is of considerable interest; and it is important to determine, if possible, the precise epoch at which such contributions from space were first received.

Attention having recently been called in Germany, as elsewhere, to the danger connected with paper-hangings and window blinds, which are often saturated with arsenic, there has been found in Weimar, in the house of Schiller, and more particularly under the present wall-paper of his study, a paper in which, after examination, arsenic has been ascertained to be present. The premature death of the poet may, it is conjectured, be attributed to the poisonous exhalations to which he must thus have been continually exposed.

A new substance called *plastilina*, for use of artists, has lately come into use. It retains its plasticity—which is equal to that of clay—indefinitely. From a note by M. Giesel to the Berlin Chemical Society we learn that it is composed of sulphur, oleate of zinc, unsaponified oil, a little wax, and clay (the exact proportions are not given). It is thought likely to become popular with modellers. The price is scarcely 1 mark per kilo. Plastilina contains no substances injurious to health, and can hardly be thought dangerous in connection with fire, though caution would be advisable in using large quantities of it.

For protection of workmen against accidents with circular saws, M. Ganne has devised an arrangement in which the appearing part of the saw is covered with an envelope which leaves free that portion of the tool where the wood has to pass. This envelope is suspended rigidly from a small standard fixed on the bank of the machine, being connected therewith by a rack in large apparatuses—a simple rod with sleeve and screw in small ones; so that it can be rapidly raised and put aside when the saw has to be examined or removed; and in any case the arrangement serves to regulate the distance of the envelope from the table according to the thickness of the wood.

The taking of cod-liver oil is seldom found a pleasant operation. M. de Pontever recommends, in the *Union Médicale*, mixing a spoonful of the oil with the yolk of an egg and ten drops of oil of peppermint, and adding half a glass of water with some sugar. This is said to effectually conceal the characteristic taste and odour.

In last week's number we described a new mode of demonstrating the laws of falling bodies. Another apparatus for the purpose, devised by M. Steract, is described in a recent number of the *Revue Universelle*. We shall merely state that it consists of a sort of fly-wheel, supported by its axis on two thin parallel rails One portion of the rails being inclined to the other, the wheel rolls down and along the level, and by electric contacts which its axle makes on the way currents are sent in particular courses, so that the motion of the descending wheel is indicated by pointers on a dial plate.

That section of the Society of German naturalists which is charged with questions of public health lately applied to the Government, in view of the myopy which is so prevalent, to take into consideration the health o children by giving a better light in school rooms. Another proposition adopted is tha children should not be required to read mor than three-quarters of an hour without resting or changing occupation.

M. Bjerknes, of the Göttingen Society o Sciences, calculated that two bodies which, i an incompressible fluid, undergo periodi changes of volume, in performing oscillation perpendicularly to the line of centres, woul attract each other if the phase of the tw movements were the same, but would repe each other in the contrary case. Experimen has verified this. Two balls suspended in ai are let drop simultaneously into water—thei oscillations then produce attraction; but, i one be depressed and the other raised, then both let go, the movements are opposite, an the balls repel each other. If a small bal oscillate in the neighbourhood of a large bal of density *u*, of radius *r*, in a liquid of densit *q*, there is always attraction if *u* is greater than *q*. If it be less, there is attraction or repulsio according to the distance apart of the centres.

The phenomenon of ringing or tingling in the ears (*tinnitus aurium*) has recently been studied by Dr. Aigre. He believes that, in every case, it may be attributed to vibration o the walls of blood-vessels of the labyrinth These vascular vibrations act on the termina fibres of the auditory nerve, which they agitate They may act on the nerve in two ways—either by increasing in amplitude, or simply by refle action, by concentration, or by resonance. The former case occurs when there is increase or diminution of tension of the blood in the vessels of the labyrinth, or when the constitution of the blood is altered, as in chlorosis or anæmia.

LETTERS TO THE EDITOR.

[*We do not hold ourselves responsible for the opinions of our correspondents. The Editor respectfully requests that all communications should be drawn up as briefly as possible.*]

All communications should be addressed to the Editor of the ENGLISH MECHANIC, 31, *Tavistock-street, Covent-garden, W.C.*

All Cheques and Post-office Orders to be made Payable to J. PASSMORE EDWARDS.

*** *In order to facilitate reference, Correspondents, when speaking of any Letter previously inserted, will oblige by mentioning the number of the Letter, as well as the page on which it appears.*

"I would have everyone write what he knows, and as much as he knows, but no more; and that not in this only, but in all other subjects: For such a person may have some particular knowledge and experience of the nature of such a person or such a fountain, that as to other things, knows no more than what everybody does, and yet, to keep a clutter with this little pittance of his, will undertake to write the whole body of physicks: a vice from whence great inconveniences derive their original."
—*Montaigne's Essays.*

◆

ENCKE'S COMET—THE SELENOGRAPHICAL CLUB — CARBONIFEROUS FOSSILS — CEMENTING OBJECT-GLASS—A GREGORIAN REFLECTOR —METEORIC SATELLITE — AN EXCEEDINGLY BAD TELESCOPE—LOCAL TIME OF MOON SOUTHING—WHAT IS A METRE, &c.?—BARLOW LENS — MERIDIAN ON ORDNANCE MAPS—NOT GILTY—ANTIQUITY OF MAN.

[14087.]—I MAY inform Mr. Lane (letter 14031, Vol. XXVI., p. 601) that the perihelion passage of Encke's comet in 1875 occurred on April 13th. It was observed with extreme difficulty, and only with the largest instruments, during its apparition in that year.

What, may I ask, is "The Selenographical Club," spoken of by Mr. Birt (in letter 14032, Vol. XXVI., p. 601)? Presumably it mustbe some kind of association for the examination of the Moon's surface; but, so far as I know, no publicity has, up to this time, been given to its constitution or objects. If it be what its title indicates, I should think that there are many students of Astronomy who would be glad to join it; especially now that interest in Selenography has been so revived and stimulated by the publication of Mr. Neison's *Moon.*

I am sorry that the information contained in reply 31984 (Vol. XXVI., p. 607) does not enable me to say anything more definite than that I suppose Mr. Cox's fossil fern to be the Sphœnopteris Crenata, a common carboniferous form. As to his fossil "something between a frog and a fish," this is simply impossible to identify. The true fish of the coal measures were very sauroid in their character, and the batrachian-like reptiles of that epoch too diversified in their structure for any species—or even genus—to be recognisable from so very vague a description.

I would say, in limine, with reference to query 32249 (Vol. XXVI., p. 612) that if Mr. Davies has an astronomical telescope with an object-glass of 7½in. (or any other) aperture by Dolland, he is the unhappy possessor of a piece of fraudulent rubbish. There never was an optician of that name. The famous makers of achromatics in days gone by were named Dollond, and the spelling "Dolland" has been from time to time adopted by the lowest stamp of makers to pass off worthless trash upon those who were ignorant or heedless of this fact. If my querist's telescope be, as he says, a Dolland, he may cement the lenses or do anything else he likes with them (preferably use them for a camera obscura or a peep show). Should he, however, by a lapsus calami, have substituted an "a" for an "o" in writing his question, and be, after all, the owner of a real specimen of Dollond's work, then let him by no means attempt to cement it, but send it to some competent optician to see what is the matter with it. His concluding sentence, of course, merely describes a common optical illusion.

"Disappointed One" (query 32265, Vol. XXVI., p. 613) has got hold of a Gregorian reflecting telescope. His "small shield or disc" is the second speculum of the instrument. The "coloured glass of a deep orange colour" is intended to view the Sun with, and must be removed (by unscrewing) before looking at any other object, celestial or terrestrial. This having been done, your correspondent should direct his telescope to any distant object, and, by the aid of the rack-work of which he speaks, move the small mirror, until the object he is regarding appears sharp and distinct.

In answer to "Delta" (query 32270, Vol. XXVI., p. 613) I may tell him that "the opinion of modern astronomers with regard to the meteoric satellite whose elements were supposed to have been calculated by M. Petit," is, that (like Vulcan) it was un Petit méprise.

The reply to query 32273 (Vol. XXVI., p. 613) is of the most simple character possible. "Totham's" telescope is an abominably bad one, and should be sold straightway for old brass and glass.

The most simple way for "T. F. R." (query 32288, Vol. XXVI., p. 635) to find the Local (and hence the Greenwich) Mean Time of the Moon's transit at his station, is that given on p. 500 of the *Nautical Almanac.* It will be best illustrated by an example. At what time will the Moon South in Longitude 3° West of Greenwich on the night of March 15? Turning, in limine, to p. 41 of the *Nautical Almanac* (IV. for March), we find that the Moon will cross the Meridian of Greenwich on March 15 at 9h. 30·3m. p.m. We further observe that her transit there on the 16th will take place at 10h. 24·7m.—a difference of 54·4m. Then we say as 24h. : 12m. (*i.e.*, 3°) :: 54·4m.—what we shall find to be ·45m. We may say, then, that the Moon will cross the Meridian of a place 3° West of Greenwich on the night referred to at 9h. 30·8m. L.M.T. = 9h. 42·8m. G.M.T.: a result amply sufficient for all ordinary purposes. The rigidly accurate computation of the Local Mean Time (I mean to hours, minutes, seconds, and decimals of a second) of the Moon's transit at any place differing much in longitude from Greenwich, involves, however, interpolation to the second order of differences at least; and even the use of the differential calculus. In the case of the Sun, the equation of time would enter as an element. Thus on the day which we have selected, the Greenwich Mean Time of the Sun's Southing will be 0h. 9m. 4·55s. p.m., while in 3° West longitude he will cross the Meridian at 0h. 9m. 4·41s. p.m. = 0h. 21m. 4·41s. G.M.T. The fixed Stars, and the more distant planets, may be taken to South 12m. (and *not* 12′ as your correspondent writes it) later by Greenwich time at his station than they do at the initial one.

"Ajuto" (query 32289, Vol. XXVI., p. 635) is quite correct in his value of the mètre—viz., 39·37079in. The number of grains in a kilogramme is 15432·3488; and as there are 7,000 grains in a pound avoirdupois, 1 kilo must be = 2·2046192lb. I am sorry to find any reader of the ENGLISH MECHANIC troubling himself about that most unscientific and arbitrary system, the metric one. Let the South Kensington party persist in their endeavours to ram it down our throats, but let us adopt the wise policy of the old lady, who "went on never minding." If "Ajuto" wishes to learn how really unphilosophical the metric system is he should read a little shilling tract by the late Sir John Herschel, published by Longmans, on "The Yard, the Pendulum, and the Metre." It has been reprinted in Sir John's "*Familiar Lectures on Scientific Subjects.*"

"Ballymacarret" (query 32335, Vol. XXVI., p. 636) is mistaken in speaking of the "Barlow Eyepiece." He really means the so-called "Barlow lens," which is a negative achromatic combination (*i.e*, a concave crown and a convex flint) placed in the tube of a telescope, between the object-glass and the eyepiece. It is placed within the focus of the former; and its effect is to increase the power of each eyepiece to an extent dependent upon the ratio of its distance *within* the primary focus of the telescope to its own (negative) focal length. Thus a Barlow lens of 10in. focus placed 5in. nearer to the objective than the focal point of that objective will exactly double the power of every eyepiece used with it.

The same correspondent (query 32337, Vol. XXVI., p. 636) may draw straight lines for Meridians on a 6in. Ordnance Map, without introducing any measurable error.

The "gold" of "Edmund" (query 32340, Vol. XXVI., p. 636) is worthless iron pyrites. It is very rare to examine any considerable quantity of coal without finding some of it streaked with this mineral.

I cannot answer query 32346 (Vol. XXVI., p. 636) being ignorant of the locality to which it refers; but with reference to the succeeding one (32347), may inform "Float" that the latest edition of Sir John Lubbock's book contains all the information which had accrued up to the date of its publication. At any rate, it is eminently well worth reading, for a variety of reasons; and enters into a kind of detail which is absent from Sir Charles Lyell's work. I notice, by the bye, the advertisement of a book just out, called *The Dawn of History.* I have not seen it yet; but I should fancy that it would contain a good deal of information of the description which "Float" is seeking.

A Fellow of the Royal Astronomical Society.

CONDENSED OXYGEN — KOUMISS — ESTIMATION OF CARBOLIC ACID—HEAT FROM COAL—ESTIMATION OF BORIC ACID—DAVYUM.

[14088.]—I AM sorry to say I still differ from Mr. Lancaster as to the prospects of seeing his oxygen dream realised. I fail to perceive that the liquefaction of oxygen by MM. Pictet and Cailletet can be considered at all an approach to what we should all like to, and Mr. Lancaster believes we shall, see.

It is true that oxygen has been obtained in a liquid state, but under what conditions? M. Cailletet found that oxygen, under a pressure of 300 atmospheres, and at a temperature of −29° C., remained perfectly transparent, and it was only the enormous additional reduction of temperature (calculated to equal 200° C.) that sufficed to produce a momentary fog. Similarly, M. Pictet found that liquid oxygen exerts a vapour-tension of 320 atmospheres at the temperature of −140° C. Oxygen has more than once been submitted to pressures far in excess of the above at the ordinary temperature, and has shown no signs of liquefying. People often forget that no pressure, however great, will cause the condensation of a gas if the temperature be above its "critical point." This point is different for different liquids. For liquid CO_2, if I remember rightly, it is about +30° C., and for water about 360° C. Above this temperature no amount of pressure will effect the condensation of steam to the liquid state. Hence, whatever trouble Mr. Lancaster took, by means of powerful freezing agents, to reduce the temperature of the oxygen so as to introduce it into his storing vessel in a liquid state, it would necessarily be gaseous on rising to the ordinary temperature, and would exert greatly increased pressure into the bargain. Assuming that he has no difficulty in making his bottles stand the pressure, and that he does not object to the great weight which the necessary strength implies, what has he got? Merely highly-compressed gaseous oxygen. Well, he could have had that if the liquefaction of oxygen had never been effected, and so MM. Pictet and Cailletet's experiments have brought him no nearer to his goal. In fact, they merely prove the difficulty of obtaining liquid oxygen, and show conclusively the impossibility of retaining it in a liquid state.

M. Pictet has proved that the density of liquid oxygen is about the same as water; hence, oxygen gas at 0° C. is about 699 times as light as the liquid, but at −140° C. (the temperature of M. Pictet's experiment) these 699 volumes would be decreased to 340 volumes. As the pressure was 320 atmospheres the oxygen which retained the gaseous state was nearly as dense as the liquefied portion. Hence, if Mr. Lancaster took some of M. Pictet's liquefied oxygen, and stored it in a strong bottle, the latter would be subjected to a pressure of about 700 atmospheres on acquiring the ordinary temperature.

In further reply to query 32045, page 608, respecting koumiss, I do not think the addition of new milk to old koumiss would result at once in a product resembling fresh koumiss. As "A." seems actively interested in the subject, I condense the following facts from the *Pharmaceutical Journal* (Oct. 24, 1874) which paper itself obtained them from the *Daily News.* Various tribes in Tartary were found to prepare a fermented liquid from mare's milk. Those who habitually drank this were entirely free from consumption and cognate disorders. A Dr. Postinkoff started a koumiss establishment at Samara, on the left bank of the Volga. Dr. Yagielski, a Polish physician resident in London, says cow's milk is as good, or better, than mare's for the manufacture of koumiss.

The following is the process of preparation:—One-third of koumiss is mixed with two-thirds of fresh (mare's) milk in a clean wooden vessel resembling an English churn, and there left from six to eighteen hours, according to the alcoholic strength required. During this time it is occasionally churned. Any secret there is in koumiss-making is to know the amount of churning required. It must be suspended at the point where curds or butter would be formed. Habit and practice alone teach this. After this churning and fermenting process has lasted for, say, six hours, a portion of the contents of the vessel is drawn off, and this constitutes the weakest kind of koumiss. Another portion tapped off, after a continuation of the process for a further period of six hours, is of stronger quality, and so on with the last or third degree of strength.

The koumiss is put without delay into strong bottles. When koumiss is not obtainable for the initiation of the fermentation, the process may be conducted as follows:—Two tablespoonfuls of yeast are put into a quart bottle filled with (mare's) milk, and the mixture is allowed to ferment for twenty-four hours. This may then be used instead of koumiss for starting the fermentation of twice its bulk of fresh milk, and this again for a still larger amount. Some patients at Samara drink six or eight bottles of koumiss per diem, subsisting entirely on it. It is, in no sense, a specific for consumption, but is of sovereign efficacy in recovery from a long illness where no organic detriment exists.

Clearly the London koumiss, of which I gave the analysis on page 555, was prepared from, wholly or partially, skimmed milk, and it is probable that sugar was also added. The koumiss made at Davos, Switzerland, has the following composition

	Per cent.
Alcohol	3 21
Fat	1·78
Sugar	2·10
Lactic Acid	0·19
Casein and Albumin	1·86
Salts	·51
Carbonic Acid	·18
	9·83

I do not remember what process I formerly suggested that Malcolm Sellars should try for "Estimating carbolic acid in crude samples." (Query 32226, page 612.) It is difficult to recommend a process without knowing what skill the querist has in chemical manipulation, and those which are serviceable for the strong acid are not applicable to dilute solutions. Koppeschaer's method is one of the best. The solution of the known quantity of the sample is treated with bromine water of known strength, in quantity more than sufficient for the reaction $C_6H_6O + 6Br = C_6H_3Br_3O + 3HBr$. The free bromine remaining is ascertained by adding potassium iodide and titrating the liberated iodine with standard hyposulphite; the original strength of the bromine water is ascertained in a similar manner. The process is accurate and fairly simple. If Mr. Sellars is chemist enough to understand the principle of the above process, I shall be happy to give him working details, but, otherwise, it is useless.

Another plan, which appears very simple, but which can only give approximate results, is the following:—Take 100cc. of the 5 per cent. solution, allow any tar, &c., to settle, filter if necessary, and add to 100c. of the clear liquid 10 drops of a 10 per cent. solution of ferric chloride in water. A violet-blue colour is produced, the depth of tint of which is compared with that yielded by a freshly-prepared aqueous solution of carbolic acid of known strength.

C. E. Clinch asks a curious question about heat from coal (query 32286, page 613). In two coals, containing respectively 1 and 2 per cent. of ash the combustible matters are consequently in the proportion 99 and 98. Hence, if burnt under exactly the same conditions, and if the combustible matter had exactly the same composition, the first coal should last 99 minutes to the other's 98. Is C. E. Clinch sure it did not? Has he tried any such experiment with sufficient care, and is he sure his method of experiment did not involve a far larger possibility of error than 1-99th of the total result? If he is I should like to know the plan he employed.

Boric acid (query 32257, page 612) can be determined in borax by titration with standard sulphuric acid, using litmus as an indicator. As soon as enough sulphuric acid has been added to convert all the base into neutral sulphate a single drop in excess will change the colour of the liquid from a wine to a bright red tint. The acid used calculated into its equivalent of boric acid shows the amount of the latter present in the sample of borax.

Davyum is a metal recently described by M. Sergius Kern, of St. Petersburg, who obtained it from a particular solution resultant from the analysis of platinum ore, which solution had been indicated by Bunsen as likely to contain an unknown metal. M. Kern's analytical antecedents are not very favourable, and therefore his description of the characters of Davyum and its salts must be received with some reserve. The platinum ore from which Davyum was obtained contained, according to M. Kern, only about 0·01 per cent. of the new metal. Davyum is said to have a density of 9·39, and an atomic weight approximating to 154. Boiling sulphuric acid converts it into a nearly insoluble yellowish-red sulphate. The metal dissolves in aqua regia, yielding a chloride which is very soluble in water, alcohol, and ether. The chloride forms double salts with the chlorides of the alkali-metals. The potassium, thallium, and ammonium are insoluble in water, but soluble in alcohol. The sodium salt is nearly insoluble in water and alcohol. Davyum is precipitated from acid solutions of the chloride as Davyum sulphide, soluble in alkaline solutions. Even in solutions of Davyum perfectly free from iron sulphocyanides give a characteristic purple-red colouration. I think by the above facts Sergius Kern has proved his case.

Sheffield, March 2. **Alfred H. Allen.**

OXYGEN.

[14089.]—WHILE reading the answers given as to the cause of a recent explosion it has occurred to me that it would be well to mention an occasional cause of accident—viz., the bursting of the retort owing to the water in the wash-bottle rushing back into it consequent upon the supply of oxygen ceasing temporarily. A friend of mine once suggested a means of avoiding this calamity, by connecting the retort with an empty vessel, which in its turn is connected with the wash-bottle, &c. If the rush back does take place no harm is done, and, moreover, it serves as an indicator to the operator. **Yule.**

ALCOHOLS.

[14090.]—THE term achohol was originally applied to the spirituous liquor produced by the fermentation of sugar—thus, $C_6H_{12}O_6 = 2CO_2 + 2C_2H_5 + Ho$. From the formula C_2H_5Ho we see that it is a compound of the hydrocarbon ethyl, C_2H_5, and a semi-molecule of hydroxyl, H_2O_2, and as the other hydrocarbons of the series having the general formula, $CnH_2n + 1$, to which C_2H_5 ethyl belongs, unite with hydroxyl, forming homologous compounds possessing chemical properties analogous to this substance, the term alcohol has been made generic, and has therefore been applied to the whole class of substances. This term has been still further extended to all neutral compounds of carbon, hydrogen, and oxygen, which produce ether by the abstraction of water by acids from those compounds. The alcohols may be supposed to be derived from water by the substitution of radicals of the series $CnH_2n + 1$ for one atom of hydrogen thus, $O\begin{cases}H\\H\end{cases}$ and $O\begin{cases}C_2H_5\\H\end{cases}$.

Methyl alcohol is one of the products obtained from the destructive distillation of wood in closed vessels. It is obtained from methosalicylic acid by the action of potassic hydrate, thus, $C_7H_4OMeOHo + KHo = CH_3Ho + C_7H_4OKOHO$.

By the action of potassic hydrate on methylic chloride, which is obtained by the action of chlorine on marsh gas, thus:

$$CH_4 + Cl_2 = HCl + CH_3Cl, \text{ and}$$
$$CH_3Cl + KHo = KCl + CH_3Ho.$$

When distilled from wood it is accompanied with acetic acid, methyl and ammonic acetates, hydrocarbons, and tarry matter. This mixture of substances is saturated with lime and distilled. The lime retains the acetic acid, tarry matter, and water, and the methyl alcohol and other substances distil over. After another distillation with lime dry calcic chloride is added to the distillate, which combines with the methyl alcohol. The other substances can be drawn off by heating to 100° C. The dry mass that is left is mixed with water and distilled, when this alcohol distils over and is dried by redistillation with quicklime.

Methyl alcohol is an inflammable colourless liquid, having an odour somewhat like ordinary alcohol, and a burning taste. It has a specific gravity of ·8 and boils at 66° C. Its molecular weight is 32, and one litre of the vapour weighs 16 criths. Water, alcohol, and ether dissolve it in all proportions. It burns like common alcohol, producing water and carbonic anhydride. It is generally used as a substitute for ordinary alcohol on account of its cheapness, and these two are mixed and sold as methylated spirit. It dissolves fats, essential oils, and resins. The resin solution is used as varnish. This alcohols unites with calcic chloride, forming crystals, having the composition $2MeHoCaCl_2$, and it dissolves baryta, forming the crystal compound $2MeHoBao$. It dissolves sodic and potassic hydrates, and when oxidised water and formic acid are formed thus, $CH_3Ho + O_2 = OH_2 + HCoHo$. Sodium and potassium displace one atom of hydrogen, forming the methylates CH_3Nao and CH_3Ko. When heated with potassic hydrate hydrogen is given off, and potassic oxalate is formed thus, $2CH_3Ho + 2KHo = (CoKo)_2 + 5H_2$. Chloroform is produced when it is distilled with bleaching powder and water, thus, $2CH_3HO + 4CaoCl_2 = 3oH_2 + (Cao)_2O\ (CaCl)_2 + 2CHCl_3$. Hydrochloric acid acts on it, forming water and methylchloride thus, $CH_3Ho + HCl = OH_2 + CH_3Cl$. Similar compounds can be formed by the action of HBr and HI. It forms CH_3HSO_4 and $(CH_3)_2So_4$ with H_2SO_4. When it is distilled with CH_3HSO_4, methyl ether is formed which is isomeric with ethyl alcohol thus, $CH_3HSO_4 + CH_3HO = H_2SO_4 + (CH_3)_2O$.

Ethylic alcohol is prepared by the action of HI on CH_3Ho, giving methyl iodide thus, $CH_3Ho + HI = OH_2 + CH_3I$, and by the action of zinc on the iodide ethyl hydride is obtained thus, $2CH_3I + Zn = C_2H_6 + ZnI_2$, and by the action of chlorine on this hydride ethyl chloride is obtained thus, $C_2H_6 + Cl_2 = C_2H_5Cl + HCl$. By acting on this chloride by potassic hydrate the alcohol is obtained thus, $C_2H_5Cl + KHo = C_2H_5Ho + KCl$.

Acetylene C_2H_2 is produced by the voltaic current passing between carbon points in an atmosphere of hydrogen, and nascent hydrogen acting on C_2H_2 forms C_2H_4, and H_2SO_4 with this forms $HC_2H_5SO_4$, which, being distilled with water, forms alcohol thus, $HC_2H_5SO_4 + OH_2 = H_2SO_4 + C_2H_5Ho$. By adding one part of fresh beer yeast to four parts of cane sugar dissolved in twenty parts of water, fermentation will commence in less than an hour at a temperature of about 20°C. The cane sugar takes up water and forms grape sugar thus, $C_{12}H_{22}O_{11} + OH_2 = 2C_6H_{12}O_6$, and the yeast acting on the grape sugar forms carbonic anhydride and alcohol thus, $C_6H_{12}O_6 = 2Co_2 + 2C_2H_5Ho$. The fermented liquid is distilled by which the crude alcohol is obtained, containing water and small quantities of other substances. This crude spirit is poured on fragments of quicklime in a retort and allowed to stand until the lime falls to powder, by abstracting water from the alcohol and forming calcic hydrate. It is distilled in a water or calcic chloride bath, the result being absolute or anhydrous alcohol. However, if it still contains traces of water, subject it to another distillation with quicklime.

Ethylic alcohol is a volatile, inflammable, limpid, colourless liquid, with an agreeable odour and a hot burning taste. It boils at 78·5°C., and has not been solidified, but at —110°C. it becomes glutinous. For this reason it is used, when coloured by cochineal, to register low temperatures. Its molecular weight is 46, and one litre of the vapour weighs 23 criths. Its specific gravity is ·81 at 0°C., and in the state vapour it is 1·6. It burns with a non-luminous flame, forming water and carbonic anhydride, requiring three volumes of oxygen for perfect combustion, thus, $C_2H_5Ho + 6O = 2Co_2 + 3oH_2$. As it burns at a high temperature and deposits no soot on bodies introduced into its flame, it furnishes a very valuable source of heat to chemists. It forms the characteristic ingredient of fermented liquors, of which an extraordinary quantity is consumed to produce a state of temporary insanity and curtail the natural length of life. It is a narcotic poison, and when taken in excess in the concentrated state causes death. It is one of the most important medicines and one of the most important chemical reagents. Proof spirit contains approximately equal weights of alcohol and water exactly, =50·76 of the former and 49·24 of the latter, and having a specific gravity of ·91984 at 60°F. Whiskey and brandy should contain upwards of 50 per cent. of alcohol. Wines contain from 17 to 7 per cent., and beer ale and porter from 5 to 7 per cent. by weight of alcohol. It is difficult to obtain absolute alcohol on account of its strong affinity for water. When mixed with water it emits heat and contracts in volume, 50 volumes of water and 53½ of alcohol, producing 100 instead of 103½ volumes of the mixture. Alcohol dissolves a great many substances, and, being volatile, can easily be separated, leaving the substance dissolved in a pure state. It dissolves many of the vegetable acids, most of the deliquescent salts, many of the gases, the hydrocarbons, the essential oils, the vegetable alkaloids, the resins, K, Na, KHo, NaHo, K_2S, Na_2S, NH_3, Br, I, Co_2, ON_2 $(CN)_2$, PH_3, and small quantities of SP, soaps, sugar, fats, and fixed oils. It is decomposed when passed through hot tubes, the products varying according to the temperature. At a very high temperature hydrogen alone is given off and carbon deposited at a lower temperature, naphthalin and benzol, and at a still lower temperature carbonic oxide, marsh gas, olefiant gas, water, ethylene, acetylene, and hydrogen are produced. By oxidation it is converted first into aldehyde and afterwards into acetic acid, thus, $C_2H_5Ho + O = MeCOH + OH_2$ and $CH_3CoH + O = CH_3CoHo$. When poured on sodium or potassium ethylates are formed, hydrogen being given off thus, C_2H_5Nao and C_2H_5Ko. When treated with nitric acid, oxalic, glycolic, and glyoxalic acids and nitrous ether are produced. When one part by weight of silver is dissolved in two parts of NO_2Ho and excess of alcohol added, crystals of argentic fulminate are formed. When treated with chlorine, hydrochloric acid, ethylic chloride, and chloral hydrate are produced thus, $2C_2H_5Ho + 4Cl_2 = 4HCl + C_2H_5Cl + C_2H_2Cl_3O_2$. Coloroform is produced when it is distilled with chloride of lime. Alcohol takes the place of water of crystallisation in the following compounds termed alcoholates — viz., $CaCl_24C_2H_5Ho$. $ZnCl_2$, $2C_2H_5Ho$, $N_2O_4Cao6C_2H_5HoN_2O_4Mgo6C_2H_5Ho$ and $MnCl_24C_2H_5Ho$.

Phenylic alcohol or carbolic acid is formed by passing ethylic alcohol through a red hot tube and by passing acetic acid through a red hot tube. It is produced by treating aniline hydrochlorate with potassic nitrate, thus, $NH_2\ (C_6H_5)HCl + NOKo = C_6H_5Ho + N_2 + OH_2 + KCl$. It is obtained by distilling salicylic acid with lime thus, $C_6H_5OCoHo + Cao = C_6H_5Ho + Cocao''$. It is produced by the destructive distillation of many organic bodies, especially of coal. The oil of the coal tar, which boils between 150° and 200°C., is collected and mixed with a hot saturated solution of potassic or sodic hydrate, and when some powdered hydrate is added a white precipitate is formed. The precipitate is dissolved in some water, when the solution of potassic or sodic phenate will fall to the bottom of the vessel, while a lighter layer of oil remains on the top, which is separated, and the potassic or sodic phenate is decomposed by HCl when the phenylic alcohol is liberated and rises to the top. To remove water it is digested with calcic chloride. It is distilled when it crystallises in colourless needles on being exposed to a gradually diminishing temperature. It is produced by the distillation of gum benzoin which contains benzoic acid, C_6H_5CoHo, from which C_6H_5Ho is obtained. This gum also contains an essential oil and three varieties of resin. The Xanthorrhœa hastilis, the grass tree of New South Wales, yields a yellow gummy substance, from which this alcohol is obtained by distillation.

Phenylic alcohol or carbolic acid, when pure, is a white crystalline solid, melting at about 35°C., and boiling at 187°C. Its molecular weight is 94, and one litre of the vapour weighs 47 criths. It is benzol C_6H_6 in which one atom of H has been replaced by HO. It does not, like the true alcohols, give an acid on oxidation, but the H of the HO is displaced by the metals in the same way as acids, so that this substance possesses at once the nature both of alcohols and acids. Picric or trinitrophenylic acid, $C_6H_2\ (NO_2)_3Ho$, like any acid forms salts that crystallise well. It has the odour of tar or creosote, and has a hot taste. It is much used as a disinfectant, rendering sewage, &c., inoffensive. It quickly arrests all fermentative and putrefactive changes. It readily dissolves in ether, strong acetic acid, and alcohol, but is scarcely soluble in water.

Its crystals readily liquefy in presence of moisture; with water it forms a crystalline hydrate, $(C_6H_5Ho)2H_2O$. Treated with Br it forms C_6H_4BrHo. Treated with chlorine it forms the substitutive products, $C_6H_3Cl_2Ho$, $C_6H_2Cl_3Ho$ and C_6Cl_5Ho. Treated with nitric acid it forms $C_6H_4(NO_2)Ho$, $C_6H_3(No_2)_2Ho$, and $C_6H_2(NO_2)_3Ho$. It forms with plumbic oxide an insoluble compound, C_6H_5HoPbo. The dye termed aurine is formed by mixing it with H_2SO_4 in a glass vessel and heating to 127°C., when a quantity of oxalic acid, nearly equal to the weight of H_2SO_4, is gradually added. When put in cold water it solidifies in a green mass, which is next worked in boiling water to remove some of the H_2SO_4. It forms, with potash and soda, crystalline compounds. When put in a sealed tube with ammonia and heated, aniline $N(C_6H_5)H_2$ is formed, thus, $C_6H_5Ho - NH_3 = N(C_6H_5)H_2 + OH_2$.

Hugh Clements.

DISTILLATION OF SHALE.

[14091.]—"Justitia" (let. 13978) asks me a few questions which he no doubt considers to be "posers," and characterises my article on the above subject as a "wholesale piracy." To this assertion I beg to give an unqualified denial, and would advise "Justitia" not to make such rash statements till he is prepared to prove their accuracy. At the time when I wrote the letter referred to I had neither seen nor heard of Dr. Mill's publication, and after an examination of the pamphlet I find that the only point in which they resemble one another is in the list of distillation products, the greater number of which may be found in "Ure's Dictionary," which is a standard work. The reason of this similarity I mentioned in the number of Feb. 22. In "Destructive Distillation" the whole subject of the formation of coal is dismissed in a sentence, and the manner in which the various elements group together to form the more complicated compounds, is barely touched upon, these being the principal points which I took up. Besides this a theory of coal formation similar to that of Dr. Mills appeared in No. 506 of this very journal—that is, more than three years ago. I trust I have clearly shown that the charge of "wholesale piracy" of which I am accused by "Justitia," has not the slightest foundation of truth, and that neither the Editor nor our readers will consider it "a misappropriation of valuable space" if I should continue the subject at some future date.

Jup. Rex.

[Reference to the book confirms the truth of "Jup. Rex's" statements, and we think "Justitia's" charge an unfounded one.—Ed.]

THE ALDEHYDES.

[14092.]—The aldehydes are compounds formed by the oxidation of the alcohols. Thus methyl alcohol, $HCH_2HO + O = OH_2 + HCOH$ (formic aldehyde). The aldehydes on further oxidation are converted into acids thus, $HCOH + O = HCOHO$ (formic acid). In the same way ethylic alcohol is converted by oxidation into acetic aldehyde, and by further oxidation into acetic acid, thus: $CH_3CH_2HO + O = OH_2 + OH_3COH$ (acetic aldehyde) and $CH_3COH + O = CH_3COHO$ (acetic acid). The alcohols, like other organic compounds, when burned with a sufficient supply of oxygen or air, form water and carbonic anhydride; but if the combustion is effected at a low temperature with an insufficient supply of air, aldehyde and other compounds are formed. The alcohols may be oxidised by a mixture of manganic oxide and sulphuric acid. From these reactions we see that the aldehydes are compounds intermediate between the alcohols and the corresponding acids. Methylic alcohol HCH_2Ho, ethylic CH_3CH_2HO, propylic $C_2H_5CH_2HO$, butylic $C_3H_7CH_2HO$, &c., all contain the group CH_2HO and oxygen unites with H_2 of the group, forming water (OH_2) and leave COH, which is the group common to all the aldehydes thus: HCOH, CH_3COH, C_2H_5COH, C_3H_7COH, &c., are respectively formic, acetic, propionic, butyric, &c., aldehydes, and the acids are characterised by the group COHO, which is formed by oxygen uniting with the aldehyde group COH becoming COHO. Formic, acetic, propionic, butyric, &c., acids are respectively symbolically represented by HCOHO, CH_3COHO, C_2H_5COHO, COH_7COHO, &c. The group COH of the aldehydes is converted into the corresponding alcohol by the action of nascent hydrogen forming the group CH_2Ho, the alcohol radical $C_nH_{2n} + 1$ remaining unchanged. There are aldehydes formed from the monohydric alcohols, $C_nH_{2n} + 1HO$, $C_nH_{2n} - 1HO$, and $C_nH_{2n} - 7HO$. There is also an aldehyde glyoxal $(COH)_2$ formed by the abstraction of four atoms of hydrogen from glycol $(CH_2HO)_2$, or by the oxidation of alcohol by nitric acid, thus: $CH_3CH_2HO + O_3 = 2OH_2 + (COH)_2$. The following are the aldehydes derived from the $C_nH_{2n} + 1HO$ series of alcohols—viz., formic, acetic, propionic, butyric, valeric, œnanthic, caprylic, capric, enodic, lauric, and palmitic, represented symbolically by HCoH, CH_3COH, C_2H_5COH, C_3H_7COH, C_4H_9COH, $C_6H_{13}COH$, $C_7H_{15}COH$, C_9H_9COH, $C_{10}H_{21}COH$, $C_{11}H_{23}COH$, $C_{15}H_{31}COH$ respectively. The aldehydes can be formed by distilling the potassic salt of the acid series $C_nH_{2n} + 1$, with potassic formate, thus: $CH_3COKO + HCOKO = COKO_2 + CH_3COH$. The aldehyde CH_3COH is converted by nascent hydrogen into the alcohol, thus: $CH_3COH + H_2 = CH_3CH_2HO$. Sulphuric acid converts the alcohols into sulphovinic acid, thus: $CH_3CH_2HO + H_2SO_4 = HC_2H_5SO_4 + OH_2$, and potassic cyanide converts the sulphovinic acid into ethylic nitrile, thus: $HC_2H_5SO_4 + KCN = HKSO_4 + C_2H_5CN$. Potassic hydrate converts the nitrile into the alcohol thus: $C_2H_5CN + KHO + OH_2 = C_2H_5COKO + NH_3$. Thus, by starting with potassic acetate, CH_3COKO, we have by this series of reactions ascended to potassic propionate, C_2H_5COKO, and by starting again with the latter we can obtain C_3H_7COKO, the next higher, and so on, ascending the series of fatty acids.

The aldehydes combine with oxygen forming acids thus $C_nH_{2n} + 1COH + O = C_nH_{2n} + 1COHO$. They combine with hydrogen forming the alcohols, thus: $C_nH_{2n} + 1COH + H_2 = C_nH_{2n} + 1CH_2HO$. They combine with ammonia forming crystalline compounds, thus: $C_nH_{2n} + 1COH + NH_3 = C_nH_{2n} + 1CONH_4$. They also produce crystalline compounds with the alkaline hydric sulphites, thus: $C_nH_{2n} + 1COH + HKSO_3 = HKSO_3C_nH_{2n} + 1COH$. When heated with an ammonia solution of argentic oxide, metallic silver is deposited, and they are converted into acids, thus: $C_nH_{2n} + 1COH + OAg_2 = C_nH_{2n} + 1COHO + Ag_2$. When heated with potassic hydrate hydrogen is given off and a potassic salt is formed, thus: $C_nH_{2n} + 1COH + KHO = H_2 + C_nH_{2n} + 1COKO$. Sodium and potassium decompose the aldehydes, thus: $2C_4H_9COH + K_2 = 2C_4H_9COK + H_2$. Aniline acting on the aldehydes forms diamines, thus: $2CH_3COH + 2C_6H_5NH_2 =$

$$\left.\begin{array}{l} N\,(C_2H_4) \\ \quad (C_6H_5)_2 \\ N\,(C_2H_4) \end{array}\right\} + 2OH_2.$$

Hydrocyanic acid converts aldehyde into amido-acids, thus: $CH_3COH + HCN + OH_2 = N(C_2H_4COHO)H_2$ which is alanin or lactamic acid, an amido-acid.

Acetic aldehyde can be best prepared by acting on alcohol $((C_2H_5HO)$ by potassic bichromate and sulphuric acid, and allow the gas given off to pass into ether, into which ammonia is passed. The ammonia forms with the aldehyde the compound CH_3COHNH_3 which gives the aldehyde when distilled with dilute sulphuric acid. Or by oxidising C_2H_5HO in various other ways. When the vapour of alcohol and air are passed through a porcelain tube heated to dull redness aldehyde is formed. It is prepared by placing four parts of C_2H_5HO, four of OH_2, six of H_2SO_4, and six of MnO_2 in a retort and distilling when aldehyde passes off and is condensed in a receiver cooled by ice. By calcic chloride it is freed from water and alcohol. It is then mixed with ether and separated as described above. It is also formed by the oxidation of albumen casein fibrin, by the dry distillation of lactic acid or a lactate, and by the action of chlorine on dilute C_2H_5HO. Again, it is formed when the dichloride of diethylene diamine $N_2(C_2H_4)_2H_2$ is acted on by argentic nitrate and a small quantity of sulphuric acid, thus: $N_2(C_2H_4)_2H_2Cl_2 + 2NO_2AgO = 2AgCl + 2OH_2 + 2N_2 + 2CH_3COH$. Acetic aldehyde has a molecular weight of 44, and one litre of the vapour weighs 22 criths. It boils at 22° C. It is an inflammable volatile colourless liquid having a specific gravity of ·8. It has a suffocating odour. It mixes in all proportions with water, alcohol, and ether. It gradually absorbs oxygen from the air, forming acetic acid. It unites with nascent hydrogen forming alcohol. It reduces silver salts to the metallic state. Potassium acting on it forms CH_3COK, hydrogen being evolved. Phosphoric chloride acting on it produces ethylidenic dichloride, thus: $CH_3COH + PCl_5 = POCL_3 + CH_3CHCl_2$.

Nitrous anhydride converts lactamic acid or alanin into lactic acid, thus: $N(C_2H_4COHO)H_2 + N_2O_3 = 2C_2H_4HOCOHO + 2OH_2 + 2N_2$. And hydrocyanic acid changes it into lactamic acid thus: $CH_3COH + HCN + OH_2 = N(C_2H_4)H_2COHO$. Chlorine acting on it produces chloral, thus: $CH_3COH + 3Cl_2 = CCl_3COH + 3HCl$. When treated with potassic hydrate a brown resinous mass is produced.

When aldehyde is kept in a sealed tube it changes into elaldehyde, a liquid, and metaldehyde, a solid crystalline body, both of which are isomeric with it. Paraldehyde is another isomeric form, produced by diluting it with an equal volume of water, having a trace of nitric or sulphuric acid, and exposing to the temperature of 0°C. when metaldehyde crystallises, and the paraldehyde remains in the liquid state. When it is digested with a saturated solution of sodic formiate in a sealed tube at 100°C. for two or three hours, it loses water thus: $2CH_3COH = C_4H_6O + OH_2$. When it is treated with acetic anhydride in a sealed tube to 183°C. they unite, forming a colourless liquid, thus: $(C_2H_3O)_2O + CH_3COH = CH_3COH(C_2H_3)_2O$, or $C_6H_{10}O_4$.

Benzoic aldehyde, C_6H_5COH, is obtained from the cake which is left after the fixed oil of almonds has been pressed out of the bitter almonds. This cake contains amygdalin and synaptase or emulsin. It is crushed and made into a paste with water, when the emulsin acts as a ferment on the amygdalin. The paste is put in a retort, and after a day heat is applied gradually and it is distilled, when the essential oil passes into the receiver, accompanied by hydrocyanic acid and water. It can be fusified by submitting it to the action of ferrous chloride and calcic hydrate and distilling, when the pure oil passes into the receiver freed from prussic or hydrocyanic acid, which is very poisonous.

Amygdalin $C_{20}H_{27}NO_{11} + 2OH_2 = HCN + 2C_6H_{12}O_6 + C_6H_5COH$. It is produced by the oxidation of amygdalin by nitric acid, and by the oxidation of albumen, caseine, fibrine, and gelatine by sulphuric acid and binoxide of manganese.

It is also produced by heating benzylic chloride and plumbic nitrate with water together, thus: $2C_7H_7Cl + Pb(NO_3)_2 = OH_2 + N_2O_3 + PbCl_2 + 2C_6H_5COH$. It is a colourless liquid having a bitter taste, and an agreeable odour. It burns with a smoky flame, and is inflammable. Heated to 180°C. it boils and distils over unaltered. It is dissolved by ether and alcohol in all proportions, and to the extent of three per cent. by OH_2. When exposed to the air it oxidises into benzoic acid. Nascent hydrogen converts it into benzyl alcohol, thus: $C_6H_5COH \times H_2 = C_6H_5CH_2HO$. When heated with solid potassic hydrate, potassic benzoate is formed thus: $C_6H_5COH + KHO = C_6H_5COKO + H_2$. When treated with phosphoric chloride chlorobenzol is formed thus: $C_6H_5COH + PCl_5 = POCl_3 + C_6H_5CHCl_2$. It is converted into nitro-benzoic acid by concentrated nitric acid thus: $C_6H_5COH + HNO_3 = OH_2 + C_7H_5NO_3$. It is sold under the name of hydride of benzoyle. In medicine it is used instead of prussic acid. It is used for scenting soaps and for flavouring confectionery.

Hugh Clements.

THE KENTISH RAGSTONE AND CRYSTALS.

[14093.]—In reply to "G. J. H." (p. 579) I still consider the crystals referred to bear a greater resemblance to the form of the pentagonal dodecahedron than they do to that of the six sided prism with pentagonal faces. I have made small models of these forms for the purpose of comparison, as well as of all the principal forms in which minerals crystallise. Of course it is possible, and perhaps I may say probable, that the crystals are six-sided prisms so very much modified that it is utterly impossible to distinguish between them and the dodecahedrons. In the present case it appears to me that the form of all the crystals is very similar to the pentagonal dodecahedrons, and unlike the ordinary six-sided prism. I am loth to believe that they are dodecahedrons in reality, from the considerations that I have never known calcic carbonate to crystallise in the cubic system, and would fain believe that they are six-sided prisms with pentagonal faces so far modified that they merge into the form of dodecahedrons. Does "G. J. H." think this metamorphosis (considering the manifold freaks of nature) would be extremely improbable, or even utterly impossible? I may say I have had too much experience of competitive examinations to dream of stating on such occasions that calc spar ever crystallises in the monometric system, because I am not quite certain that it does, and I know that examiners must have set answers to the questions put, and these answers must range strictly within the domain of recognised facts.

Examiners deal in facts, and facts alone, and if you venture to give opinions you must on no account give your own, unless they tally with those of the examiner or those of some other recognised authority. "G. J. H." still adheres to his statement that the six-sided prism is a secondary form of the rhombohedron. I will just ask him is the rhombohedron a hemihedral form, and is the six-sided prism a holohedral form? If so, is not the rhombohedron the derived or secondary form? If he is right then the oblique, double oblique, rhombic, and tetragonal spheroids and the hemihedral forms of the tesseral system are the primary, while the corresponding holohedral forms are secondary. The planes of all crystals are referred to axes, and on this reference is based the division of crystals into the six groups—viz., the octohedral, pyramidal, hexagonal, rhombic, monoclinic, and triclinic. In the first there are three equal axes, intersecting each other at right angles. The faces of the octohedron are all equidistant from the point of intersection of the axes. And if this distance is represented by unity then the parameters are to each as 1 : 1 : 1. In the cube each face is parallel to two axes, and intersects one axis at the same distance, which may be taken as unity; then, since each face would meet two axes at an infinite distance and the other at equal distances, we may represent the cube by ∞ : 1 : ∞. The cube is derived from the octohedron by planes passing through each solid angle parallel to two of the axes. And the rhombic dodecahedron symbol ∞ : 1 : 1, triakis octahedron m : 1 : 1, tetrakis hexahedron ∞ : 1 : n, icositetrahedron m : 1 : m, and the hexakis octohedron m : 1 : n are all derived from the octohedron by planes placed in the positions represented by the symbols.

The hemihedral forms of this system are derived from the holohedral forms by enlarging the alternate planes of the holohedral forms respectively, until the intermediate planes have disappeared, when forms are obtained having only half the number of faces; hence they have been termed hemihedral forms. And these forms are derived from the holohedral, and not the holohedral from the hemihedral. By taking the symbol O to represent the octohedron or 1 : 1 : 1, then the symbols for the hemihedral forms are $\frac{O}{2}$, $\frac{mO}{2}$, $\frac{mOm}{2}$, $\frac{mOn}{2}$, $\left(\frac{mOn}{2}\right)$, and $\frac{\infty On}{2}$ for the tetrahedron, deltoidal dodecahedron, trigonal dodecahedron, hexakis tetrahedron, diakis dodecahedron, and the pentagonal dodecahedron respectively.

In the hexagonal there are four axes, three lateral of equal length intersecting the fourth or principal axis at right angles, and each other at angles of 60° in one plane.

The hexagonal pyramid is considered the primary form of the hexagonal system, all the other forms being derived from it. It is bounded by twelve isosceles triangles intersecting the lateral axes at equal distances from the centre, and the vertical axis at any point m having the symbol mP. The hexagonal prism is derived from the pyramid by supposing the planes, instead of meeting the principal axis at the distance m, to meet it at an infinite distance, and hence parallel to the principal axis. Its symbol is therefore ∞P, and, as it is inclosed by two six-sided planes, it has the symbol OP additionally. *The rhombohedron is derived from the pyramid by developing its alternate faces.*

I have referred thus briefly to the axes of crystals in order to show that they are the basis of the primary forms from which the secondary are derived. **Hugh Clements.**

SPIRIT PHOTOGRAPHS.

[14094.]—A friend having shown me a number of the above curiosities of art, it occurred to me that their production without supernatural aid might be accomplished. For the benefit of those who have not seen similar specimens, I may say that they are likenesses of such persons as may choose to sit for them with the addition of such objects as figures draped in white in the background, bouquets of flowers, or markings of various kinds, probably caused by defects in the process. The conditions imposed on my attempt were that the sitter's photograph should be taken, to all appearance in the usual way, and that the ghost should appear at development on the negative. To do this properly (or perhaps we should say improperly), it is necessary to have two cameras, with a dark slide that will fit either. Camera No. 1 is arranged to take the sitter, while No. 2, in a separate room, has been previously focussed on a made-up figure representing the desired ghost. The sensitised plate is exposed first for the ghost and then for the sitter. Both come out on development. The same can be managed with one camera by having it arranged to take the "spirit" first, and after the exposure, removing it to take the sitter. Of course there may be other ways of taking these, but the above answers very well.

Belfast. **J. Brown.**

STOPCOCKS.

[14095.]—I beg to inform "Æquo Animo," before I answer his question, that I never read at random, and I will try to show him where he is mistaken in everything he says. In the first place, I did not pretend to use "C. E. R.'s" own words, neither did I say that I did. What I went by was the general tenor of the letter, and if "Æquo Animo" will look at the first few letters he will see that "C. E. R." quite supported him in his theory; so, even if I had misquoted "C. E. R.'s" words, I was not wrong in writing as I did. "Æquo Animo" is quite wrong regarding my thinking that I was supporting "A., Liverpool's" statements against his. As I stated in the beginning of my letter, that had it only been "Æquo Animo" and "A., Liverpool," I would not have written at all, but the editor omitted this to save space. He asked in letter 13872 "How are stopcocks turned out so accurately in the first instance, because undoubtedly the same method would be the one to set a faulty stopcock right again?" I might just as well say, how are a pair of boots made in the first instance, because if they want mending undoubtedly, &c. When they are first made the cylinder is bored out (see Fig. 1), and the plug is turned; they are then ground in, leaving a clear space of about ⅛in. at the bottom, generally three parts full of some kind of sand. Now, if a tap of this class requires grinding in, let him bore or turn out the cylinder and turn the plug. He will now find the plug nearly or quite ⅛in. too small for the cylinder; yet this is what he says is undoubtedly the way to set a faulty stopcock right again. This ought to convince him, on reading his own letter 13872, that he should let the matter drop. If he will force a screw tap through a nut with a one-ended wrench, it will cut what in workshop language is termed a drunken thread, and, if it is a cold morning, he will have a broken tap if he is not very careful. Now the violent and unequal strain on the screw tap is present in the stopcock, only in a less degree, and to prove it let him take a stopcock like Fig. 2, that requires grinding in, mix grease and blacklead into a stiff paste, spread a coat all over the plug, put it in its place, give it a turn, take it out, and you will see patches of a bright appearance. These patches or lumps are sometimes caused by the metal not being well mixed, as stopcocks are generally of the commonest metal that can be made. If he were to put a stopcock in this state into the lathe, as he says in letter 13789, and give it a few turns, he would have a fair stream of water running when the stopcock was turned off, because the lumps on the plug would grind into the cylinder, and form a hollow place all round the cylinder, so that the water could run whether the stopcock was open or shut. A tap like Fig. 2 might be re-bored, and the plug re-turned, if you have a good ¼in. of plug to spare at the top of the tap, only what would "Æquo Animo" do with the water passage, which would be quite as low down as shown by the dotted lines? Now, both taps, Figs. 1 and 2, could be made good jobs of by grinding in with the backward and forward motion. I have seen clever men try to regrind in taps with the brace (which would be far better than a lathe for this purpose), but they spoilt them after all the good advice they had offered them not to try it. I should be ashamed to put a tap into my lathe to try to grind it in. In back numbers of the English Mechanic I have seen answers enough on how to grind in stopcocks; they all advise a backward and forward motion. Surely this ought to satisfy "Æquo Animo." If "C. E. R." will take a tap like Fig. 1 apart he might find a thick pallet of sand that was used to grind it in with. **Chelt.**

FIG. 2

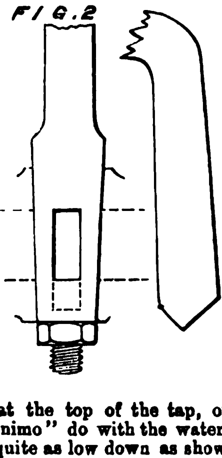
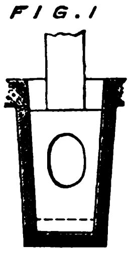
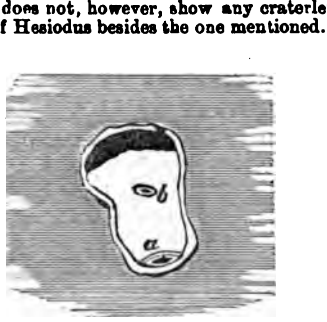


FIG. 1



SELENOGRAPHICAL.—To Mr. Gaudibert.

[14096.]—The crater alluded to by you in your letter in the English Mechanic for April 25th, 1873 (No. 422, p. 143), as being in the centre of Hesiodus, is shown on Lohrmann's map ("Karte des Monde"), and also appears very clearly in the drawing of Hesiodus in his VIIth section (Schmidt's edition). Hansen is shown with a very distinct central hill on both Lohrmann's map and on section XII. He does not, however, show any craterlet on the floor of Hesiodus besides the one mentioned.



On July 23rd, 1874, I found a craterlet in the interior of the curious formation III ξ^5 W. of Fontenelle, which is not shown by B. and M. or Lohrmann, &c., and is not found on your drawing in the English Mechanic for Aug. 5, 1870 (Vol. XI., p. 468). *Lambert.*—On the evening of April 22nd, 1877, I found a small crater, now under the exterior of the E. walls of this crater, which, as far as I am aware, has not been noticed before.

Mr. Birt, in a letter inserted in the English Mechanic for Feb. 17th, 1871, mentions that he has not seen the minute craterlet on the north border of N. Posidonius, and in your letter, No. 3698, March 1, 1872, you note that, though you have invariably looked for it on every suitable opportunity, you have never been able to see the least trace of it. On May 29th, 1876, I was fortunate enough to recover this craterlet, though it did not seem exactly in the position which Lohrmann and B. and M. assign to it. I also saw a small craterlet in the interior of "b." I annex a copy of the rough sketches made at the time.

March 1. **Herbert Sadler.**

DARK SIDE OF VENUS.

[14097.]—Absence from home has prevented me from replying sooner to Mr. Langdon's inquiry. I did not notice any "flickering light" on the unilluminated side of the planet; but it seemed sometimes more, sometimes less visible, even, as far as I recollect, to total disappearance (I have not my note-book at hand). This may possibly be another way of expressing the same thing; and if so, I think it may be explained by unsteadiness not of illumination but of visual power, as frequently happens with objects—"glimpse stars" for instance, or feeble nebulæ—just within the limits of visibility. If, however, a flickering of light over a *constantly visible* surface is intended, the explanation is not so easy, as we know of nothing analogous except the auroral light, which would obviously require to be extremely intensified and extended before it could, under such circumstances, be perceptible.

T. W. Webb.

ZODIACAL LIGHT—VENUS.

[14098.]—Have any of "ours" noticed the remarkable distinctness of the zodiacal light this spring? I fancied the region which ought to be occupied by it appeared brightish on Feb. 25d. 7h. 20m.; so to convince myself that it was not caused by the lamps of the town I walked round to the western shore here, leaving the town at my back. The note I made at the time was—"Very vivid, but paled much close to the horizon by the low lying mists. It extended right into Aries, passing between η and ε Piscium, having its apex south of β Arietis. Its edges are very ill-defined—it seems to melt away into the sky." Feb. 27d. 8h. I have another similar note, "Very vivid (comparatively), the cone extended to the middle of a line joining β Arietis (R.A. 1h. 47m. 54s., N. Dec. 20° 12′ 39″), and the planet Mars (R.A. 2h. 57m. 55s., ± N. Dec. 17° 58′ 30″ ±). At 8h. 40m. parts of the upper portion of the cone were visible, the lower being obscured by clouds." And to-night (March 2nd), although rather foggy, it is easily visible.

The so-called figures of Venus on p. 553, letter 13975, are certainly very little like the sketches they are supposed to copy. The bright edge round the limb is shown much too narrow (about as 1 : 3). The brightening towards the terminator is totally omitted. So also is the bright spot at *a* in Figs. 1 and 3. The woodcut above it in the same column is excellent.

Southampton, March 2. **Frank C. Dennett.**

ASTRONOMICAL NOTES.
To Mr. T. W. Webb.

[14099.]—On the evening of the 25th ult., on looking at Σ 939, to which you drew attention in letter 13938, I was rather surprised to see, or think I saw, a faint point *n.p.* the lucida of the triple. It appeared about as far from this as is the most N. star of the three. Would you tell me if this is the little star you mention in your letter? If it is I think it must be much above 13 magnitude, for my object-glass is only a 2¾in. I see you place this companion *p.* the *lucida*, but I thought that what I saw was rather *n.* of *p.* I am sure all the astronomical readers of "ours" would be pleased to see more frequently these "notes" by the author of "Celestial Objects." **Mac.**

COLLIERY CATASTROPHES.

[14100.]—As to the uprising of the floor of mines, as mentioned by several of your correspondents, "T. E. J." in letter 14046, seems to attribute this entirely to the pressure of the pent-up gas, but this cannot be, as the roads often lift where there is no gas. I think both agents come into play generally, the strata pressing above, and the gas exerting its force from below upward. I should be glad if "C. M." would explain more fully what he means in letter 14047 by saying the gas would not explode by reason of its "purity."

I cannot agree with "C. M.'s" statement respecting flame not being necessary to ignite light carburetted hydrogen (fire-damp). I am sure he cannot have tried the experiment. If he has not I would advise him to do so, and get the erroneous idea out of his head. To prove his theory he brings forward the fact that gas used in houses will ignite when a red-hot poker is brought near. Certainly it will, but we don't burn fire-damp in our houses; the gas burnt in streets, houses, &c., is totally different from fire-damp.

The reason a safety-lamp becomes dangerous to use in an explosive atmosphere after having got very hot is that the flame, coming in contact with the wire gauze, so absorbs the heat and cools the flame that it will not pass through the gauze, but when the gauze becomes as hot as the flame, then it will pass through and ignite the gas outside.

P. M. Chester.

TELESCOPIC APERTURES.

[14101.]—If I were told that a telescope was of 1in. aperture I should conclude that the "exposed portion" of its O G. was circular, and of 1in. in diameter (letter 13840), but I should never suppose, if I heard that the power of a telescope was so much to the *inch* of aperture (letter 13309), that any but a *square* inch was intended. The light-grasping power of an O.G. may increase as the square of its diameter, but it increases as the area of the "exposed portion" of the O.G. increases also, and as it is customary to give the areas of circles (and plane figures generally, so far as I know) in *square* inches, square feet, &c , why should a *round* inch be chosen for an O.G. ? Moreover, a circle of 1in. in diameter is an inch in one sense only ; its area is less than an inch. Is it not then a mistake to speak of the power of a telescope as being so much to the *inch* of aperture, unless a *square* inch be used for the purpose ?

8¼in. O.G.

WOODEN SLIDE-REST.

[14102.]—I send you a description of a wooden slide-rest for cutting light screws for microscopes, &c., which may interest some of your readers. It was made by a friend of mine from his own design entirely, he never having even seen or rather examined a real slide rest.

It consists of a wooden body, A (made of beech), to slide into the ordinary rest piece. Fig. 1 is section of side, and Fig. 2 of end, both cutting it in the centre of sliding block, B, which carries the cutting tools, C and D, and is propelled in two slides (as shown in Fig. 2) by the screw, L.

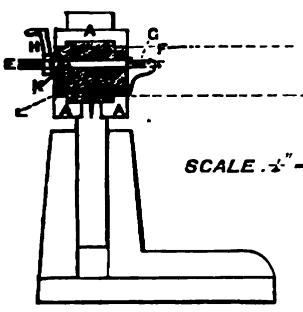


FIG. 2

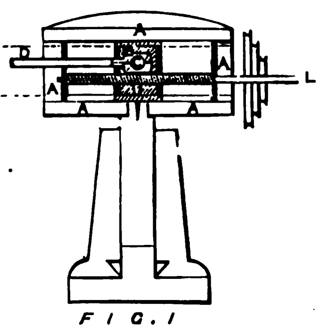


FIG. 1

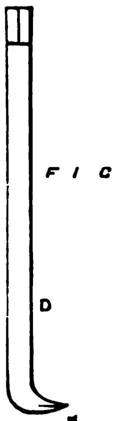


FIG. 4

FIG. 3

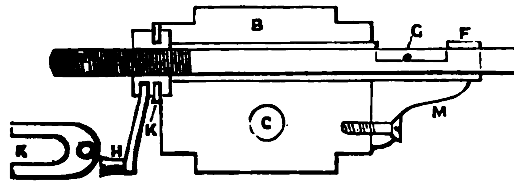
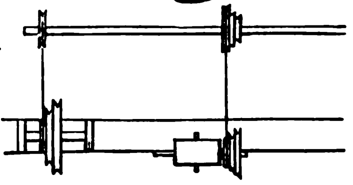


FIG. 5



The body is made of beech, with the ends dovetailed in, the tenous being on the ends to resist the end pressure. The top and bottom have two grooves cut very accurately in their length, between which slides a boxwood block, B, which carries the cutters, C and D, the one for outside thread and the other for inside thread. The screw, L, which carries B, is made of steel about ⅜in. turned to ¼in. at left hand end, and 3-16in. at right hand side, where there is a washer and pin. The thick black lines show where brass plates about ⅛in. or rather less are screwed on for bearings. The screw is cut with a screw plate or die.

In the boxwood block, B, there is a hole ⅜in. n diameter, bored for the cutter, C, which consists of a tight-fitting tube, F, in which slides the steel rod, C, having the point ground of a convenient shape, and a screw cut on the other end. The tube, F, is of brass, and cut away, as shown at G, to allow a cross pin, G, passing through the steel rod to slide backwards or forwards without turning, and is jammed tightly in the block, B. The tool, C, is projected forwards by the nut, H, which has a narrow groove turned in it to receive the plate, K, which slips on and is screwed through to the block, B. The cutter for inside threads, D, is formed of a bar of steel ¼in. diameter, with the end turned at right angles to the body and pointed ; it slides through brass plate in the left hand end of frame, A, and the other and being squared fits into the brass plate in block, B, and is propelled forward by screw, L.

In making the body, A, the best plan for the slides is to screw two accurately planed slips on to the top and bottom instead of cutting a groove, or else to screw one on in the middle, and cut the groove in the boxwood. I prefer the latter. The brass plates for bearings, &c., may be made of sheet brass. The end of the brass tube should be kept from springing by an angle piece being placed under it, as at M. The same letters apply to all Figs. The two first are to scale, the others not. A three-coned pulley is fixed on the end of the screw, L, to be turned by a pulley running on a wooden shaft at the back of the lathe, which is turned by a strap from the mandrel. The pulley on shaft should be able to shift along, and fixed by a wedge. By having three motions you can get nine different pitches of thread. I have drawn a rough sketch, showing arrangements in Fig. 5.

Ickey.

SUBSTITUTE FOR ORGAN PEDAL BASSES.

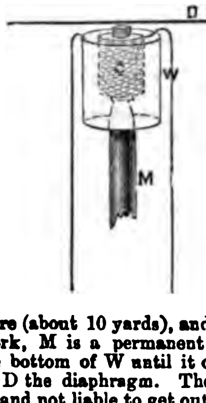
[14103.]—When I said that "Istriel" fell into a similar error to myself, I of course alluded only to his initiatory attempts, and I hope he understood such to be my meaning. Unlike him, however, I was not rewarded with success, and am to this moment mystified to know how he has attained such ends with similar means, and so seemingly contrary to what one might expect from the theory of vibrating bodies, the fundamental proposition being that a note, to be a musical sound at all, must be a combination of a tonic and its harmonics. Now, it is hard to realise how the latter can be obtained from the simple to-and-fro movement of a vibrating spring, excited as "Istriel's" is, by a pluck at the extreme end, and, setting aside the fact that the ear has become accustomed to such combination, its mechanical effects on the soundboard are great. There is, I think, little doubt that the nodal point of a vibrating rod or spring acts as a kind of fulcrum, by which the remaining portion acquires increased command. Fortunately, it is possible to test the acoustic effects of a body vibrating both with and without nodes. If, for example, one of the lower bass strings of a piano is plucked by the finger from about the middle of the string—and this, I think, fairly represents, in duplicate, a vibrating spring, partaking as it does of a simple to-and-fro movement—the note given is a monotone; but though the amplitude of its swing is great the sound is very feeble, because the mere motion of the string itself through the air is not sufficient to produce sound-waves, and it has not the power of conducting the necessary pulsation to the soundboard. If, now, the same string is struck with its hammer, the string no longer vibrates as a whole, but also in segments, and the difference in power is palpable, while if the finger be applied to the bridge the alteration is manifest—the first giving a comparatively slow and jolting motion, whilst the energy in the latter is so augmented as to cause a partial numbness of the wrist, and the quality of the tone is rich and full. A free end wire will also exhibit like phenomena, and as it does not seem probable that a spring will prove any exception, I cannnot but conclude that a sharp blow with a hammer will be found preferable to the twanging method. I must thank "Fiddler" for calling attention to another instance of vibrating strings, not exactly without nodes, for the manner of plucking is different, but one in which motion, as a whole, is too great to allow of their distinct formation, and their partial absence is the reason of weak notes in the bass. If the same were struck the increase of tone would be great, as can very easily be tested.

Referring to a suitable soundboard I can speak only from theory, not having been successful enough with springs to warrant making one specially, but I think the principle would apply sufficiently well. The soundboards I have found yield the best results have been those that were fastened all round, not continuously, but on studs, with intervals of about 9in. between. Those with one side entirely free exhibit, like the plucked string, too much motion, and, if tested by sand or fine dust, instead of this settling into concentric rings, starting from each point of junction, it is tossed all about, proving that its energy is all wasted instead of settling into musical pulsations. There is a plan that I think will greatly assist its susceptibility, and that is to place stretched wires at intervals bearing on the bridge ; the soundboard is thus between two springs, and answers to the slightest vibration. So far as the action is concerned, I think, for the ends to be attained, that it is perfect, and though I think Mr. Gnikrod's objections as to its quick repetition and the return of action are valid, I do not see how they can be remedied since it is obvious that ordinary dampers would be powerless against such an unruly vibrator, for the probability is that they would be soon flying about the room to the possible detriment and certain consternation of its occupants.

W. H. Davies.

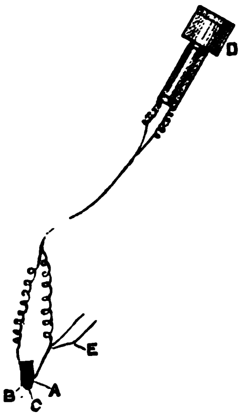
TELEPHONY.

[14104.]—I have found the annexed a very convenient arrangement in making a simple telephone : W is an ordinary wine-bottle cork, hollowed rather more than half out. C is a soft iron core wound with 36 insulated wire (about 10 yards), and inserted in the hollowed cork, M is a permanent magnet pushed through the bottom of W until it comes in contact with C, and D the diaphragm. The contrivance is very simple and not liable to get out of order. The sounds, too, are much louder and more distinct than in the ordinary telephone with the wire wound round the magnet itself. I do not claim originality, but, never having seen the plan recommended, thought it might interest some of your telephone-making readers.



Colchester.

[14105.]—I think "J. C. F.'s" experiment, letter 14041, page 603, well worth attention, especially to those who are acquainted with the Morse signals. I work it as follows :—The ear is applied to the telephone, D, fixed to double line wire. A shilling and a halfpenny are rubbed bright, the half penny is laid on the wire at B, a piece of wet paper covers it at C, the shilling is laid on at A. Each time the finger presses the wire at E a distinct tap is heard in the telephone. It may be of interest to your colonial subscribers to know that Bell's patent telephones are supplied to the colonies at a price (according to my thinking) which renders it better to buy than to risk time and disappointment in making one's own.



R. G. Bennett.

23, Gt. Tower-street, 4th March, 1878.

FERROTYPE PLATES FOR TELEPHONES.

[14106.]—Some correspondents say there is no use in removing the japan, and others say the contrary, without giving any reasons. I have made a pair of telephones partly after "Hazy's" description, which work well, and will give "Senopehlet"

(let. 14043, p. 603) the reason why I thought it advantageous to remove a small part of the japan next the magnet. After buying the materials I found that one side of each ferrotype plate was much more strongly attracted by contact with the end of the magnet than the other side. This I found was in consequence of one side being two or three times more thickly coated with japan than the other, so I resolved to keep this thick coat of japan next the mouthpiece, so it would but prevent the rusting of the plate. From a clipping of the plate I then removed the japan from the thinly coated side, and the result was greater attraction by the magnet than before removal. So I came to the conclusion that it must be advantageous to clear a a small part of the disc opposite the end of the magnet, and did so, with a round-pointed knife and glass paper. Before screwing the discs on I gave the clear spot a thin coating of spirit varnish to prevent rust. **Perthshire Farmer.**

LATHE FOOTWHEEL AND TREADLE.

[14107.]—IN the Feb. 15 number, page 553, 13971, "J. L." has been kind enough to express a desire to know whether my treadle arrangement was an accident or whether I had worked it out. I shall be very happy to tell all about it. It was, and was not an accident, if one may so express it. The fact is I had the excellent good fortune in my earlier life to possess two friends, both admirable practical workmen, and also good theoreticians, and all these points were matters of thought and consideration with them.

One friend especially had given his more careful attention to the whole crank and treadle question, and his views were somewhat about as my lathe at present is. His lathe, too, went admirably, and I know had been altered by him to suit his views, which were that the crank rod should be about vertical at the last part of the pull down, which would, it was held, begin decidedly before the crank got level and end a little after.

When I had my lathe I found it set so nearly correctly that I never have altered it. If I ever do I should put on a dodge which would enable me to shift the lower axis of the crank hook rod a little more out, and so try the position of vertical when crank is level. My friend used a counterbalance just heavy enough to bring the crank at about 40°. I see in 14057, p. 406, the use of a spring is advocated by Mr. Childs. I have not tried it because I really find my arrangements so perfect as not to be tempted. I think the spring would hardly be so pleasant in one point of view, and that is the inability of the spring to put the crank in the 40° position, which I find so very convenient. As to my lathe, it is on an upper room floor, and is a fairly powerful 6in. lathe. The counterbalance gives apparently no vibration or roll, and it is only to be detected by a spirit level with a bubble, having one-tenth of an inch motion to half a minute of angle. With this on the lathe bed there appears to be a perceptible roll, but only about 1-50th of an inch bubble motion. No hand could detect it.

Remarking that "J. L" was surprised at the ease of my footwheel, I thought I would see if I had erred in my 189 turns, one can err in counting, and I only tried it once. I first took off the crank hook and thoroughly cleaned the surfaces of crank and hook, then carefully oiled and tried the one tread. 34, 40, and 40 turns were what I got. I was a bit surprised and tried a run, crank hook part not jumping. I got only 130 turns. I then tried a lot of different oils. I, as a rule, use neatsfoot with a trifle of petroleum in it, to stop the cold setting it, and enabling it to keep good longer. I tried almond, olive, pine, the thick deposit as well, then a very crude dark treacly petroleum, then lard, but I did not do better, and rather worse with the stiff lard. I then recollected an old experience that I had found it unwise ever to clean off the crank, and that when I did I had to run the lathe a considerable time before it got to its old state. I therefore re-oiled with the neatsfoot and worked it. Results were 120, 125, 136, 142, 132, 144, 146, 139, 145; re-oiled with a drop, 163, 169, 177, 174, 181; touched with oil, all points in work, 190, 186, 196, 204, and then I tried the one tread five times and got an average of 49. In starting this experiment I remarked that the silence was not complete, but at the 204 runs it was so much more so that no one would have, without careful listening, heard anything. I think, however, that the single tread is the best of the two rough tests, for the other, or long run test, will be so very dependent on the weight of the wheel. Now, mine is a very heavy one, really two, and together, at least, one and a half times the usual weight, and my point bearings are very well got up. I myself, years ago, took great pains to get my crank bearings round, fitted the hook well, and nicely polished all. They are not, either of them, case-hardened, but though only ⅜in. wide, it is clear that they wear well. One thing I am careful of—that is, I prevent with every care the chance of grit or turnings getting at the bearings. Without in the least despising calculations, I think this is a case where it would be easier to secure the best results by having one's hook-rod arranged to shorten and lengthen, as well as by adding some contrivance for enabling the operator to shift the pin of the crank hook lower, bearing either from or toward the footboard.

I myself am against the idea of the crank hook-rod being vertical when the crank is level, because, first, I think one gets a sum total greater amount of square or all but square pull on if all is set about as mine is; and, secondly, on the lift it would give too much back horizontal thrust on the treadle axes, and make the lifting pull, too, seriously oblique. I do not think this point should be altogether lost sight of. **A. I. C. E.**

MICROSCOPICAL.

[14108.]—Now that Drs. Nicholl and Bull have shown so conclusively the utter failure of Mr. Wenham's method of reducing the angle of other people's objectives, it is possibly admissible to inquire how so able a man came to fall into a mistake. Readers of the controversy cannot have failed to notice that Mr. W. based his objection to extreme wide angles on the ground of their impossibility. He has over and over again put it, that the angle of limit of refraction rendered it impossible to make a dry lens of more than about 87° angular aperture. It seems marvellous that no one has ever called his attention to the fact that angle of limit has nothing to do with the matter.

The angle of limit of a beam of light passing from glass to air is undoubtedly below 45°, but from air to glass it is conversely the surface of the glass that forms the limit.

Mr. Wenham has, in fact, it appears to me, turned the idea topsy-turvey, and considered it as if the beam travelled in the other direction. A beam of light impinging on a surface of glass at any angle, even if 1in. from air, will be part of it transmitted, and form an image. Of course in this extreme case the major part would be reflected. There is no angle of limit for light passing from a rarer to a denser medium, except the limit formed by the surface of the substance, and therefore a dry objective is possible, as far as that only is concerned, up to 180°. In "Hogg on the Microscope" there is another idea ascribed to Mr. Wenham on pages 115 and 116, to which I should like to call his attention, and ask for an explanation. It is a description of a binocular eyepiece. The rays after passing through the eyepiece are stated to be divided by a prism and a picture sent to each eye. The objection to this method is stated to be that, owing to the distance of the eyes from the eye-lens the field of view is small. In attempting to put it in operation I have found a greater objection—one indeed fatal to the idea. I find that, when any contrivance whatever is so placed as to divide the rays from eye piece, the field of view is bisected, and one-half the field is thrown one way and the other half the other. Thus we do not get two similar pictures, but obviously two entirely different ones, which cannot combine to form a stereoscopic or even a non-stereoscopical picture, any more than a horse's head seen with one eye and his tail with the other can do so. I cannot conceive how any one who had tried this could write a description of it as even a possible expedient, so that I am driven to conclude either that it is wrongly ascribed to Mr. Wenham, or that there is some very important error.

In reply to Messrs. Schulze and Zeiss (14075) I must say that, while they deny my statement in words, they admit it in fact. My caution was certainly needed as to the 1-14in., if as Mr. Zeiss seems to admit, 440 lenses out of 590 will not work through the ordinary thin glass. I did not notice the numbers on those I tried, and it is quite likely they belonged to the majority. I did not remount my objects on purpose to measure the thickness of cover, but based my opinion of its shortness of working distance on the fact that it touched before bringing objects in focus, while with the same objects three different 1-16in. would all work freely. Mr. Zeiss only takes 440 out of 590 out of the competition, and his letter, therefore, contains a needless challenge. He has made during the last two years 150 with longer working distance. He will find, on referring to my letter, that I distinctly spoke of those I had examined. They are not now in my possession, but if they were numbered lower than 440 he does not challenge my assertion at all. **Essex.**

[Much of this letter, referring to its last subject, is omitted, and we are indisposed to continue the controversy.—ED.]

THE number of miles of streets which contain mains constanty charged, and upon which hydrants for fire purposes could at once be fixed, in each district of the metropolis, is now as follows:—Kent, 80 miles; New River, 190; East London, 85; Southwark and Vauxhall, 112½; West Middlesex, 70; Grand Junction, 41½; Lambeth, 70; Chelsea, 56, making a total length of 711 miles, and the water companies are ready to affix hydrants thereon when required by the authorities. The total number of hydrants erected is at present 4,450, of which 2,706 are for private purposes, 542 for street watering, 646 for public use, and 475 in Government establishments.

REPLIES TO QUERIES.

◆

*** *In their answers, Correspondents are respectfully requested to mention, in each instance, the title and number of the query asked.*

[31576.]—**Friendly Societies.**—I thank Mr. Brabrook for his information that the report of the Chief Registrar for 1876 is published, and accepting his correction of my misnomer of "Registrar-General," I waited until I could obtain a copy of the report before replying. I believe my letter, complaining of the delay in publishing the report, was acknowledged in the column "Answers to Correspondents," on February 8th, and having been written some days previously—a fortnight ago—at the time of my writing would be, I expect, very near the date of the actual publishing. But is not Mr. Brabrook himself "misinformed" as to the report having been published at the date of his lettter (which appeared on March 1st), more than a month ago? The copy I now have is called Part I., and on page 2 I am told that Part II. "will contain lists of friendly societies, &c., &c.," so that, at the date mentioned—unless the bookseller has failed to execute my order in its entirety — the report was not issued to the public, but only Part I. Will Mr. Brabrook allow me to withdraw any reflections my former communication seemed to cast upon the office with which he is connected? The first part of the report seems (so far as I can judge from a casual glance) to contain a great deal of very useful information, and shows, beyond doubt, that the Registrar's staff are doing their utmost to render the information collected by them valuable to friendly societies. I would, however, ask Mr. Brabrook to consider whether my suggestion as to the "experience of sickness" returns now required from societies quinquennially would not be far more likely to be correct and valuable if the societies were obliged to render them annually instead of at the end of every five years? Separating, in such annual returns, the new members joining during the year from the members of more than one year's membership, and then let the Registrar's staff analyse and compile the experience (thus collected year by year at the end of each quinquennial period. On page 1 the Registrar acknowledges that in those large societies who have furnished apparently correct (quinquennial) returns it has transpired that professional assistance has generally been found necessary. Would not annual returns, in a year or two, save this expense, which must be a heavy drag upon some societies with ill-kept accounts? And would not the necessity of such a return being made be in itself an incentive to correct bookkeeping? I again hold that the forms on which the Oddfellows require their sickness experience to be furnished to their central office, and for their own purposes, are far preferable to the Government forms. Keeping, for the moment, the financial part of the question in abeyance, should I be very presumptuous in advising that for sickness experience (apart from financial effect of continued sickness on particular societies the Registrar should press the adoption in the returns of seven days a week sickness, even if six days only be paid. There is a class of society that must be a sad source of trouble, I should think, to actuaries. Will Mr. Brabrook kindly say if it is not so? allude to those who, after continuous sickness of certain duration, deduct one day or two days per week sick pay, or perhaps deduct ½ or ¼ sick pay, in lieu of the usual monthly contribution! There must be hundreds of readers of the ENGLISH MECHANIC who are interested in the successful working of friendly societies, and I would ask any of the executive of such for an expression of opinion as to the labour involved in the present quinquennial returns. I fancy many returns may be "judged" to save trouble, and, of course, where this is the case, the practically mislead, and are worse than useless for statistical purposes. I have seen a "law of sickness" amongst assumed members, mentioned by an actuary—viz., in quinquennial periods call the total sickness of the first five years x, then, for the same members, call the sickness of the second period y; in the third quinquennium it should be $x + y$; in the fourth $y + (x + y)$; in the fifth $(x + y)$ $[y + (x + y)]$—i.e., calling the quinquenniums 1, 3, 4, 5, &c., 3 = 1 + 2, 4 = 3 + 2, 5 = 4 + 3, and on in progression. Is there anything in the formula? Some societies allow sick pay "when partially disabled." I believe this to be a great abuse. How do actuaries allow for it when not supplied with the financial effect of such allowance distinct from "total disablement."—PERCY VERE

[31732.]—**Preparing Wood for Polishing.**—think "A., Liverpool," has come to rather a has conclusion when he denounces a filling of tallow and plaster as "humbug." We have a great deal polishing, and I have used no other filling for years. Besides having the value of readily coming to shine, it helps to bring out the shading, whereas the effect of sizing is to annul this result. If "A." w try again on a piece of Spanish mahogany, one side with each preparation, he will, I think, be converted.—W. H. DAVIES.

[31732.]—**Preparing Wood for Polishing.** Does "A., Liverpool," mean that tallow and plaster as "filling" are to be avoided? He says he found it a "humbug." What does that mean? Let the original querist refer to the index of Vol. XVIII.—DRAGON'S BLOOD.

[31781.]—**Reversing of Locomotives before Starting.**—"A., Liverpool," will, no doubt, see from the answers to this question on pp. 606-7 that there is a part of the stroke when the steam has less power than at another, and that the theory I advanced was correct, which has been so amply explained on pp. 606-7. I take the opportunity to thank those gentlemen for their information, which will doubtless set all fears of "A., Liverpool's" on the subject at rest.—G. L. P.

[31854.]—**Mixing Borax with Starch.**—Add a small pinch of borax as soon as you have made your starch, which must be Glenfield starch, mixed with hot water. A very small portion of borax will make the starch as fluid as water.—Polaris.

[31878.] — **Bogie Tank Engines on the Somerset and Dorset Joint Railway.**—I am somewhat surprised that your correspondent, "The New Clock," on page 607, has disputed my answer, on page 538, without having first made himself acquainted with the facts. He writes that engines have not been built at Nine Elms for the Somerset and Dorset Joint Railway, and that "he is inclined to think that my statement is equally inaccurate with respect to Derby." It is useless for "The New Clock" to deny the existence of these engines, as they are well known, and your correspondent, "L. L.," page 488, states that he saw one running between Derby and Manchester, and he asks me to explain the letters S.D.J.R. Before answering this question I had inquiries made as to the reason why this engine was running to Manchester. I found that "L. L.'s" discription of the engine was perfectly correct, and that the engine was on a trial trip before being handed over to the joint committee. This particular engine, No. 11, was not sent from Derby to the Somerset and Dorset Railway direct, viâ Bath, as several of the others had been, but was sent up by a "goods train," without steam and "uncoupled," over the Midland line to Brent sidings, and was taken by a London and South-Western goods train to Nine Elms. It was kept there a week, working trial trips with an engine of the London and South-Western construction for the same line, after which it was sent from Nine Elms to the Somerset and Dorset Railway. I saw this engine myself being conveyed from Derby to Brent. As to those built at Nine Elms I have ample proof that the London and South-Western Railway Company have built engines for this joint line, and not many days ago I saw an engine of South-Western construction quite new, with the letters S.D.J.R. upon it, at Clapham Junction. Also last week at Brent sidings I noticed another engine of South-Western pattern, bearing the letters S.D.J.R., drawing a South-Western goods train. If the engines built by the Midland and London and South-Western Railway Companies bearing the letters S.D.J.R. are not intended for the Somerset and Dorset Joint Railway, perhaps "The New Clock" will oblige your readers, and also "L. L.," page 488, by explaining for what purpose they have been built.—C. E. S.

[31901.]—**Soft Soap (U.Q.)**—is made with potash instead of soda. If you are accustomed to soap-boiling a few experiments will soon set you right.—Os.

[31910.]—**Electroplating.**—These goods must be burnished.—Os.

[31937.]—**Telegraph Instrument and Block Dials (U.Q.).**—I have an idea they are printed, but have no positive knowledge.—Os.

[31945.]—**Time of Fall of the Earth to the Sun.**—"A Fellow of the Royal Astronomical Society" has evidently been at some trouble to reply to my question. As the querist, I have to thank him, whilst at the same time I have to inform him that, in all cases of circular motion about centres of attraction, and in which the attractive power or efficacy is abated in a duplicate ratio of the distance, bodies complete one-quarter of a revolution in the same time as they would fall to the centre, if under the influence of central force alone. This may be new to him and others; but, with our Editor's permission, I will demonstrate that such is the fact. In the mean time, if "F. R. A. S." will look into the law next given—viz., that the squares of the times of fall from different distances in space are as the cubes of the distances"—he will see the reason for the first-given law. The last law is arrived at by considering the case of falls of bodies from distances at which the value of g is no longer 32·2ft., but at 2 semi-diams. from centre equals ¼, at 3 semi-diams. $\frac{1}{9}$th, &c., &c., of g. These laws lead to very interesting and important conclusions, and will enable me to show that the sun's attractive power on planetary matter is of greater intensity as regards not only any difference that may be due to size or mass, but also as regards velocity: for instance, whereas the earth's efficacy of attraction on matter may be measured (at different semi-diam. distances) in values of g, as $\frac{g}{4}$, $\frac{g}{9}$, &c., so the sun's (or a mass of equal size to earth, and having same power of attraction as sun) will be measured by near $240g$, $\frac{240g}{4}$, $\frac{240g}{9}$ &c. I hope to have the opinion of "F. R. A. S." on the foregoing.—G. Pinnington.

[31949.]—**Table Legs.**—A method of turning the ball for the legs of fancy tables was illustrated and described on p. 456, Vol. XIV., No. 350.—Amateur Turner.

[31960.]—**Drawing Rings out of Locomotive Tubes.**—This operation cannot well be done when steam is up, and I, for one, cannot see its necessity when a tube breaks, and needs prompt plugging.—Essar.

[31971.]—**Coating Wire with Guttapercha.**—Several methods have been given in earlier volumes. Perhaps winding on sheet gutta would answer the purpose. As to the work as it is done at a factory it would be necessary to have a machine to squeeze the gutta through a die, the wire passing in the centre.—Oberhof.

[31972.]—**Ash-pan in Locomotives.**—The ash-pan is necessary in both portables and locos., to prevent the access of air to the fire at times, and also to prevent burning coals falling on the road. Perhaps "Engine's" ash-pan does not fit close. In the case of a locomotive the ash-pan also prevents the dust from getting amongst the motion work.—K. H.

[31973.]—**Dantzic Spruce**—Is an extract obtained by boiling the young tops of the black spruce-fir. Another kind of spruce is made from molasses or treacle, and, being fermented, is probably intoxicant to a slight extent. Spruce beer prepared from fir-tops is antiscorbutic, and doubtless exercises a 'healing" influence in colds, &c.—Abies.

[31976.]—**Compound v. Ordinary Condensing Engines.**—In No. 675, p. 607, I noticed a reply to a query of the above title. The way, however, in which "Marine Engineer" disposes of it is far from satisfactory. I am one of those who hold that with equal initial and terminal pressures and ratio of expansion there is no advantage in the compound system, but a disadvantage, even when considered as a heat engine. For example, take an ordinary condensing engine and a compound engine, and let the initial pressures in the high-pressure cylinder of the latter and the single cylinder of the former be equal. Now, suppose that in both these engines the steam is expanded down to two pounds above the line of perfect vacuum, every rational person will admit that, as the loss of pressure in each case has been the same, the same amount of heat has been absorbed by the single-cylinder engine as by the compound engine. So far, then, no advantage is discernible in either; but let us look into the matter more fully. In the compound engine the heat is distributed over the areas of two cylinders, and therefore the fluctuations in temperature are not so great as in the single-cylinder engine, which is the only good point I place to the credit of the compound engine, and which, no doubt, is more than overcome by the loss of pressure, and therefore loss of heat, in the transmission of steam from one cylinder to the other. It is here where the ordinary condensing engine obtains its advantage, for in the compound engine, as I have just shown, a certain quantity of heat is absorbed in keeping up the temperature of the pipes and other waste room, which heat cannot be said to be utilised, because in the single-cylinder engine all this heat is lost in the cylinder, and therefore performs duty. To put it in a simple form, we have in each case the same amount of heat to begin with, and at the termination we find that in each case we have lost the same quantity; but in the single cylinder all this heat is represented by work done, whilst in the compound engine only a part of this heat lost is represented by work, the remainder being lost in pipes, &c. In conclusion, I would say that I am not averse to compound engines under all circumstances, and I admit that, as engines are at present constructed, I should prefer a compound engine; but, were I going to make an engine, it certainly would not be a compound one, as I think that more can be done with a properly-constructed single cylinder engine than ever was done by the best compound engine. In a single cylinder there is much less waste room than in the compound system. In some cases, however, when parties have engines already too small for their work, it is cheaper to "compound" than to put in a set of new engines. In most cases where firms put in compound engines, to begin with, it is more because it is the fashion than anything else. Do I hear some one ask how they came to be the fashion? My answer is, that when the compound engine was first introduced it was a more economical engine. But since then times have changed, and with them my opinions of the steam-engine.—John S Sunderland, Armitage Bridge, near Huddersfield.

[31989.]—**Precipitated Solutions.**—What is the nature of the precipitate?—Nemo.

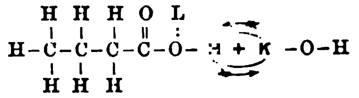
[31992.]—**Galvanic Belts.**—If "Z. Z." makes a belt as he suggests, it will probably be as effective as any other form of galvanic belt.—Infidelis.

[31993.]—**Weight of Sulphuric Acid.**—The weight will depend on the quantity of water.—J. H.

[32003.]—**Brass Cannon.**—To "J. B."—I give emphatically *Punch's* advice, "Don't." Casting guns is a business requiring great experience, and an ordinary brass-founder should not undertake it. Gun metal is composed of 9½ per cent. of tin, with 90½ per cent. of copper. If "J. B." will advertise his address, I will inform him where I saw some good second-hand guns for sale, about the size he requires.—R. H. Y. C.

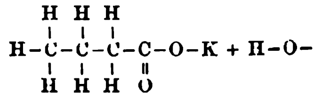
[32007.]—**Sunrise.**—I thank "A Fellow of the Royal Astronomical Society" and Edward M. Richards for their attention to my inquiry. Each will have perceived that my stock of astronomical knowledge is but scanty. Referring to the information given me by the former, I have seen in the "Cabinet Encyclopædia" edition of Herschell's "Treatise on Astronomy" (1833), cap. 1, sec. 43., that when the sun is apparently first visible in the horizon its disc is actually below it, and to the best of my recollection, having observed its rising through a coloured glass, it is as nearly as may be five minutes from the appearance of its upper edge until the whole orb can be seen. Assuming the Government Ordnance maps to be printed due North and South, and the latitudes and longitudes of the towns given in the index of S.D.U.K. maps to be accurate (the index does not give 11), the latitude of my house is as nearly as may be 31′ South of the Observatory at Greenwich and 3° 41′ West longitude. I much regret that I have no earlier volumes of the English Mechanic than June, 1875, when I first heard of the publication. Referring to the reply of Edward M. Richards, I have not a theodolite, but I suppose this would be more easily procurable than the back numbers of the English Mechanic, though as yet I have not the slightest idea of what is meant by "running out a meridian line." As to the plumb-bob, I suppose I could manufacture one with sufficient accuracy by boring a hole lengthways through an egg-shaped piece of lead, turning it down in my lathe, and then passing a stout darning-needle through it. I have masons' levels (the triangular ones, I presume) home-made and fairly accurate.—J. L. H. S.

[32103.]—**Organic Chemistry.**—Having been invited by Mr. Grey to throw some light on isomerism, I am anxious to do so, but I am afraid my condenser will prove powerless in throwing a beam of light on that subject, and I am unaware of any satisfactory explanation by any chemist of the numerous cases of isomerism that occur in organic compounds. The intricacies of this subject are like the windings of a labyrinth through which the experimenter has to grope his way in the dark. Considering the number of elements that enter into the composition of organic compounds are so few, and that the varieties of qualities are so great, they cannot be due to the contained radicals alone, but must be influenced in a great measure by the molecular arrangement of these radicals. I am inclined to agree with Mr. Grey's opinion about the normal and its isomers. The instance mentioned by Mr. Grey is a wonderful example of isomerism—viz., that of ethylic acetate or acetic ether and butyric acid. These substances though wholly different in all their qualities yet contain exactly the same amount of carbon, hydrogen, and oxygen, and have the same specific gravity and molecular weight. Butyric acid, smelling like rancid butter, is an oily liquid that causes alkaline carbonates to effervesce, reddens litmus paper, and boils at 150° C, while acetic ether is a limpid liquid, having an agreeable odour somewhat like that of apples, and boils at 74° C. Acetic acid has the formula CH_3COHO, potassic acetate CH_3COKO, and ethylic acetate will have the formula $CH_3CO(C_2H_5)O$. By acting on $CH_3CO(C_2H_5)O$ by KHO we obtain CH_3COKO and C_2H_5HO, but when we act on butyric acid C_3H_7COHO by KHO we obtain C_3H_7COKO and OH_2. From this reaction we conclude that the K in KHO displaces merely the H in the group COHO or the radical, such as C_2H_5, which takes the place of the H, and that the radicals CH_3 and C_3H_7 are unaffected in either case. The reaction, perhaps, might be made plainer by showing the reaction by means of graphic formulæ. Butyric acid:—



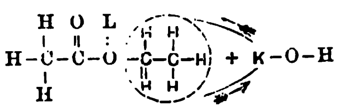
$$\begin{array}{ccccccccccc} & & H & & H & & H & & O & & L \\ & & | & & | & & | & & \| & & : \\ H & - & C & - & C & - & C & - & C & - & O - H + K - O - H \\ & & | & & | & & | & & & & \\ & & H & & H & & H & & & & \end{array}$$

Potassic hydrate becomes by the interchange of the elements K and H potassic butyrate:—



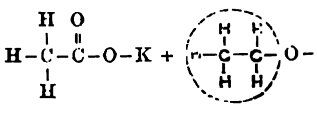
$$\begin{array}{ccccccccc} & & H & & H & & H & & \\ & & | & & | & & | & & \\ H & - & C & - & C & - & C & - & C - O - K + H - O - H \\ & & | & & | & & | & & \| \\ & & H & & H & & H & & O \end{array}$$

water; and ethylic acetate—



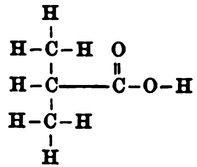
$$\begin{array}{ccccc} & & H & & O \quad L \\ & & | & & \| \quad : \\ H & - & C & - & C - O - C_2H_5 + K - O - H \\ & & | & & \\ & & H & & \end{array}$$

becomes by the interchange of the radical C_2H_5 and K—

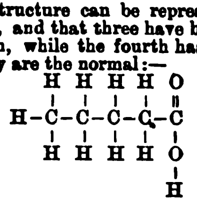


$$\begin{array}{ccccc} & & H & & O \\ & & | & & \| \\ H & - & C & - & C - O - K + C_2H_5 - O - H \\ & & | & & \\ & & H & & \end{array}$$

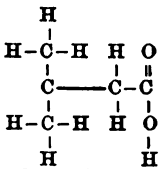
potassic acetate and ethylic or common alcohol. From a consideration of the above formulæ and the reactions produced, we observe that the KHO does not break up or act on the group firmly interlocked to the left of the O, above which is placed the letter L in both cases, but on the outlying element, H, and the radical, C_2H_5 (to the right of O marked L), which are, as it were, loosely suspended or attached, and are, therefore, easily displaced by the K of the group KHO. There is isobutyric acid,



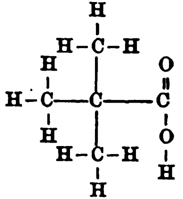
so that we have at least three substances having the same composition. Thus we have two butyric acids, but when we turn to valeric acid we find that its molecular structure can be represented in four different ways, and that three have been identified, and are known, while the fourth has so far eluded discovery; they are the normal:—



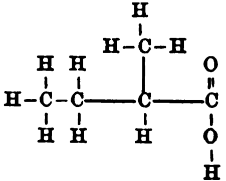
the isovaleric:—



or isopropacetic and the trimethacetic:—

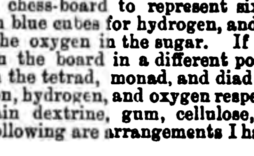


and the fourth methethacetic acid:—

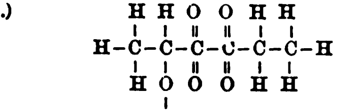


They are represented symbolically by C_4H_9COHO, $CH(CH_3)_2CH_2COHO$, CMe_3COHO, and MeEtCH COHO. The first and third are more symmetrical than the others. As in the case of butyric acid, it is the atom of hydrogen to the right in the four graphic formulæ given above that is not so thoroughly incorporated in the compound, and is, therefore, displaced by any radical or element capable of substituting it. The following cases of isomerism may be cited—viz: propylic alcohol, $C_2H_5CH_2HO$ and isopropylic $CH_3CH\ (CH_3)\ HO$; ethylenic oxide $(CH_2)_2O$, aldehyde CH_3COH and oinylic alcohol C_2H_3HO; lactic acid CHMeHO, paralactic acid $(CH_2)_2HOCOHO$, and methyl glycollic acid $CH_2MeOCOHO$: the four forms of tartaric acid; fumaric, mallic, and isomallic acids $(CH)_2(COHO)_2$; cane sugar and its isomers having the formula $C_{12}H_{22}O_{11}$, grape sugar $C_6H_{12}O_6$ and its isomers; starch $C_6H_{10}O_5$ and its isomers, &c. The difference in all these bodies having the same composition therefore depends on different arrangements of the atoms of carbon, hydrogen, and oxygen. For instance, starch $(C_6H_{10}O_5)$ has six atoms of carbon, ten of hydrogen, and five of oxygen, and by different arrangements of these atoms among themselves we obtain dextrine, gum, cellulose, glycogen, &c., the isomers of starch. Supposing we placed six black cubes on a chess-board to represent six atoms of carbons, ten blue cubes for hydrogen, and five white cubes for the oxygen in the sugar. If these were arranged on the board in a different position consistent with the tetrad, monad, and diad characters of the carbon, hydrogen, and oxygen respectively, we should obtain dextrine, gum, cellulose, glycogen, &c. The following are arrangements I have made—viz.:

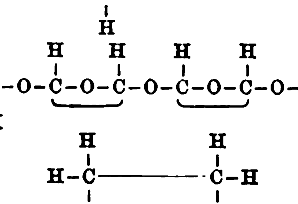
(1.)



(2.)



(3.)



&c.—HUGH CLEMENTS.

[32104.]—**L. and N.W. Railway Engine, Cornwall.**—"Itzaex" says that this engine does not run in winter, which I know, for a positive fact, she does except when in for repairs, which is not very often. "S. J. W." says that she does not run at more than 35 miles per hour. I have known her to run at 65 miles per hour without pitching in the least. "J. A. C." says that she is heavy on repairs and nominally useless. I believe she is very useful for running the different trains, especially those between Chester and Shrewsbury. He says also that he has not known her to run the limited mail. I have known her to run the Scotch limited mails from Carlisle to Euston at a rate of about 75 miles per hour.—W. A., Crewe Works.

[32114.]—**Colourless Spirit Varnish.**—Bleached shellac should be kept in the dark, and used as soon as possible after bleaching. This is a trade secret which I learnt from a Birmingham man, after failing to dissolve the bleached shellac which had been exposed to light.—A BARRISTER.

[32119.]—**Speed of Trains.**—The Irish mails are always run by a single engine with 7ft. 6in. driving wheels, outside cylinders 16in. × 24in. of the Marmion and Pandora class. The train leaving Euston at 7.15 a.m., which is both Irish and Scotch mail, is run by one of the new four-coupled engines with cylinders 17in. × 24in., such as Meteor, Disraeli, and sometimes by a single engine with 7ft. driving wheels and inside cylinders, such as Umpire, Burmah, &c. I do not know where the fastest runs are made, but I have seen the Scotch limited mail run from Willesden to Harrow (5¼ miles) in 5min. 20sec. That part of the line rises considerably. The engine was a single 7ft. —WILLESDEN.

[32120.]—**Definition.**—I thank Mr. Lancaster for his kind reply to this query, and as he has offered to give some further information, I shall ask him to tell me the size and focus of glasses for eyepiece suitable to use with a 3¼ O.-G., so as to enable me to easily read the type in Answers column at 100 yards? Will Mr. L. further say if microscope eyepieces, A B C, may be used in the arrangement next the eye in a terrestrial eyepiece? They will, I suppose, do for the celestial eyepieces?—DEFINITION.

[32120.]—**Definition.**—The best objective will certainly give the most satisfactory results. You won't beat one of Wray's 3in. O.-G.'s, price £6.—F. C. DENNETT.

[32127.]—**Flute.**—If the flute you have is an heirloom then by all means have the key F♮ added to it, otherwise don't do so. It is a matter of impossibility to play some passages on a four-keyed or six-keyed flute without the long F♮. I most decidedly object to "Old Philo's" statement, on page 611, that the long F♮ key is never used worth mentioning. There is not a piece of flute music in F♮, B♭, E♭ A♭, &c., written for the flute but what there are plenty of passages for that key which cannot be played at all, except by cross fingering on a flute, without the long F♮. For example, let "Old Philo" take Nicholson's beauties, or any of the master works for the flute, and try to play them without the long F♮. Do not think you cannot play difficult music with a six-keyed flute—that is, a flute with two F♮ keys, B♭, A♭, C♮, and E♭. You can believe me there was a time when I could play almost anything at first sight, and what I could do you can do, for I could not whistle or play a tune when I was 16, but determination and without assistance overcame the difficulty, and I can now play halfadozen instruments, and read music as well as I can read a newspaper. There is Potter, a flute-maker, even now in London. Get one of Rudall's flutes, and you will find it all you desire. The two long C keys are no use to me in a flute.—T. CRIDLAND.

[32140.]—**Telephone Failures.**—In addition to my former answer to this query, I have to state that I have not experienced any difficulty with the telephone when using it upon a piano or musical box. I have noticed that every chord, and, in fact, every combination produced in the piano was conveyed intact to the other instrument, and in one case, although working through a distance of about 200 miles (due to a resistance interposed in circuit), I found the harmony pure throughout, and not, as I expected to find it, alternating and discontinuous. I had previously imagined that the louder tones by causing the plate to vibrate more quickly, would produce a more powerful current of electricity, and that this travelling through the wire quicker than the weaker current should be heard first when reconverted into sound. This, however, was not the case. In regard to the band, I could account for the indistinctness on the theory of interferences, and also on the diminished intensity of the tones of each instrument in relation to its distance from the telephone. I am decidedly of the opinion that when the telephone is placed in the centre of a number of musical instruments, so that each and all of the distances are equal, the whole of them will be heard at a distant telephone. I had really hoped to pick out of the received sound the fundamental tone, and then the harmonics in a rising ratio, but although I have experimentally worked upon this subject, yet I could not obtain what I had expected by theoretical considerations.—W. J. LANCASTER.

[32149.]—**Thermometer for High Temperatures.**—There are no thermometers which will enable you to read higher than about 640° F., but you may make a pyrometer which will do the work for you. An iron rod securely fixed at one end, an allowed to expand at the other end, is the best thin you can have. The rod must be connected with system of levers, and a dial with an index finge This you can easily arrange, and by getting th expansion obtained in boiling mercury, say 660° F Then place it in melted flint glass, when yo should mark 1,000° F.; it will be an easy matter fo you to then make a scale running up to about 1,400 F., although you cannot depend upon the degrees you must always be prepared to allow some 20° or s on either side.—W. J. LANCASTER.

[32154.]—**Stereoscopic.**—You should mount th pictures in one plane, and not more than 3in. fro centre to centre. Thus you should look for som point on both pictures, and measure between the tw points, and the distance should not much exceed th space between the two pupils. Of course, if you ar an amateur and cannot tell which is right and lef by all means have two pieces of glass same size a stereo card; then put the two photos between th glasses and look at them in stereoscope. If righ then mount them in same manner on card.—W. J LANCASTER.

[32161.] — **Rubbers for Plate - Electric Machine.**—The rubbers for a 24in. plate should b made of pieces of wood 5 × 2½in. These should b covered on one side with two or three layers o chamois leather. between which and the wood a pa made of dry flannel or wool should be laid; th leathers should then be pulled tightly round th sides of the wood, and tacked all round with smal tin tacks. They should then be connected to th silk flaps, which ought to reach to within 1in. of th points on the conductor. The silk should be goo black ribbed silk, and may be covered with anoth thickness of the same silk, or with oiled silk. Th rubbers should be mounted so as to be brought clo to the plate, and to be directly opposite each other.—W. J. LANCASTER.

[32168.]—**Latitude and Longitude.**—A degre of longitude at latitude 20° is 65 02 miles, at 25° it i 62·72 miles, at 45° it is 48·99 miles, at 50° 44·54 mile and at 55° it is 39·76. I am not acquainted with an simple method for obtaining the length of any par ticular degree of longitude, or would have bee pleased to have given it.—W. J. LANCASTER.

[32170.]—**Pianoforte Playing.**—I am muc obliged to the several correspondents who have give replies to my query, but should like to add a remar with reference to the answer given by "Fiddler." He implies that my only idea is to obtain mechani cal accuracy, and very properly warns me agains working for that end only. I know one lady, wh practises some five hours daily, who plays just a well as one of the barrel pianos which we hear in th streets. My difficulty I may state, perhaps, mo fully as follows:—I am acquainted with the rud ments of harmony, and have studied the science o music to some extent. I have, further, done a goo deal of singing in oratorios, cantatas, and so forth and find that my ability to read at sight and unde stand a pianoforte piece is much in advance of th finger dexterity which I possess, to play it proper when I have learnt it. So that my object in inser ing this query is to obtain, if possible, some guide i selecting pieces, the study of which will enable m to spend the somewhat limited time which I have fo practice in as profitable a way as possibl "Fiddler" recommends Beethoven's sonatas. The I know very well by ear, but I am afraid that it wi be some time yet before I can play them. Can an one recommend any good series of pieces arrange according to degrees of difficulty, and fingered?—F. H.

[32175.]—**Bichromate Battery.**—The cells wi work well for about an hour. Why not make the up as Bunsen's, using a porous cell for the carb plate. Then they will do what you want. The 4 cell would work well, arranged as above.—W. J. LAN CASTER.

[32178.]—**More Telephones.**—The wire must b soldered to the wire on the bobbin, and be careful t wind on in same direction.—W. J. LANCASTER.

[32188.] — **Lantern.**— The condensers may b mounted in the following manner:—Make a ring o tin to fit over the lenses loosely, then solder the rin so as to make outer cell. Now, put this ring on to chuck, and roll one end down, so as to form a should then make another ring about 1in. wide to fit into th larger ring, the larger ring being 1¾in. deep. No burnish each end of the inner ring, so that it will ke the lenses in place when in the lower lens, bei placed in with plane side down. Then, on to this pu the inner ring; then place the upper lens' convex si down, and fasten the lot down with a strong wi ring, also make a small hole in two parts of the co denser, to allow any heat to go out. The tube f Silber chimney should be very thin mandrel bra tube; have no lumps of brass in it, but make it a light as possible.—W. J. LANCASTER.

[32191.]—**Optical.**—The plane side towards th light will give best results.—W. J. LANCASTER.

[32192.]—**Tourmaline.**—To MR. LANCASTER.—A Nicol's prism would be extremely useful to you in fact, it has before struck me that a pair of fiel glasses, with two of Nicol's prisms in, would be i valuable to captains, because they would destroy al the reflection from surface of water, and would thu enable him to see clearly anything in the shape o rocks or boats ahead. I do not care to introduc anything that might by any evil-disposed person h ppy, but I am just now so interested in on (writing a lecture on it), that I would lend you a pair of prisms arranged to suit ve written about. Your address may be igh Editor, as I have no means of know- from your *nom de plume.*—W. J. LAN-

—**Achromatic Eyepiece.**—The violet ch "Country Bumpkin" sees round Venus magnitude stars is the secondary spectrum, all telescopes whose O.G.'s are over-cor- Mr. Wray's objectives are about the only h are practically free from this defect. As romatic eyepiece, all I can say is that I it. When using the 9½in. mirror last always preferred a Huyghenian 132 power r or Saturn, to a 215 or 410 achromatic one, by Browning, for the definition of but for colours I preferred the 215, as it hem much the best. The power I should r a 4in. achro. (or mirror) would be 60 120, 200, 300 (Huyghenian), and 400 (Rams- is useful for Nebula, Cluster, Sun, Moon aking the whole of the discs at once), and 120 and 200 are the most generally useful amination of lunar and planetary detail, he resolution of closer clusters, and the of double stars. 300 and 400 have to be or the examination of difficult objects on evenings. For the examination of small tars, some eyes and some stars want differ- s; but I will not advise on this subject, as erience.—FRANK C. DENNETT.

—**Oiling of Slate Nails.**—I have read used for gardening and other outdoor ald be made hot before immersion in the C.

—**Oiling Slate Nails.**—Get them very ot red hot, and dip them in any kind of il. You could use an old piece of sheet f small holes to heat them on. Let them the oil till they drain all off on pulling out, ough to form a good scale or coat. You learn the time for this with a little -CHELT.

—**Diatoms.**—I presume by "show objects" ans objects suitable for exhibition to a riends, and calculated to afford pleasure action to them. If so, I think "J." would ased with specimens of the following:— iscus, Heliopelta, Actinoptychus, Aulaco- scinodiscus, Triceratium, Cymbella, Pin- urirella, Pleurosigma, Gomphonema gemi- nd Orthosira. Tastes, of course, differ; y mind, most of the above are superb nd many of them can be got arranged in al groups which are exceedingly beautiful. no doubt "J." would find them to be all —E. MAWE SMITH.

—**Diatoms.**—The following are good or show:—Heliopelta, Eupodiscus, Arach- Aulacodiscus, Actinocylus, Actinoptychus, cus, Triceratium, and Isthmiahewosa.— .

—**Old Oak.**—Lay on liquid ammonia with brush. The colour (on new oak) deepens nd does not fade, this being an artificial of the process arising naturally from age. rom receipt book.)—F. F. C.

—**Violoncello.**—The scratches may be ss visible by rubbing a little French polish The only thorough remedy is to have it ed. If the "cello" is a superior instru- h good oil varnish, I should say, "let it . P. T.

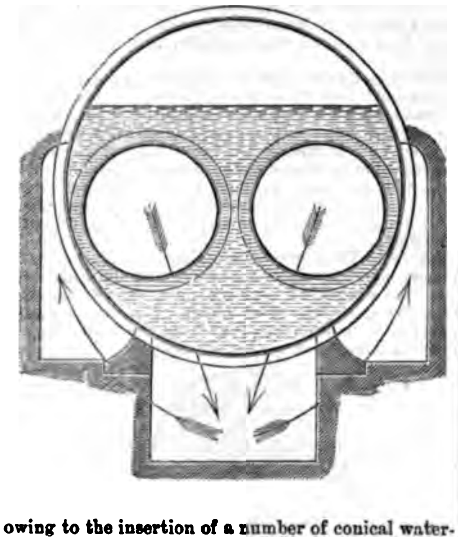
—**Violoncello.**—"C. C." would do well e scratches on his instrument alone, as o remove them generally make the matter ess the belly is entirely revarnished, which, night seriously injure a good instrument oks and tone. There is a fine course of r the "cello" by De Schwert, which can be hrough any music-seller.—SKILSCH.

—**Boiler Flue.**—In the case of a double- r, it is best for the smoke, &c., to first der the bottom, and then back again at for the reason that it is easy to keep the om (inside) clean in the case of double single-flued boiler the other system would f moderately pure or soft water be used consequence which style is adopted.—W. LDSON.

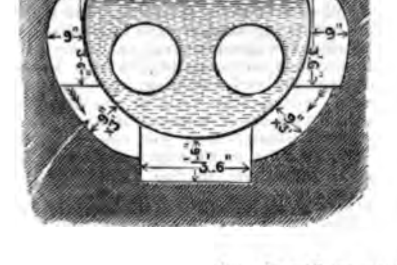
—**Boiler.**—If your boiler is seated so that goes through the flue tubes, back under of boiler, and then on sides to chimney, nd it more to your advantage through less epairs. By bringing the flame back on the then under bottom to chimney, you may team, but it causes much more unequal and contraction, as I have found from repair them. By arranging as in first n keep the boiler at a more equal tempera- ACTICAL BOILER-MAKER.

—**Boiler.**—I have had great experience ass of boilers, and find it better to fire e tubes, returning along each side, and then bottom, to the chimney. By so doing the which settles at the bottom of boiler does o the iron, as the heat is a little lower in re after passing along sides of boiler. I both plans, but find that to answer the CARTER.

[32216.]—**Boiler.**—Appended is a rough sketch, showing mode of setting for a Lancashire boiler, 7ft. diameter, as adopted by all first-class boiler-makers. The object of causing the draught to pass first underneath the bottom, after leaving the tubes, is to equalise the temperature, thus preventing straining and leakage at the lower seams and rivets. If the draught, on the contrary, passes along the sides first, the upper part of the shell and tubes are rendered much hotter than the lower portion; consequently, the expansion and contraction are unequal, causing serious straining, especially if the feed-water be introduced at a low level, and cold. This does not apply quite so much in the case of Galloway boilers, as the circulation is more perfect, owing to the insertion of a number of conical water-tubes in the oval flue tube. Still, it is preferable, where the arrangements permit of doing so, to take the draught last up the sides. The feed-water, in all cases, should be delivered some 3in. above the furnace crowns, by means of a horizontal perforated pipe, carried several feet into the boiler. As regards the comparative merits of the two systems, steam, no doubt, may be generated more quickly from cold water at starting when the draught takes the sides first; but as this is a secondary consideration in boilers of this class, it does not compensate for the evils referred to.—W. G.



[32216.]—**Boiler.**—The most approved method of setting Cornish or Lancashire boilers is to split the draught at the back of the boiler, bringing it to the front by the two side flues, and returning it under the boiler to the chimney, as shown roughly by the annexed sketch. The dimensions figured are nearly those usually adopted, but, of course, the actual proportions of the flues will depend on those of the internal tubes and grates, rapidity of combustion, &c.—W. MORSHEAD.



[32218.]—**G.N. Railway Engines.**—The following are a few of the dimensions of the express engines built by Messrs. Fowler and Co., for the above company in 1866:—

	ft.	in.
Diameter of leading wheels	4	3
Diameter of driving and trailing wheels ...	7	0
From centre of leading to centre of driving wheels	9	6
From centre of driving to centre of trailing wheels	8	6
Total wheel base	18	0
The cylinders are placed inside, distant from centre to centre	2	4
Diameter of cylinders	1	5
Length of stroke	2	0
Diameter of boiler (smallest)	3	10
Length of barrel of boiler	10	1
	sq. ft.	
Total heating surface	1,021¼	
	ft.	in.
Diameter of tender wheels	4	3

The tender carries 2,500 gallons of water.
T. G. S.

[32219.]—**L. C. and D. Railway Engines.**—I believe there are six engines belonging to the Myrtle class, but, however, I can only vouch for four. They are:—Rose, No. 75; Thistle, No. 77; Myrtle, No. 78, and Daphne, No. 80. Rose was built by R. and W. Hawthorn, Newcastle-on-Tyne, in 1863. I have seen them running between Oxford Junction and Seven Oaks, Beckenham and Norwood Junction, Sittingbourne and Sheerness, and Chatham and Rochester. Myrtle has lately been shunting carriages at Victoria Terminus. I cannot say that they are running now at the same places, as they seem to be rather unsettled in their work.—G. L. P.

[32223.]—**Venetian Blinds.**—To make green paint varnish, grind a pound of Chinese blue and chromate of potash together, and mix them thoroughly in common copal varnish, thinned with turpentine. The blue and the chromate must be ground to an impalpable powder, and the tone of colour varied with the amount of each ingredient used. A yellow green requires about twice the quantity of chromate of potash to that of the Chinese blue.—H. CRAWFORD.

[32224.]—**Ruby Pin of Lever Watch.**—The fault of your watch lies in the pin in the lever not being sufficiently close to roller. All you have to do is to bend the pin a little towards the roller. If you bend it too close to the roller the balance won't vibrate freely.—R. HUDDY.

[32228.]—**Paraffin Stoves.**—Water is sometimes added to paraffin by dishonest traders. It can be detected by a "sputtering" in the flame. If you do not wish to spoil your wicks and burners do not add any water to the oil. It causes the wick to char and smoulder, and creates a smell. It is about the worst thing you can do to use such a mixture.—ARIEL.

[32229.]—**Davyum.**—A very rare metal, discovered in platiniferous sand by Sergius Kern, of St. Petersburg, June, 1877. It is silver-coloured, density nearly 9·4, or between copper and bismuth; chemical equivalent about 150—154. For a number of its reactions see papers in *Phil. Mag.*, August and November, 1877.—J. BROWN, Belfast.

[32237.]—**Mining Question.**—Since the two seams of coal run parallel with each other, the question will simply be one of a right-angle triangle, the two sides being given to find the other side. Now, 1′ : 50′ :: 10′ : 500 feet—that is, supposing you were to cut a road through the upper seam of coal and direct to the dip, its length to where the cross-cut mine would gain the top seam will be 500 feet: therefore, 500 feet will be the hypothenuse or longest side of the triangle, and 50 feet the perpendicular; then to find the length of the cross-cut mine or base of triangle you proceed as follows:—

$$\sqrt{500^2 - 50^2} = 497{\cdot}5 \text{ feet,}$$

$$\text{or} \quad \sqrt{10^2 - 1^2} \times 50 = 497{\cdot}5 \text{ ,,}$$

In the above case I am supposing the two seams of coal are vertically 50 feet apart; but if they be 50 feet apart by an imaginary line taken at right angles to the line of dip, then the question will stand thus—

$$\sqrt{500^2 + 50^2} = 502{\cdot}4 \text{ feet,}$$

$$\text{or} \quad \sqrt{10^2 + 1^2} \times 50 = 502{\cdot}4 \text{ ,,}$$

—ALEX. CAMPBELL, Coal Miner.

[32237.]—**Coal Mining.**—If the two coal seams are 50ft. apart, measured at right-angles to the seams, the cross-cut will be 502ft. 6in.; but if 50ft. apart in a perpendicular shaft, seams having a gradient of 1 in 10, a level cross-cut will only be 497ft. 6in.—S. H., Liverpool.

[32237.]—**Coal Mining.**—"A Constant Reader" would require a cross-cut 510ft. in length from the lower to gain the upper seam, driving it water level. —SLAMAMAN.

[32239.]—**Bicycle Bearings.**—I decidedly recommend "Bristol Bicyclist" to avoid rollers; they are good in theory, but only for a short time in practice. Cones are best for back wheel, but nothing better than steel parallels for front wheel, such as on the Premier machine by the same maker he names.—W. L. RENNOLDSON.

[32245.]—**Brunswick Black.**—There are two kinds of Brunswick black—viz., best and common. The way the best is manufactured is as follows:—In an iron boiler, over a slow furnace, 90lb. of foreign asphaltum is boiled for about 13 hours, and at the same time 12 gallons of boiled oil is re-boiled for 13 hours. During the boiling of the oil about 12lb. of litharge is gradually introduced, and boiled until it becomes stringy. The boiler containing the oil is then emptied into the boiler containing the asphaltum. They are both boiled together until, upon trial, the two mixtures will roll into hard pills. The mass is then cooled, and mixed with 50 gallons of turpentine. Common Brunswick black is made as follows:—112lb. of common black pitch and 112lb. of common asphaltum made from tar are put in an iron boiler, and boiled for 32 or 40 hours, by which time the gas and moisture will have evaporated. It remains standing for two nights, and on the third morning is re-boiled. As soon as it boils 32 gallons of boiled oil are added; then 40lb. of red lead and 40lb. of litharge are gradually introduced, and boiled for 12 hours, or until it will roll very hard. When ready for mixing, 80 gallons of turpentine are introduced, until the whole mass is of a proper consistency. This will dry in half an hour, if properly boiled.—H. CRAWFORD.

[32248.—**Repolishing Marble Clock.**—You will find that directions for polishing marble have been given two or three times in the last two volumes. If there are not many scratches in your clock-stand you may begin with the snake stone. Black, and other coloured marbles, when they have been polished with the thick felt and putty powder, as described in previous numbers, may be finished off with a moistened buff of clean old calico and a little putty powder. If your clockstand is made up of several pieces, as it probably is, you may have to take it apart before you can repolish it. To do this place it in water, and let it remain till you can separate the pieces by gently tapping a thin table knife into the joints. The longer the joints are soaked the less risk there will be of chipping the marble. When the work is repolished stick it together again with plaster of Paris, darkened with a small quantity of lampblack. Let the mixture be thin, so that you may get fine joints; and, before it is dry, wipe off the superfluous plaster with a clean white rag. Keep all grit away from the work.—W. H.

[32249.]—**Cementing Object-Glass.**—As I have never had any experience in cementing object-glasses, I would rather withhold an opinion Before attempting such a thing, I would advise Mr. W. H. Davies to try the effect of a stop of some 6½in. or 7in. aperture, when an object appears with a blurred limb, as he describes Mars. The curious effect as to the angular diameter of Mars seems inexplicable—*i e.*, supposing the observations were made on the same nights. How does the instrument deal with γ^2 Andromedæ, and ε Boötis? This last is a very difficult star. I have known a telescope divide η Coronæ Bor. quite easily; yet, with the same power, at the same time, fail with ε Boötis.—Frank C. Dennett.

[32251.]—**Telephone.**—(3) I have wound about 100 yards of insulated wire, No. 36, on my telephones, and they succeed well. (*c*) When the wire was wound direct on to the magnet no articulation, and a very feeble sound was heard. (*d*) When wound on a boxwood bobbin it was all that could be desired, and articulation quite perfect.—A. B. C.

[32265.]—**Telescope.**—"Disappointed One" has evidently been presented with a 2ft. Gregorian reflecting telescope. The orange-coloured glass is to be used on the instrument in observing the sun. When other objects are to be viewed it must be taken off. Probably it may be unscrewed. The small shield or disc is the small metal or small speculum, which must not be meddled with (unless out of adjustment, and then only by a person who understands telescopes); but if it be protected with a cap or cover, that must be removed before anything can be seen with the telescope.—8½in. O.-G.

[32265.] — **Telescope.** — Evidently the "Disappointed One" knows very little about the telescope. The deep orange-coloured glasses should be unscrewed from the eyepieces for ordinary work, and only added when solar work is intended. What do you mean about the "small shield or disc . . . seemingly to cover the open aperture of a silvered speculum?" Is it a small speculum that you mean, or the large one at the bottom of the tube. If "D. O." does not obtain quite sufficient information about the "small shield," perhaps he will send a sectional outline drawing of the instrument to "ours."—F. C. Dennett.

[32265.] — **Telescope.** — Your telescope is a Gregorian reflector. The image falls upon the silvered speculum at the bottom of the tube, and is reflected on to the "small shield," which is a small silvered speculum, by which it is reflected through the hole in the large speculum to the lenses. The coloured glass is only to be used when looking at the sun, to protect the eyes from injury. To use it on any other object you must screw off the coloured glass, and look along the top of the telescope towards the object; move the telescope until the end is just above the object, then, looking through it, move the rack slowly, until you can see the object distinctly. The instrument will then be focussed.—No. 11a.

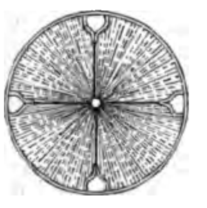
[32267.]—**Friction Wheel.**—For the purpose "J. B. C." requires it would be better to have the smaller wheel made of metal. The one I use is cast in type-metal with flanges to prevent the rubber band slipping off. This should be just so much smaller than the wheel as to insure a firm grip. If the rubber is too much stretched it loses its superficial elasticity, and is more liable to injury from sharp edges, &c., otherwise it is almost everlasting. I have had one pair in use for years, and my velocity is 3,000 per minute. The band should be vulcanised, and about ¼in. thick. I have mine made to order, the cost being 4s. per pound. I must confess my ignorance of its trade name. The sizes of wheels mentioned by "J. B. C." would, I should say, easily bore a 1in. hole with a centrebit, but not with a twisted bit, as that enters too quickly with the speed, and will work only with a slower motion. This, at least, is my experience.—W. H. Davies.

[32273.]—**Telescope.**—I am sorry not to be able to give "Totham" a more satisfactory reply than I am going to. The reason why is that the telescope is not achromatic; the O.-G. is one of the "cheap" ones. If you have Volume XXIII., just turn to the number for Aug. 25, p. 614, and you will find my experience with a similar, though smaller objective My advice is, sell the imperfect glass you now have and purchase a smaller and more perfect instrument with the money.—F. C. Dennett.

[32274.]—**Railway Wheels.**—Provision is made for difference of distance traversed by wheels on opposite sides of railway carriages in going round a curve by coning the wheels—that is, tapering them in an outward direction, so that when thrown by centrifugal force to the outside of the curve the outer wheels run on a larger, and the inner wheels on a less diameter than when running on the straight. In addition to this provision a certain amount of play is allowed in many engines by making the axle boxes of the leading and trailing wheels larger than the horn plates which slide in them, thus allowing from ⅜in. to 1in. end play. Various other devices are also used, such as mounting the carriages on wheels in bogie frames, which are free to move on a central point underneath the carriage. But most of these plans for preventing slip of the wheels on curves have the objectionable property of increasing the oscillation on the straight. If you have access to back numbers of English Mechanic I would advise you to look up March and April, 1874, in which you will find this question fully discussed.—H. F. R.

[32276.]—**Liabilities of Owners of Building Land.**—All that "Inexperientia" need to do is to let the land as a garden, making the tenant liable for all rates and taxes, except landlord's property tax, which "Inexperientia" would have to pay to the collector or refund to the tenant. No doubt the land will be liable to poor rates, highway rates, general district rates, and any other local municipal rates usually paid in the borough.—The Yorkshire Yeoman.

[32277.]—**Diatoms.**—Referring to "W. A. F.'s" query respecting the diatom Aulacodiscus, I may tell him that I have had sent me by a friend recently returned from the West Coast of Africa a small quantity of diatomaceæ taken from the River Congo, or the Livingstone, as Mr. Stanley would prefer to call it. I have cleansed and mounted some, and there are splendid specimens of the Aulacodiscus—I think the Aulacodiscus Crux. However, I inclose a rough sketch of one, and if "W. A. F." would like a little of the diatomaceæ I should have pleasure in forwarding him some if he will advertise his address.—E. Mawe Smith.



[32278.] — **Microscopical.** — I do not know "W. A. F.'s" method of transferring the scales to the glass, but I think, by simply pressing a portion of the wing upon the centre of his slide he will find a sufficient quantity of scales adhere for the purpose of mounting, and if they should not be distributed exactly as he would wish, he can, with the aid of a bristle, a magnifying glass, lens, and a little care, arrange the scales more to his liking—at least, I have many times succeeded in doing so myself.—E. Mawe Smith.

[32280.]—**Two Boilers to One Engine.**—Take a pipe from each boiler, and, at a short distance therefrom, join into one which take to the engine. Place a stop valve in each pipe between the junction and the boilers near to the junction. You may then work the boilers together, or each by itself, by opening or closing the necessary valves. Bear in mind that, though it is not necessary to have the water lines on the same level, yet, when working together, the pressure will equalise itself in the two boilers; therefore, if they are of unequal strength, it must not be greater than the weaker one will bear. I should suggest a 3in. steam-pipe being used. It is a mistake to put these in too small.—Straight Edge.

[32282.]—**Violoncello.**—The theory of thicker and weighted strings is that, as each note requires the same tension to be of equal quality and power, the lower notes would have to be proportionately lengthened, but as this cannot be, the material that would be in the extra length is added to its bulk, and so satisfies the conditions. The explanation of the jar is simple, being caused by the contraction of the gut during dry weather, leaving the covering wire loose. Had the strings been covered, as they should have been, during their greatest contraction, this would not have happened.—W. H. Davies.

[32282.]—**Violoncello.**—The jarring is caused by the catgut shrinking from the wire-covering, from excessive dryness. Dip a piece of rag in olive oil, and oil the strings thoroughly from tail-piece to pegs. Let it soak in, and then wipe off with clean rag. All covered strings improve by occasional oiling.—C. P. T.

[32282.]—**Violoncello.**—The reason of "T. T.'s" third and fourth strings jarring in fine dry weather is on account of the gut inside the wire having slightly contracted, and thus leaving the wire like a shell on the string, which, however, is removed on the atmosphere becoming damp, precisely the same action as the old gut barometers or weather-glasses. A very good plan of effectually stopping the jarring noise is to rub a little fine olive oil on the strings, occasionally, of course, avoiding the part immediately above the bridge. The strings will absorb all the moisture they require, and the process will make them last much longer.—Skilsch.

[32285.]—**Indiarubber Binding.**—You must put the papers between two flat boards, and knock them up quite straight to the edge you intend to cement, then rub some indiarubber cement all along with your finger. Be sure to rub it well in. You must do the work in a warm room mind, and not let paper slip. You may put them in a small copying press, with just the edge out; now get a little coarse muslin, rub a little of the cement on one side a little larger than the back of the paper, and when both are nearly dry stick them together and give them a good rub, and then let them dry. You can buy indiarubber cement better than you can make, at most large indiarubber shops. It is pure rubber dissolved in naphtha.—Polaris.

[32286.]—**Heat from Coals.**—Does the querist suppose that in any practical operations the effect of 1 per cent. extra ash would be perceptible? It would require very delicate observations and instruments to appreciate the difference in the heating powers, and the extra ash might be more than compensated by other differences in the composition of the coals. —Sigma.

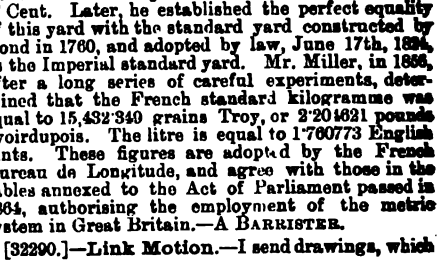
[32286.]—**Heat from Coal.**—It is quite possible that the 98 per cent. combustible matter in No. 2 coal would give off more heat in burning than the 99 per cent in No. 1. Different kinds of combustible matter give off very different amounts of heat in burning. For instance, hydrogen evolves more than 15 times as much heat as an equal weight of sulphur. J. Brown, Belfast.

[32288.]—**Astronomy.**—As "T. F. R." can only require an approximate answer to his query—"Having the moon's meridian passage at Greenwich given (say, from *Nautical Almanac*), to find out at what time (G.M.T.) the moon would cross the meridian in long. 3° W.?"—he will be quite near enough if he adds 12′ to the given time, the correction for daily variation for this long. not amounting at any time to much more than half a minute. The same will also apply to a star or planet.—George Bell.

[32288.]—**Astronomy.**—In order to find the G.M.T. of the moon's transit over any meridian, take the difference of the times of two consecutive transits over the meridian of Greenwich, and apply the proportional part of it due to the difference of longitude. Example: To find the G.M.T. of the moon's meridian passage on March 16th, 1878, in longitude 15° or 1h. west of Greenwich. The moon souths at Greenwich on that day, at 10h. 24·7min., and on the 17th at 11h. 17·5min. The difference is 52·8min.; therefore, 24h. : 52·8min. :: 1h. : 2·2min., to be added to 10h. 24·7min., because the longitude is west; so 10h. 26·9min. is the local time of transit over the meridian, 15° west of Greenwich. But we want the G.M.T.; therefore, we must add 1h. to this result, as the longitude is 15° west.—J. G. Vine.

[32289.]—**What is a Metre?**—According to Captain Kater, who, in 1818, compared the standard yard of Sir George Shuckburg with two French standard metres by Fortin, the length of the metre equals 39 37079 English inches, the metre and yard having each their normal temperatures—*i.e.*, the yard 62° Fah. = $16\frac{2}{3}$° Cent., the metre 32° Fah. = 0° Cent. Later, he established the perfect equality of this yard with the standard yard constructed by Bond in 1760, and adopted by law, June 17th, 1824, as the Imperial standard yard. Mr. Miller, in 1856, after a long series of careful experiments, determined that the French standard kilogramme was equal to 15,432·340 grains Troy, or 2·204621 pounds avoirdupois. The litre is equal to 1·760773 English pints. These figures are adopted by the French Bureau de Longitude, and agree with those in the tables annexed to the Act of Parliament passed in 1864, authorising the employment of the metric system in Great Britain.—A Barrister.

[32290.]—**Link Motion.**—I send drawings, which



I hope will suit "C. E. G. H."—Dorset Member A.M.S. and M.S.E.A.M.C.

[32296.]—**Platinum Silver Alloy.**—Dissolve the alloy in nitro-hydrochloric acid, breaking it down occasionally with a glass stirrer, to remove the silver chloride. This insoluble residue, after careful washing in boiling water, may be dissolved in ammonia, to insure that it contains no other substance, then evaporated to dry, fused, and washed, which will give the weight of silver. The platinum may be assumed by the difference, or it can be directly ascertained by evaporating the solution and washings to dry, dissolving in a little water, adding chloride of ammonium and strong alcohol; the yellow precipitate washed with alcohol, and ammonium chloride is to be carefully ignited, and will give the metallic platinum. Another plan is to boil the alloy in sulphuric acid, diluted with an equal bulk of water, till acid fumes are given off. The sulphate of silver is to be dissolved out with abundant hot water, and the residue again treated till the acid dissolves no more silver. The alloy should be either filed to powder or rolled into a thin film for the latter process.—Sigma.

[32297.]—**Galvanism.**—A current would be produced in the case described, and the zinc vessel would represent a zinc plate in a porous cell—assuming, of course, that the openings were not closed by the coating. I cannot say whether the albumen would separate.—Sigma.

[32298.]—**G. E. Engines.**—The express engines mentioned by "New Zealand" are not now seen on the G.E.R. Nos. 87 and 291 are single 7ft. engines, with outside cylinders. No. 87 is a French built engine, built by Schneider, of Creusot, and I believe gained a gold medal at the Paris Exhibition in 1867. Of 291 I cannot at present give particulars beyond that she is of about same dimensions as 87.—Greatrix.

[32303.]—**Jamin Magnet.**—This is built up of a number of plates of thin hoops of steel, connected to soft iron pole pieces. As thin plates take a stronger magnetism in proportion to weight than thick ones, the result is a compound magnet of great energy.—Sigma.

[32304.]—**Magnets.**—The strength depends in a great degree on length, which acts on the same principle as joining galvanic elements in series to gain electro-motive force.—Sigma.

[32306.]—**Varnish for Tools.**—For tool handles there is nothing better than shellac varnish. It should be put on before the handle is removed from the lathe. Use it the same as French polish, and in small quantities.—Os.

[32308.]—**Instrument for Reducing Drawings.**—In Vol. XV. of the English Mechanic, p. 311, "Os" will find a drawing of a pantograph (pantagraph ?)—A Barrister.

[32311.]—**Commutator for Extra Currents.**—For counting revolutions I use a little apparatus made up of gas-meter wheels, which records the number of turns made by the first arbour, which is provided with a little clutch to connect it to a variety of instruments. For rate of revolution, of course, the time of action has to be noted, and the rate calculated from the number of revolutions. I do not understand the difficulty about the cylinders. They need not come close to the primary or circuit-breaking one at all. Their distance can be made as desired, as the only thing of consequence is the ranging of the teeth and the springs, so as to come into action in proper order. A drawing would be of no use, for it is simply a cylinder of wood, with the rings slipped on it, mounted on bearings, with an arrangement to drive it. My own is one which is adapted to apparatus having several other uses; but the idea once given, any one can arrange it to suit his own means and purposes.—Sigma.

[32314.]—**Bichromate Battery.**—The local action is very great, so it is not adapted for work in which the zincs are to be left long in the solution; therefore, it is not suited for use with bells.—Sigma.

[32317.]—**Capacity of Metals for Magnetism.**—I have very little faith in the various formulæ given. There is always an element "c = a constant varying," and so on, and it seems to me that in general the formula leaves us pretty much where we were, as this c is just the one thing which is always of most importance. The principal laws as to shape are (1) the magnetic moments of saturated magnets of same substance, and form are proportional to the cubes of their like dimensions; (2) in cylinders of the same length the power is proportional to the diameters. These laws leave open all the questions of hardness, quality of steel, time and conditions since magnetising, and twenty other variable matters which all affect the result, and render formulæ of little practical use.—Sigma.

[32319.]—**Cast Zinc Plates.**—These are best hardened by rolling or hammering on a perfectly flat surface.—Os.

[32324.]—**Examination Papers.**—Each year's papers are published in the following year's "Calendar," but I think not in a separate form. As to the translations from unprepared classical authors it would probably be possible to pass without doing them: but I have reason to believe that considerable importance is attached to them, and as the passages set are never difficult, it would be very unwise not to attempt them.—Amara.

[32327.]—**Wooden Legs.**—I would advise the owner of these to get two strong brass or iron ferrules well fastened, about one or two inches from the end (or, rather, from where the end should be). The metal should project beyond the wood. Short pegs can then be driven into the ferrules, and these can be renewed from time to time—in fact, the wearer can make them himself. The end of the leg can be turned down, so as to form a shoulder for the ferrule; this will prevent the ferrule rising; but I would recommend a shoulder to the ferrule also. This will serve two purposes: it will prevent the ferrule moving, and will hinder the wood from being torn or split by the top of the ferrule.—Os.

[32327.]—**Wooden Legs.**—Would not india-rubber or thick leather do?—Amara.

[32328.]—**Telephone.**—I am surprised that "John" has failed altogether with the telephones, as he seems to have been very careful in their construction. It is certainly no detriment for the magnets to be tight in the holes—rather the reverse. But his magnets are extremely weak; they ought to take each other up easily. To strengthen them, see reply by "H. F. R." (p. 611). They may also be strengthened by rubbing them against a stronger magnet; but I should take them back, and demand to have them changed. Paterson changed me a pair. It cannot signify much how the telephones be kept. Theoretically they should stand or hang with the north poles of the magnets downwards; keep them connected, and solder the wires to the binding screws. The plates should be moderately tightly pinched in their places. I have tried three plates in each instrument with a hole through the centres of *all*, but shall replace the entire bottom plate, as I find no advantage. The 2nd and 3rd are certainly advantageous additions. I prefer to scrape the varnish off my plates, for the purpose of scouring them with sand-paper occasionally, thereby reducing their thickness. I have two large telegraph multipliers of 2,000 turns each in the circuit, No. 36 wire, and find little (if any) diminution of sound.—George Bell.

[32333.]—**Corrosive Sublimate.**—You are quite right to be afraid of this, as it is "an exceedingly powerful poison." I should consider it much worse than arsenic in paper, as it is, I think, more volatile, and with gas in the room a portion of it would be sublimed. It is certainly very destructive to vegetable and animal life. In reply to your question as to what part of a grain would kill a child—well, the fourth of a grain would kill a young child, and half a grain would produce decidedly unpleasant effects (to say the least) in an adult. The medicinal dose varies from the twelfth to the thirtieth part of a grain.—Os.

[32334.]—**Artificer for the Navy.**—The best way for "Fitter" is to state his case, and give references to the chief engineer, Portsmouth Dockyard.—Royal Navy.

[32336.]—**Frog.**—In a fern case. Supply with insects (alive) for food.—Amara.

[32338.]—**Covering Telescope Body.**—In manipulating bookbinder's cloth, I always use strong glue. Gum, I should think, would soak into the cloth and make it damp, and very liable to pucker. Let your zinc body be warm and the glue tolerably thick, but still thin enough to be easily used. The zinc should only be warm, as when hot it is very tender. I would put on the whole length at once and bring the cloth round, so as to overlap about an inch; then, with a very sharp knife and a straight edge, I would cut through both thicknesses of cloth. If this is done carefully and quickly you will make a very close joint. You should have a sponge and hot water to remove any superfluous glue, and to keep your hands clean. It will be tolerably hard in a few minutes. Should you observe any blisters or puckers flatten them down with the hot sponge barely damp. When dry you might give it a coat of what bookbinders call glaire, for which see back numbers.—Os.

[32340.]—**Gilt Appearance on Coals.**—I once in the Australian woods met with a prospector, who revealed to me that he had discovered a valuable site for gold-washing; he showed me a quantity he had collected in some weeks' working. He was awfully disappointed when I told him that his discovery was in a stream flowing from a granite district, and that his gold spangles were simply—mica. "Edmund's" collection is of equal value; it is simply pyrites or sulphide of iron, incapable of smelting or working, and of no conceivable use, except for making sulphuric acid, for which purpose it would hardly pay to collect.—Sigma.

[32340.]—**Gilt Appearance on Coals.**—This is either sulphur itself, or, most likely, iron pyrites. Shortly after I entered my "teens" I was "taken in" in this manner myself. I obtained possession of a very nice metallic crystal, which I carefully tested with nitric acid; but in order to be sure I determined to put it through the fire, which I did in a small crucible. During its ignition (or supposed fusion) I observed a very suspicious blue flame, and a strong smell of burning sulphur. On inspecting the interior of the crucible the truth dawned on me. If "Edmund" wants to waste more time let him "go and do likewise."—Os.

[32341.]—**Gilt Appearance on Coals.**—The substance is iron pyrites (sulphide of iron)]; not being a metal, it cannot be worked as proposed. It is useless, and is a fault in the coal.—Amara.

[32353.]—**Screw Cutting by Hand.**—Use a cleaning tool for V threads. What is easier?—Dorset Member A.M.S. and M.S.E.A.M.C.

Submarine Volcanoes.—The master of the D. M'B. Park (British barque), which arrived at West Cowes (I. W.) on the 3rd of March, from Batavia, reports as follows:—"January 29, at 7 a.m., in lat. 4.20 N., long. 21.45 W., saw several submarine volcanoes throwing large columns of water about 100 feet into the air, while the sea was in great commotion, as it is when there is a very strong under-current, the weather at the time being very cloudy, with rain, and nearly calm. The sound was like distant thunder."

UNANSWERED QUERIES.

The numbers and titles of queries which remain unanswered for five weeks are inserted in this list, and if still unanswered are repeated four weeks afterwards. We trust our readers will look over the list, and send what information they can for the benefit of their fellow-contributors.

Since our last "Os" has replied to 31901, 31937.

31678.	Jaundice, p. 415.
31686.	Loss per cent. of High-pressure Steam, 415.
31690.	Induction, 415.
31694.	Speculum Grinding, 415.
31708.	Soap Lather, 416.
31712.	New Safety Bicycle, 416.
31715.	Knights of Windsor, 416.
31716.	Monograph of Fossil Crustacea, 416.
31717.	Fossils, 416.
31722.	Mathematical, 416.
31723.	Microscopical and Optical, 416.
31725.	Antiquarian, 416.

31938.	Microscope Objectives, p. 513.
31939.	G. N. Tank Engines, 513.
31942.	Bees' Feeding Bottles, 513.
31943.	Uncoupling Railway Carriages, 513.
31946.	Paper Slates, 513
31952.	Rotating a Disc in Vacuo, 513.
31955.	Annealing Steel Wire, 513.
31950.	How to Make a Harp, 513.
31963.	Spongy Iron, 513.
31965.	Dyeing, 513.
31981.	Clock Tool, 514.
31982.	Sending Caustic Soda by Rail, 514.
31994.	Pompeii, 514.

QUERIES.

[32361.]—**Induction Coils.**—Would "Omega," or some other correspondent who has constructed coils on the disc principle, kindly give some information on the following points? 1. For a core giving 3in. spark, core 1in. in diameter, 10 inches long, of No. 17 wire, two layers of No. 15 for primary, 3lb. No. 36 silk-covered wire for secondary, what should be the outside diameters of discs? 2. Would three thicknesses of printing paper, prepared with paraffin, between each disc, actually six thicknesses between the wires, be sufficient insulation, discs being less than 1-16th inch thick? 3. Would there be any material advantage in using No. 20 iron wire instead of No. 17?—F. A. M.

[32362.]—**Underground Tubes.**—Can any one of our readers inform me of a receipt for protecting iron welded tubes from corroding, when placed in gravelly soil more particularly?—Mechanic.

[32363.]—**Dry Soap.**—Will some kind reader inform me how they make dry soap for washing clothes?—C. S.

[32364.]—**Experiment with Magnet.**—What is the simplest and surest way of showing to an audience the fact that a magnet's power is diminished by the approach of iron? I have used an electro-bar magnet, and so regulated battery power as just to sustain a given weight. On the approach of iron the weight should fall, but I have not always been successful in effecting this.—Vox Humana.

[32365.]—**Phonautograph Curves.**—In what work can I find the representations of the curves obtained by the phonautograph, corresponding with various organ stops and the different musical instruments?—Vox Humana.

[32366.]—**Organ Queries.**—Will Mr. S. Taylor (letter 32193, E. M., 8th March, 1878, p. 634) kindly say where a good organ by Walker may be heard? I mean good by comparison with fair specimens of Schmidt, Harris, and Schultze, who are absolutely, and of Green, England, and Hill, who are relatively disparaged, and of Walcher, of Ludwigsberg, Cavaillé, Willis, and Lewis, who are ignored. I should also like some authorities for the statement that "many of our best builders are continually using even better metal (than Schmidt's) and more weighty too."—S. C.

[32367.]—**Flock or Wool Cutting Machine.**—Can any of our friends tell me what sort of a machine to make to cut or grind wool as fine as the finest flour?—English Mechanic.

[32368.]—**Chromatic Pitch Pipe.**—Can any reader of the E. M. inform me how to make the above and give the sizes of the different parts of it with small sketch?—T. D. J.

[32369.]—**Paper Paste.**—Can any readers inform a constant reader the best method for making brown paper paste for moulding papier mâché trees and rock work for stuffed specimens?—Taxidermist.

[32370.]—**Marine Examinations.**—What are the examinations which persons are subjected to by the Board of Trade before obtaining a certificate as being competent to act in the capacity of second or third engineer on board a merchant steamer? Also which books are necessary or most suitable to obtain the required information?—L. Sugden.

[32371.]—**Speculum Testing.**—I am polishing two mirrors—one of glass, the other of metal. Will Mr. Purkiss kindly inform me how to test so as to arrive as near as possible to the parabolic figure? Will the glass one need to be silvered before it can be tested?—A Country Reader.

[32372.]—**Contraction of Pupil of the Eye.**—Could any reader give a sure remedy for the above malady?—T. H. M., Seghill.

[32373.]—**Cleaning Bronze and Steel Work.**—Will some one favour me with instructions as to the best method of cleaning a (yellow) bronze and bright steel ash pan? It is seemingly discoloured both by heat and dust.—W. S. L.

[32374.]—**Non-Absorbent Material.**—Required a non-absorbent substance, devoid of taste or smell, of a somewhat resilient and yielding character. I may say that indiarubber and spongio-piline have been tried: the first smells and tastes, the latter is too absorbent.—Enquirer.

[32375.]—**Rules for Choir.**—May I inquire if some choir-master will furnish me with a series of rules, rewards, and any other information for the government of a boy choir; how to keep a record of their relative merits so as to award to each his proper reward?—Choir Boys.

[32376.]—**Scale in Steam Boilers and Hot Water Pipes.**—Will some reader kindly tell me of a remedy for scale in steam boilers and hot water pipes? I have read somewhere of heavy lubricating petroleum oil being a preventive against scale. Can any reader tell from experience whether it could be used with safety, and whether it would stop the hot water pump in being introduced through the feed pipe?—Flour Mill.

[32377.]—**Artificial Trees.**—I want to place some imitation trees in a case for stuffed birds. I believe they are formed of some composition that will set very hard, but not too brittle. I think they are hollow and very light. If any reader will give me a receipt for the above I should be obliged.—Siskin.

[32378.]—**Trapeze Bar.**—Will some reader kindly give me particulars for making the above portable? What should be the length and diameter of bar, how should the ropes be fitted to the ends, and what would be the most convenient way of suspending it in a passage or room? Also what diameter steel core is usually used?—Sedentarius.

[32379.]—**L. and N.W. Railway Engines.**—Thanks to "Itzaex" for his attention. I should be very glad of any particulars of "Cornwall's" performances that he can give me. Can he oblige me with the principal dimensions of the four-coupled engines with 6ft. 6in. wheels, and the reason why the boiler is placed so high above the rails? These engines seem able to maintain a high speed with a heavy load better than the 8-footers on the Great Northern Railway.—Douglas.

[32380.]—**Cementing Ivory to Lathe Chuck.**—Could any of your readers oblige me with a receipt for making a cement for fixing bones, ivory, or alabaster to wood-blocks to be then chucked and turned in my lathe? I had formerly a tolerable good one, now lost. I remember two of the three ingredients with which I used to make it—viz., plaster of Paris and resin; the third may have been beeswax, but I have entirely forgotten the proportions.—J. L. H. S.

[32381.]—**Gilt Corners.**—Would W. H. Davies please to inform me of what the gilt corners for picture frames are composed?—Anerley.

[32382.]—**Globes**—I have bought two globes by Newton. On the celestial is laid down all the "stars, &c., in the works of Rev. Dr. Wollaston, De la Caille, Herschel, Hevelius, Mayer, Flamsteed, Bradley, &c." The stars are not lettered from the "British Catalogue." On the terrestrial it is said, "With corrections and additions up to 1823." Now are they of any practical use as to date? Is the "British Catalogue" published, and by whom? I find that the celestial globe rises about 2° too high above the wood horizon. How shall I correct it? What kind of cement must I use to fix an axis to the terrestrial globe, the south pole having a large hole in it?—A Poor Cornishman.

[32383.]—**Cutting Steel Discs.**—I can get a good order to supply some hexagonal discs in thin sheet steel about 2in. square, if in bright and soft steel, with two clean-cut openings through the steel. I propose to do the work with a press and die, first cut the blanks, and then cut the openings. If the best plan, please state. 1. What kind of press of sufficient power would best cut the steel blanks? 2. Which steel is the softest for the purpose? 3. Should I punch the openings, or cut them with a die and force?—K. H.

[32384.]—**Telescope.**—Can any of your readers give me a description, and, if possible, a working sketch of the mount of the plane mirror of a reflecting telescope—i.e., of that kind which can be made to move in every possible direction?—C.

[32385.]—**Yarmouth Sou'-westers.**—Can any correspondent inform me how the waterproofing of what is known in the trade as Yarmouth sou'-westers is done? They have a much better finish than the ordinary oilskin goods possess. Specify the ingredients used, and the mode of application.—Phantom Hand.

[32386.]—**Centre-board Boat.**—Will some of "ours" give me the lines for a fast-sailing centre-board boat, 20ft. long?—Tyneside.

[32387.]—**Lionite.**—Would some of our correspondents inform me what lionite, the new compound for picture frames, is made of; and is it soluble in bisulphide of carbon? Also what substances could be dissolved in bisulphide of carbon that would, on evaporation, leave a film somewhat elastic, waterproof, and of a consistency that would have the strength of strong letter paper; must stand all ordinary temperature, colour no object? I have thought of a compound of glue, paraffin wax, and some of the gum resins; the glue would give strength, but the question is would the compounds make an homogeneous mixture?—Americus.

[32388.]—**Apparatus for the Oxyhydrogen Limelight.**—Wanted information as to the relative merits of recently-invented appliances—more particularly as regards gas-heated retorts, and metallic gas-holders? Also the advantage of the latter over the usual india-rubber bags?—T. S. K.

[32389.]—**Krupp v Royal Arsenal.**—Will any reader inform me whether our arsenal at Woolwich is larger than Krupp's foundries? Also give me particulars of these places—such as the number of men employed, the amount of money paid yearly for wages, and which of the two is capable of turning out the most work?—H. B.

[32390.]—**Defective Hot-water Apparatus.**—I have a saddle-boiler supplying hot water to floor above. Near to the point of exit is a small cistern. Turn the tap, and the water runs pretty freely for about 7 seconds and then ceases. Close the tap, wait a short time, and the above phenomenon repeats itself *ad infinitum*. The pipe, 1in. diameter, was new three years ago, and I think cannot yet be choked up. Would air in the pipe cause this? What is the fault and the remedy? I have been told that steel pipes are not so liable as iron to incrustation. Is this a fact?—Josephus.

[32391.]—**Vortex Rings.**—Is there any cheap or easily constructed apparatus by which these rings may be produced, either by smoke or in water?—Amara.

[32392.]—**Netting.**—Could any of your kind subscribers describe the method of making ordinary netting, such as is used by gardeners to protect fruit?—J. Scott.

[32393.]—**Legal.**—A wife has a claim made at her marriage on some rented land, so that if her husband dies before her she shall have £60 per year, a charge on the land whilst its term of lease shall last. Now, for the benefit of her family, she and her husband wish to sell their interest in the land, but the trustees to the marriage articles say they will not consent, because they think they might become liable for that £60 per year. Under these circumstances the wife consents to give up all claim to the £60 per year, and I wish to know if she can legally do so; or how she can manage to sell with her husband their interest in the land, for if sold with that prospective charge it would be of little value to the buyer, and, of course, much less would be obtained for it by the seller.—Westminster.

[32394.]—**Indiarubber Stamps.**—Will the same reader that answered the above before kindly say if the mould would do if put in a hot oven? Also should I use pure bottle rubber cut in cakes the size I want the stamp?—Polaris.

[32395.]—**Reflecting Telescopes.**—How far must the plane be from a 5ft. focus speculum? Also about the distance of eyepiece from the plane, as I wish to mount one?—Polaris.

[32396.]—**Manchester Bells.**—In the number for October 26 two subscribers gave some particulars of these bells, but the information was not full enough. I should like to know the weight, note sounded, and the diameter of the mouth of each bell?—Campanologist.

[32397.]—**Stuffing Furniture.**—Will some one kindly give directions for stuffing chairs with hair in rep?—H. S.

[32398.]—**Circulation of Steam.**—Will any kind correspondent assist me?—I have a 5ft. diameter boiler, 20ft. long, steam 40lb. to inch, over the top of which I have fixed a drying-room, 10ft. wide, 40ft. long. In addition to the heat from crown of boiler I have fixed two rows of 4in. steam-pipes along each side of the boiler, extending the whole length of closet. I have put 1in. supply pipe from dome of boiler into four pipes, and ¾in. pipe from the other end back into boiler end for the return of the condensed steam, but I cannot get the steam to circulate round the pipes. I want a continuous circulation round the pipes. Is the supply pipe too small, and what size should it be? The supply pipe is 12in. above the return condense pipe.—H. Carter.

[32399.]—**Sympalmograph.**—Can anybody tell me why the pendula of my sympalmograph stop when the arms are fixed on, as before they are fixed it works beautifully? The arms are made of whalebone, which is lighter than cane, which is generally used for that purpose. I do not think it can be the fault of the rest upon which the arms work, as they have a perfectly free motion.—Bossyte.

[32400.]—**Mechanical.**—Would some mechanical reader oblige by answering the following, and state the rules by which he arrives at his results?—Two shafts have to revolve at right angles, one at 25 and the other at 375 revolutions per minute. Employ two wheels and two pinions. Give the number of teeth to each wheel and pinion. A traction engine weighs 6 tons, and is capable of drawing 20 tons behind itself on a good level road. What will it draw up an incline of 1 in 10?—Henri W.

[32401.]—**Indigo Refining.**—Will any of our readers tell me where indigo refining commercially is carried out? Kindly give me any information regarding the process. I am working it on a small scale, and before extending am anxious to know any hints which may be of value while doing so. First, as to quality and price of indigoes used for refining; size of cistern for refining 100lb. raw indigo; method of reducing; and whether oxidised by air or chemically; size of settling cisterns; and method of filtering, and drying, and general operations?—W. T. Kerr.

[32402.]—**Marmozet Monkeys.**—No doubt amongst the many readers of the English Mechanic there are some who keep these pretty little fellows, and who would be willing to give a few plain directions as to their management. 1. As to the best arrangement of cage or box, with sleeping bunk, detachable or otherwise; and in what temperature they should be kept by day and at night, both winter and summer? 2. The kinds of food that agree best with them when in captivity in this country, both liquid and solid? 3. Whether it be necessary or allowable to wash or cleanse them in any way so as to keep them sweet and clean? I should be exceedingly obliged for this information, so as to enable us to keep two little chaps in the healthy lively state in which we have just received them. We were given two about a year ago, of different species, white faced, with bright white patch on forehead. During the summer they were lively and well, though not so smart and nimble as the late arrivals; through the autumn and winter, however, they have been getting gradually weaker, until now their limbs, especially the hind ones, have little power in them. One of the monkeys is much worse than the other in this and all respects; in its case there seems to be much internal inflammation and swelling, with great pain, amounting to agony when touched. Both have clear bright eyes through it all. They have been kept in blankets before the fire all the winter, and fed on milk or cream, with fig or raisin, and a bit of sugar to suck; whole meal bread they will eat, but have just begun to get it; they will also suck, and sometimes eat, a bit of raw meat, but don't get much. Any hints as to the treatment of the invalids would be very acceptable to—Jacko.

[32403.]—**Lathe.**—Can any one give me any information about a screw-cutting lathe which I have? The lathe is made by Mr. W. Blackett, similar to that advertised by him in this journal. I want to shift the change-wheels on the lathe spindle or mandrel, but I cannot do so because there is a 15-teeth wheel on the spindle which gears into another 15-teeth wheel, which is fixed on a quadrant, which carries a stud where you put on one of the change-wheels. I want to know how to cut screws of any pitch, and the rule how to find the various wheels required for screw-cutting, single and double threads.—Pedro Adelphi.

[32404.]—**Electrical.**—1. Would a medical coil, composed of a ¾lb. of No. 24, and ¼lb. No. 40 wire, and wrought by 3 Daniell's, be strengthened by adding a condenser of 30 sheets tinfoil, size 5in by 3in.? 2. In making a condenser, does the foil require to be kept shorter than the paper at the ends (projecting at the sides of course) A description I have says, "cut the paper and foil the same size," which I cannot think correct, as the foil and paper when laid would coincide at the ends, thereby destroying the insulation of the alternate sheets of foil. 3. How is a condenser fixed? The description I have says, "place it below the base, and carry one end of the secondary to each strip of gauze to which the foil is soldered; then carry wires from the gauze to the binding screws." By that I would understand that each end of the secondary has simply to be attached to each side of the condenser, and the wires prolonged to the binding screws, from which shocks or sparks will be got. I have done so, but could get neither. Where am I at fault? 4. Is it possible to make bar magnets, telephone size, with a ¾lb. No. 24 covered wire, and 3 Daniell's cells? I have tried but could get no permanent magnetism whatever.—D. C. S.

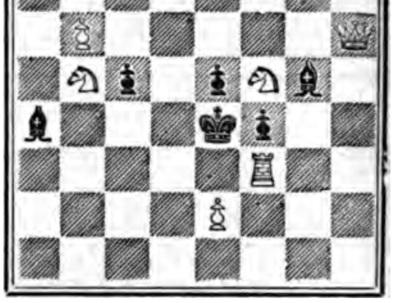
CHESS.

◆

All Communications intended for this department must be addressed to J. Pierce, Copthill House, Bedford.

PROBLEM CCCCXIV.—By A. Bayersdorfer.

Black.



White.

White to play and mate in four moves.

Solution to 412.

White.	*Black.*
1. B to Kt. 6.	1. Anything.
2. Mates.	

Solution to Mr. Meyer's Problem 402.

1. R to K R 2.	1. P takes P at K B 4 (a).
2. R to K B 2.	2. P to K B 5.
3. R to K 2.	3. P takes R.
4. B to K B 2 (ch).	4. K moves.
5. P mates.	
	2. Q takes Q.
3. R to K B 4.	3. Moves.
4. B takes P.	4. Moves.
5. R mates.	
	2. B to Q B sq.
3. Kt. takes Q.	3. P takes P at K Kt.
4. Kt. takes R.	4. Anything.
5. Q mates.	
	(a) 1. B takes P.
2. R to K R 4.	2. B to K Kt. 5.
3. R takes B.	3. R to K B 5.
4. Kt. takes Q.	4. R to K B 3.
5. R mates.	
	2. B to K 5.
3. Kt. to K B 3 (ch).	3. K to Q B 5.
4. Mates.	

Notices to Correspondents.

Correct Solutions to 412 by Arcanum and J. G. Finch.

Arcanum.—In 413 how do you mate if 1. Q to Q

2. $\frac{\text{R takes Kt. (ch).}}{\text{P takes R}}$?

Balata.—A hardened resin of the so-called bully tree, found on the banks of the Amazon and Orinoco, is being used as a substitute for guttapercha. Each of these trees yields from ⅓ to ½ kilogrammes of balata each year. This substance is so similar in appearance and properties to guttapercha that it is often imported as such. It is tasteless, has the same smell as guttapercha when warmed, has the same leather-like toughness, but is far more elastic. At 50° C. it becomes plastic, and melts at 150° C.—hence at a higher temperature than guttapercha. It is partly soluble in pure alcohol and ether, but completely soluble in warmed turpentine, and in benzol and carbon di-sulphide even when cold. It becomes strongly electrified when rubbed, and is a better isolator for heat and cold than guttapercha, and will doubtless soon find an important application in electrolysis. The caustic alkalies and concentrated hydrochloric acid have no action upon the balata, but warmed concentrated nitric and sulphuric acids have the same violent action upon it as upon guttapercha.

SPHINX.

ommunications for the “Sphinx” should be T. Mitcheson, B.A., *City of London School,* *E.C.*

the influx of mathematical correspondence a ill be required for a satisfactory perusal and insertion, the space allotted for the “Sphinx” rily restricted.

Questions.

ubic foot of brass is drawn into wire $1\frac{1}{16}$in. What length of wire, allowing no waste of NES.

, Dick, Harry, Eliza, Mary, and Jane went o buy pigs; each paid as many shillings per umber of pigs which he or she bought. Tom ore than Eliza, and Dick bought 23 more than persons were three married couples, and in e husband spent three guineas more than the h was Tom's wife? Which Dick's? Which J. A. H.

indefinite line, B D N, slides along a fixed nd always perpendicular to it. From a given A is drawn parallel to B N, and A D is always gles to B C. Find the locus of the middle intercept, B D.—L. S.

make a triangle equal to a given triangle.— s.

d all the solutions of the equation $15 (x^3 + 1)$ $16 x^3$.—Amara.

en has $\frac{1}{0}$ a value different from $\frac{1}{0}$?—Amara.

bodies are projected at the same moment in rtical plane with velocities $3g$ and $2g$, and $\frac{\pi}{3}$ and $\frac{\pi}{6}$; prove their directions are parend of $6 + 4\sqrt{3}$ seconds.—J. F. W.

given triangle, A B C, find a point O; such gles, O B C, O C A, and O A B are equal.—

Solutions.

$$_1 = \frac{1}{2} n (n + 1), S_2 = \frac{1}{6} n (n + 1) (2n + 1)$$

$$n (n + 1) \}^2, S_4 = \frac{1}{30} n (n + 1) (2n + 1) (3n^2 + 3n - 1)$$

$$= \{ \tfrac{1}{2} n (n + 1) \}^2 \left(\frac{2n^2 + 2n - 1}{3}\right).$$

$$^1 \frac{3n^2 + 3n - 1}{5}, 5 S_4 S_2^{-1} = 3n^2 + 3n - 1$$

$$\frac{2n^2 + 2n - 1}{3}, 3 S_5 S_3^{-1} = 2n^2 + 2n - 1$$

$$^1 - 3 S_5 S_3^{-1} = n^2 + n = n (n + 1) = 2 S_1.$$ —Ibid.

ce $x + y + z = 0$, we know that x, y, z are the cubic

$$t^3 + (xy + yz + zx) t - xyz = 0,$$

ore, by a well-known theorem in the “Theory ns” (see Todhunter's, chapter 21)

$$^7 + y^7 + z^7) = xyz (xy + yz + zx)^2$$
$$= xyz (-z^2 + yz)^2$$
$$= xyz (x^4 + y^2 z^2 - 2 x^2 yz).$$

by symmetry, interchanging x and y,

$$+ y^7 + z^7) = xyz (y^4 + x^2 z^2 - 2 y^2 xz).$$
$$\tfrac{2}{7} (x^7 + y^7 + z^7)$$
$$xyz [x^4 + y^4 + z^2 (x^2 + y^2) + 2 z^2 xy]$$
$$xyz (x^4 + y^4 + z^4).$$ —Leidhold.

$$\cos. \theta = 1 - \left(\frac{\theta^2}{\lfloor 2} - \frac{\theta^4}{\lfloor 4} + \frac{\theta^6}{\lfloor 6} - \dots\right)$$

$$\log. \cos. \theta = - \left(\frac{\theta^2}{\lfloor 2} - \frac{\theta^4}{\lfloor 4} + \dots\right)$$
$$- \tfrac{1}{2} \left(\frac{\theta^2}{\lfloor 2} - \frac{\theta^4}{\lfloor 4} + \dots\right)^2 - \dots$$

$$= \left(1 - \frac{4\theta^2}{\pi^2}\right)\left(1 - \frac{4\theta^2}{3^2 \pi^2}\right)\left(1 - \frac{4\theta^2}{5^2 \pi^2}\right) \dots$$

$$\theta = \log. \left(1 - \frac{4\theta^2}{\pi^2}\right) + \log. \left(1 - \frac{4\theta^2}{3^2 \pi^2}\right) + \dots$$
$$= - \frac{4\theta^2}{\pi^2} - \tfrac{1}{2} \frac{4^2 \theta^4}{\pi^4} - \dots$$
$$- \frac{4\theta^2}{3^2 \pi^2} - \tfrac{1}{2} \frac{4^2 \theta^4}{3^4 \pi^4} - \dots$$

he co-efficients of θ^2 in the two expressions:

$$\frac{1}{\pi^2} + \frac{1}{3^2 \pi^2} + \frac{1}{5^2 \pi^2} + \dots \Big) = \frac{1}{\lfloor 2};$$

$$1 + \frac{1}{3^2} + \frac{1}{5^2} + \dots = \frac{\pi^2}{8};$$

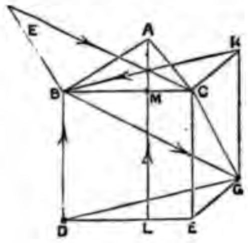
$$+ \frac{1}{5^2} + \frac{1}{7^2} + \dots = \frac{\pi^2}{8} - 1.$$ —Amara.

$$\text{Tan.}^2 \theta (\sec. 2\theta - 1)^{-1}$$

$$\frac{\tan.^2 \theta}{\tan.^2 2\theta - 1} = \frac{\tan.^2 \theta}{\sqrt{1 + \dfrac{4 \tan.^2 \theta}{(1 - \tan.^2 \theta)^2}} - 1}$$
$$= \frac{1 - \tan.^2 \theta}{2}.$$

$\theta = 0$, $\tan.^2 \theta = 0$, and therefore the limit of ion, when $\theta = 0$ is $\frac{1}{2}$.—W. Morshead.

722.—(Maggie.)—Draw E G perpendicular on A C, produced; then the triangles, B A C, C G E, are equal in every respect, as also the triangles F B C, G C B; therefore E K, F G, are parallelograms. In the parallelogram,



F B K G, the forces K B, D B, are in equilibrium with the force B G. The forces, F C, L M, are transferred to the parallel positions, B G, D B, acting at the point B.—J. F. W.

Answers.

W. Morshead, 729; F. Fulwood, 730, 731; F. S. B., 729, 730, 731; Amara, 729, 730, 731; L. S., 726, 723, 724; R. Stewart, 730, 731; Carter Pegg, 730, 731.

A. B. C.—Your figure accompanying solution to 727 is too complicated. Cannot you revise it?

USEFUL AND SCIENTIFIC NOTES.

The Acme Lawn Tennis Marker.—A handy little machine for marking the courts in lawn tennis has been introduced to the public by Messrs. Boult Brothers, of Tower Chambers, Liverpool. It consists of a shallow toothed or ribbed wheel held in a trough frame attached to a couple of small roller wheels. The machine can thus be easily run over any distance without making a mark; but as soon as the large wheel touches the ground it begins to revolve, and leaves a chalk line wherever it is directed. In the front of the trough is a block of prepared chalk, kept up to the ribbed wheel by a spring; a small can of water, with a drip tap, is supported on the handle, and thus as the wheel revolves it prepares the whiting or chalk paint without any further trouble. Ladies can use this machine without fear of splashing their dresses.

The Telephone.—At the meeting of King's College Engineering Society, on the 15th February, Mr. C. W. Cunnington read a paper on the “Telephone,” in which, after describing the different forms of telephone invented, he stated the theories which attempted to explain their action: for the molar theory he contended that the vibration of the iron plate of the sending instrument, under the influence of sound, was amply sufficient to induce currents of electricity, strong enough to cause the plate of the receiving instrument to vibrate, and thus to reproduce sound. He also referred some of the sound produced in the receiving instrument to the effect of the undulatory currents on the magnet itself, thus explaining the results obtained without the use of a vibrating disc. In comparing the vibrating disc with the membrana tympani of the ear, he pointed out the fact that the predominance of the fundamental note of a flat plate would drown a large number of the overtones of the voice, thus causing many of the observed peculiarities of the sound transmitted in ordinary telephones; the membrana tympani being funnel-shaped, whilst peculiarly susceptible to the influence of sound, had no special fundamental note, and therefore transmitted all of the sound vibrations impinging upon it (within certain limits), without giving undue preponderance to any particular set. He also referred to the important place the instrument was likely to take in the investigation of earth currents. During the discussion which followed, Professor Adams, referring to the molar theory of the transmission of sound, demonstrated by experiment the effect of a slowly vibrating iron plate in causing electrical currents. His apparatus consisted of a magnet within a helix, opposite to the pole of which was suspended a thin iron disc; the terminals of the helix were connected with a delicate reflecting galvanometer, throwing an image on a graduated scale; the slightest vibration of the disc produced a corresponding deviation of the image on the scale. The professor also showed why a large proportion of the force of the sound in telephones was lost in transmission.

The Paris Exhibition.—One of the leading publishing houses of Paris is making arrangements for the speedy appearance of an enormous work, “Etudes sur l'Exposition de 1878,” under the direction of M. E. Lacroix. This work is intended to be a complete record of the progress made in all the arts up to the present date, and its thoroughness and value have been assured by the promised co-operation of a large number of leading authorities. The French Ministers of Public Works, of Commerce, and of Agriculture have already promised all necessary assistance on the part of the Government, so that the undertaking will start under the most favourable auspices.

ANSWERS TO CORRESPONDENTS.

_ *All communications should be addressed to the* Editor *of the* English Mechanic, 31, *Tavistock-street, Covent Garden, W.C.*

HINTS TO CORRESPONDENTS.

1. Write on one side of the paper only, and put drawings for illustrations on separate pieces of paper. 2. Put titles to queries, and when answering queries put the numbers as well as the titles of the queries to which the replies refer. 3. No charge is made for inserting letters, queries, or replies. 4. Commercial letters, or queries, or replies are not inserted. 5. No question asking for education or scientific information is answered through the post. 6. Letters sent to correspondents, under cover to the Editor, are not forwarded; and the names of correspondents are not given to inquirers.

The following are the initials, &c., of letters to hand up to Tuesday evening, March 12, and unacknowledged elsewhere:—

J. G. Bergman.—D. Yonge.—David Siemens.—J. B. Spicer.—S. H. Webb.—Major-General Anderson.—E. Blakey and Co.—T. Calliphronas.—D. Nolan.—Rother Ironworks Co.—W. Mathie.—A. Verraert.—G. H. Bartlett.—W. Rogers.—E. C. Rotheram.—G. F. Riddiford.—W. J. Symons.—J. L.—R. J. Johnson.—O. E. C. C.—X. Y.—G. Bell.—G. S.—Boshfaker.—Tax.—W. M. S.—Snyder.—Jobbing John.—C. M.—F. C. S.—M. T. O.—Fangasse.—W. G. Wenley.—H. C. Parlour.—A. E. Bannister.—Charity.—Rob Roy.—J. H. Collins.—Hazy.—W. G. H. A.—Enthusiastic Scot.—John Meldrum.—J. Taylor.—E. J. Marshall.—F. C. Dennett.—A., Liverpool.—A. Pumphrey.—W. Williams.—J. B. Poole.—H. Southett.—No Sirrah.—Skerryvore.—Full and Bye.—B. F.—Ishtar.—Ne Sutor.—C. B. M.—Towe.—F. W. C.—John Dawson.—Glatton.—Fiddler.—Straight Link.—Henry Jones.—C. O.—W. B.—An Anxious Enquirer.—W.—Target.—J. A. W.—W. P. T.—A. B. R.—Enquirer.—J. A. A.—Harry Beta.—W. F. Knox.—J. Browning.—W. J. Lineham.—N. T. C.—Telescope Tele.—F. L. Striffler.—W. L.—Poor Fiddler.—C. Cooper.—Relieur.—Smallboy.—A. Stelfox.—X.—L. W. D.—Roscoolite.—Inquirer.—J. K. Jennings.—G. J. B.

Lover of Flute and J. D. (We cannot invite opinions as to merits of different makers; the second name you mention is a good one.)—Young Builder. (End pieces and other easily managed contrivances are introduced. See front page of *Building News* for advertisements of makers of apparatus and write them for particulars.)—Member of Society of Arts. (Apparently local tradesmen's tokens—not worth engraving.)—Trouble. (You can only become such by being regularly articled to a civil engineer.)—J. T. N. (Several cheap books have been advertised on the subject from time to time, and much information given in back vols.)—Chips. (Follow your medical man's advice.)—J. Mossop. (We have illustrated the best known firearms as they have come before public notice. We certainly have not room for a description of all the arms used in the service, while so many more useful and important matters claim our sorely-taxed space.)—H. Boswell. (You cannot polish wood stained in the manner you describe—your only resource is to varnish it.)—A Learner. (Not at all; the best phonographers are the most legible writers.)—A Draper. (All are acknowledged, and we have received nothing from you lately.)—W. H. Davies. (We are glad you have found such proofs of the wide circulation of the English Mechanic. As you say it is nothing new to us, but it it is nevertheless gratifying.)—H. Crawford. (Thanks for last abstract and offer of next, but we think all has been given in our columns that is known at present with regard to both subjects.)—A Constant Subscriber. (Ordinary sticking plaster is made by spreading gum on thin linen or silk. We cannot ask for or give recipes for “green salves.” Such unguents are either useless or harmful unless applied under proper advice.)—G. Y. P. (Simply inserting your letter without the name of the dishonest maker would be useless, and to give the name would probably subject us to an action for libel. You have your remedy in the county court if you can prove the facts you allege.)—H. W. J. (Yes, unfortunately, our law at present is powerless to interfere in such deplorable cases, until actual crime is the result of the terrible propensity. Many social reformers and good men have been striving to establish homes for the inebriate, under legislative control, where habitual drunkards might be placed, just as lunatics can be sent at present to asylums, on the testimony of medical men that such a step is necessary. There are such establishments under private management, and your friend might try to persuade his wife to enter one of them.)—Townsend Petrie. (Sampson Low and Co, 188, Fleet-street.)—Brickwall. (The report can be obtained of Spottiswoode and Co., the Queen's printers. You had better get the *Home Chronicle*, published by E. W. Allen, 11, Ave Maria Lane.)—Robinson Crusoe. (Yes.)—J. R. H., Rochdale. (Letter next week. Unfortunately the glass slides have reached us in fragments.)—Pivot. (Yes.)—Nelson. (Simply nitric acid; previously protect the metal by means of soap, wax, or plaster, and etch the desired pattern on the steel with a needle or fine pen.)—Orderic Vital. (Mudie's for general literature, and probably the leading scientific works, but we know of no establishment for the loan of technical books.)—Self-taught. (Simply by learning to read the signatures at the beginning of the stave.)—Stannus. (See articles on “Solders and Soldering,” pp. 391 and 465, Vol. XX., Nos. 510 and 513. See also indices to every published back vol.)—W. S. Franks. (We do not remember receiving the letter.)—Haiarn. (Is your letter on Loco. Injectors complete—one leaf?)

Musical Glasses, B. T. M., R. J.—See indices to back vols.

J. P., Noman, A Pole, Verisopht.—Your communications are advts.

Alfxitas and others have replied to queries already similarly answered.

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FRIDAY, MARCH 22, 1878.

ARTICLES.

SPONTANEOUS GENERATION.

THE paper by Dr. Bastian which we briefly noticed on p. 590, Vol. XXVI., and which was intended as a reply to Prof. Tyndall's papers read before the Royal Society, has produced a rejoinder from the famous physicist, in which, for the first time, we believe, he employs the argumentum ad hominem. It is well known to those conversant with the bearings of the spontaneous generation controversy that, if the question were merely one of opinion and not of fact, both Prof. Tyndall and Prof. Huxley would be brilliant, not to say enthusiastic, exponents of the hypothesis which in this country finds an ardent advocate in Dr. Bastian; but the facts are against the theory they have formed—at all events, as regards the beginnings of life nowadays, and accordingly we find them honestly separating their experimental results from their speculative inductions. Towards the conclusion of his paper in this month's *Nineteenth Century* Prof. Tyndall says that as to any suspicion of bias or prejudice he has only to remind the reader that few persons at the present day have more distinctly avowed belief in the "potency of matter," and few have paid more dearly for that avowal than himself. Indeed, with the views he holds, he has taken special care that no theoretic leaning should taint his judgment of experimental evidence, while his only desire has been that the potency of truth should be vindicated. "No denier of the potency of matter could labour more strenuously than I have done to demonstrate its impotence as regards spontaneous generation." So far is that hypothesis from being the logical interpretation of known facts, as Dr. Bastian asserts, that Prof. Tyndall affirms that "no shred of trustworthy experimental testimony exists to prove that life, in our day, has ever appeared independently of antecedent life." Some members of the medical profession do not accept Prof. Tyndall's germ theory of disease, but they do not dispute the truth of the experimental evidence he has brought to bear on the question of spontaneous generation. Others refuse to accept either, and, unable themselves to explain the cause of zymotic disease, as they are unable to control its effects, have imported some little heat, probably engendered by professional pique, into a controversy which, considering the human interests involved, should have been carried on as calmly and dispassionately as possible. The medical world, in fact, is divided into three sects, and not the least important of the three have loyally accepted the truths submitted to them by Prof. Tyndall, and done good service in the same line of experimental discovery. It is, perhaps, not to be wondered at that in this "last word" the writer has not attempted to conceal his contempt for the manner in which his "respondent" has conducted the controversy, but concludes his paper with the remark that, "neither honour to the individual, nor usefulness to the public, is likely to accrue from its continuance, and life is too serious to be spent in hunting down in detail the Protean errors of Dr. Bastian." Still, it is a matter for regret that when the opportunity occurred for settling one point in the controversy, it was lost by gross mismanagement or indifference, and through no fault of Dr. Bastian. He at least has shown himself ready to demonstrate the truth of his crucial experiment, and it is really a matter of some scientific interest to discover how experimenters like Pasteur and Tyndall on one side, and Dr. Bastian on the other, should have obtained contradictory results under what are said to have been exactly similar conditions. The experiment consists in boiling urine in tubes and neutralising it with caustic potash. According to Dr. Bastian, the tubes have invariably swarmed with organisms a few days after preparation, and in spite of every precaution tending to the exclusion of atmospheric germs. Prof. Tyndall has repeated the experiment, and obtained results which differ entirely from those invariably following the same series of operations when performed by Dr. Bastian. In some cases a few of the tubes have become turbid, while in others all have remained perfectly clear and unchanged. Dr. Bastian retorts that too much or not sufficient caustic potash has been added, so that this crucial experiment, which he regards as definitively settling the question in favour of abiogenesis, is reduced to a controversy upon mere matters of detail. It was to arrive at some definite conclusion as to the cause of the different results obtained by M. Pasteur that Dr. Bastian went to Paris, and it is a matter for regret that the experiments were not performed in presence of the members of the committee appointed to decide the question. Regarding the urine test, from the point of view of the unequivocal results invariably obtained by Dr. Tyndall in his closed chambers, we cannot avoid the suspicion that through some not altogether obvious defect in his arrangements the experiments of Dr. Bastian are practically worthless; for Prof. Tyndall expresses a confident opinion that by a little practice the sterilisation of urine by five minutes' boiling might be rendered certain in every case. With the single exception of this urine test the whole of the experimental evidence is dead against the hypothesis of Dr. Bastian, who, to use the words of Dr. Roberts, appears to be blind to the overwhelming cogency of the case against him. His failure to answer the very pertinent inquiry of Dr. Tyndall may be regarded as a tacit acknowledgment of his inability to support his hypothesis by experimental evidence; and his suggestion that particles of organic débris falling into putrefiable solutions may give rise to chemical changes resulting in the development of living matter de novo cannot be regarded as probable or even scientific. If Dr. Bastian can destroy all germs in the air to which his solutions are exposed, and then show that organisms appear in his tubes through the falling in of the dead particles of matter, his hypothesis would not appear so visionary as it does in the absence of that proof; but although he may consider it a "more logical" interpretation of the facts to assume that dead particles have set up such an action as to spontaneously generate bacteria, there are others who will regard it as more logical to assume that the organisms were evolved in the usual manner from their "germs," whatever we may understand by the term. Dr. Tyndall's unanswered question is not to be avoided by introducing a side issue. It is very definite. "Why," he asks, "when your sterilised organic infusion is exposed to optically pure air, should this generation of life de novo utterly cease? Why should I be able to preserve my turnip-juice side by side with your saline solution for three hundred and sixty-five days of the year in free connection with the general atmosphere, on the sole condition that the portion of that atmosphere in contact with the juice shall be visibly free from floating dust, while three days' exposure to that dust fills it with bacteria." It is no answer to such a question to speak of the ultra-microscopic size of the supposed germs, and to speculate whether they are germs or finished organisms. We have no right to assume that the bacteria which swarm in unprotected putrefiable solutions are generated de novo by the falling in of particles of dead matter, but we have a right to conclude that they are produced from their germs. If in a sealed chamber a number of tubes containing putrefiable matter have been kept perfectly sweet and clear for six months, though freely exposed to optically pure air, and if, after opening the chamber and loading its atmosphere with the dust shaken from a wisp of hay, we find within forty-eight hours that all the infusions have a surface scum consisting of countless multitudes of the hay Bacillus, what conclusion can we arrive at but that the bacteria present have been produced from their germs mixed with the dust from the hay? The experiment made by Dr. Tyndall last autumn, when he took with him to the Alps a number of sealed tubes containing various organic infusions, may rightly be regarded as conclusive evidence upon the point. These tubes were sealed after the air had been expelled by the steam, and there was consequently a partial vacuum into which air would rush when the long neck was snipped off. Into some of these tubes the pure air of the Alps was admitted by snipping off the extremity of the neck in a situation where the atmosphere might reasonably be expected to be free from germs, while others were opened in an exactly similar manner in the dust-laden air of a hay-loft. The results were precisely what previous experiments had led Prof. Tyndall to anticipate. The contents of the flasks or tubes opened in the practically pure mountain air, which is doubtless not altogether free from dust, remained perfectly clear and sweet, while the infusions contained in the tubes to which the air of the hay-loft was admitted speedily swarmed with organisms. Whence came they? The only reasonable answer is from something contained in the dust of the hay-loft, which, judging by analogy, must have been germs.

VOL. XXVII.—NO. 678.

Dr. Bastian asserts that the alleged behaviour of the invisible particles (germs) with regard to heat is altogether opposed to that of all known visible germs, and referring to Dr. Tyndall's theory of the capability of germs to resist a boiling temperature for many hours, he asked what present warrant there is for supposing that a naked or almost naked speck of protoplasm can withstand four, six, or even eight hours' boiling, and he answered his own question by the rather dogmatic utterance, "None." Prof. Tyndall replies that as regards "naked specks of protoplasm" he makes no assertion, but he does affirm, not as a "supposition," an "assumption," a "probable guess," nor as a "wild hypothesis," but as a matter of the most undoubted fact, that the spores of the hay Bacillus, when thoroughly desiccated by age, have in special cases withstood the ordeal mentioned. And yet these obdurate germs can be destroyed by five minutes' boiling, if the heat is applied at intervals. The finished bacterium is killed by a temperature considerably below that of boiling water, whereas the germs contained in the same liquid will remain uninjured. But if the infusion is frequently boiled at short intervals it is perfectly sterilised, because all the germs have then been subjected to a destructive heat, at a stage in their existence when they became sensitive to its effects. Why Dr. Bastian assumes that germs of bacteria are "naked specks of protoplasm" he does not say, but he concedes that there may be a "thin covering," and this, as Prof. Tyndall points out, may exercise a powerful protective influence. The seeds of some plants do not lose their germinating power, after even four hours' boiling—*e.g.*, the seeds of the Medicago (Lucern) of Brazil, the toughness of which astonished Pouchet; but, as a rule, they are devitalised by a few minutes' immersion in boiling water. Prof. Tyndall experimented with peas, beans, cress, and mustard, tying the seeds up in small calico bags. Thirty seconds' exposure to the boiling temperature destroyed the germinating power of the peas and beans, a few of the cress seed sprouted when subsequently planted, but a very large proportion of the mustard seed retained its germinating power. The explanation is that the water did not reach the seeds in the interior of the bag, for when the mustard seed was subsequently boiled without the calico bag it was completely devitalised. It is mainly for this reason that it is so difficult to sterilise turnip-cheese infusions, the germs being protected by the fluid in which they are imbedded. In a similar way a pea carefully coated with indiarubber and immersed in boiling water, will be unaffected while an unprotected pea is being reduced to pulp; and it is not improbable that germs, so far from being "naked specks of protoplasm," may be so clothed as to resist for a long time the imbibition of moisture, which is necessary to produce the swelling and softening that precede their destruction. But, whatever may be the cause, the spores of Bacillus subtilis are undoubtedly capable of resisting, under some circumstances, exposure for hours to the heat of boiling water. In concluding his "last word," Prof. Tyndall says that the present condition of the spontaneous generation hypothesis is such that no medical man seeking to realise and remove the causes of epidemic disease, need have his mind troubled by a doubt as to the derivation of those organisms to which modern physiology, with ever increasing emphasis, assigns functions so momentous. Clearly assured that they are not spontaneously generated, his efforts will be directed to the discovery and the destruction of the germinal matter from which they spring. For the sake of the public and the medical world, Prof. Tyndall has spared no pains to render his demonstrations so clear that no amount of verbal "effluence" will be able to obscure them. "This accomplished, the controversy comes to a natural end." According to Dr. Bastian himself the question "lies at the root of the most fatal class of diseases to which the human race is liable," and it remains to be seen whether he will loyally accept the teachings of experimental science, or demonstrate their incorrectness by more conclusive experiments of his own.

DURATION OF SIMPLE PSYCHICAL PROCESSES.

THE time taken by operations of the human mind has become an attractive subject of experiment in these days, and, through increasing delicacy of apparatus, it is even being more exactly measured. A series of experiments recently made in Prof. Helmholtz's laboratory, by MM. Kries and Auerbach, furnish some interesting results, of which we propose to give a short account.

The method adopted was in general similar to that of M. Donders, but the psychical process measured was simpler. When one experiences a sensation (from a stimulus being applied), and is required to give a signal immediately on doing so, a certain time elapses between the moment at which stimulation takes place, and the reaction; and this "reaction-time" has been often measured. Going a little further, the person may be required to react only after some property of the stimulus is ascertained. Thus, two stimuli, *a* and *b*, may be applied interchangeably; and the person is required to make a signal, *c*, when he knows *a* is applied, but a signal, *d*, when he knows *b* is applied. Here the time between stimulation and reaction becomes longer; and M. Donders considered the increase as representing the quantity he sought to measure.

The present experimenters considered this too complicated. After you have ascertained the stimulus was *a*, you have to remember that to *a* the reaction, *c*, belongs; also of the two reactions, *c* and *d*, for either of which you are prepared to choose the right one. Thus, in the prolongation, there is probably an appreciable portion which should not be reckoned in the time of investigation of the sensation. The experimenters, therefore, in all cases used only one reaction; and the stimuli being interchangeable, the person was required to react only when one was given.

The experiments were, then, of the two classes of simple experiments (in which a single stimulus was applied at intervals, and the person answered it immediately with always the same reaction), and experiments with distinction (where one stimulus, *a*, was irregularly exchanged with another, *b*; and the person was required to react only to *a*). First, a series of simple experiments were made; then a series of the second class, then a series of simple ones again (to eliminate disturbing influences from inconstant action of the mental mechanism). The average of the first and third series was subtracted from that of the second. The difference is termed the "distinguishing time" *(Unterscheidungszeit)*, *i.e.*, for distinguishing *a* from *b*. It is defined as the time elapsing between the first commencement of the sensation, *a*, to the moment when it is perceived that it is *a* (in opposition to *b*).

We do not stop to describe the technical arrangements of the experiments. The first series of experiments were with the sense of touch. Two places of the skin were stimulated with two pretty strong induction shocks interchangeably, and the person had to react when one of the two was stimulated (but he made no reaction to the stimulation of the other). The distinguishing time was found to be, for A. (Auerbach), 0·021 sec.; for K. (Kries), 0·036 sec. The position of the two parts of the skin had no appreciable influence. When three places were stimulated, instead of two, disturbances occurred; but after adequate practice was had it did not take longer to distinguish one place from two others than from one.

The time of distinguishing intensity of touch sensations was examined, strong and weak induction shocks being given to the same part of the skin interchangeably. In one of the series of these experiments the person had to react only to the strong stimuli, in the other only to the weak. It appeared that the distinguishing times were always less for the strong stimuli than for the weak; one perceives sooner that the strong stimulus is strong than that the weak one is weak. Expressed in numbers, the time of recognition by A. of the strong stimulus was 0·022 sec., of the weak 0·053 sec.; in K.'s case the numbers were 0·061 and 0·105 respectively. Comparing these values with the previous, it is found, as a principal result of the touch experiments, that the "judgment as to the intensity of a touch-stimulus takes place more uncertainly, and requires a longer time, than the localisation of the same."

The next series of experiments were of an acoustic nature. In one case the distinguishing time for high and low simple tones was examined; then the time in which one distinguishes whether a sound sensation is a tone or a noise; and, lastly, the time required to perceive from which direction a sound comes (on the two sides of the head). The recognition of the simple tones took, in A., 0·019 to 0·034 sec.; in K., 0·049 to 0·053 sec. Higher tones were more quickly distinguished than lower. The distinguishing of a tone from a noise took, in A., 0·023 sec.; in K., 0·046 sec.; tone and noise were with equal rapidity perceived as such. The localisation of a noise took, under the most favourable circumstances, in A., 0·015 sec.; in K., 0·032 sec.; but with more difficult distinction, the time rose in A.'s case to 0·053 sec., and in K.'s to 0·077 sec.

Optical experiments formed a third series. An electric spark was used as light stimulus, and the person had to distinguish, in one case its direction, in another its colour (it appeared through blue or red glass), and in a third its distance. The distinguishing time in the simplest case of localisation of direction was, in A., 0·011 sec., in K. 0·017 sec. That for the two colours was, in A., 0·012 sec., and in K. 0·034 sec. That in the simplest case of localisation of distance was, in A., 0·022 sec., in K. 0·030 sec.

In discussing these results the authors point out that all the distinguishing times were shorter in the case of A. than that of K., and that the individual distinguishing times are different from each other. Their relation in the two observers was pretty much the same; the quickest distinction was that in optical localisation of direction, the slowest that in localisation of sound (with the smallest angle of divergence), and recognition of weak stimuli of touch.

Like other observers who have measured reaction times, MM. Kries and Auerbach found it longer for optical stimuli than for acoustic or tactile. It is notable that while the distinguishing time of A. was shorter for all stimuli than that of K., the reaction time of K. was shorter for acoustic and touch stimuli, while, with optical stimuli, A. reacted more quickly than K.

THE ORGAN: A COMPREHENSIVE TREATISE ON ITS MANUFACTURE, PROCURAL, AND LODGMENT.*

By JOHN WATSON WARMAN,

Associate of the College of Organists, London.

PART I.—GENERAL TREATMENT IN MANUFACTURE.

k. IF it be thought that I am speaking too severely, let it be borne in mind that desperate diseases require desperate remedies; the notion that the player *as such* is able authoritatively to direct and pass judgment upon the actual structure of the instrument on which he performs is as widely spread and as deeply rooted as it is radically false and mischievous; and while those who hold the purse-strings are allowed to continue blindly going on in this belief, organ-builders, not below the average in intelligence, will inevitably see it more to their advantage to parade (and in some cases to pay for) patronage than to express their real opinions as to the critical knowledge evinced by it. The whole subject of the various writers on the Organ will be fully gone into in a future *Part*, should circumstances permit (*see also* PREFACE.)

l. We now return to the consideration of the actual structure of the Bellows. The choice of the particular species has already been sufficiently gone into (4 f., and on).

m. VARIOUS POINTS CONSIDERED.—*Shape on Plan.*—The actual plan-form of the Bellows is not in itself a matter of very great moment—that is to say, Bellows may be square, or oblong, or pear-shaped (as smiths' bellows), and work perfectly well in any case; but, as will be seen directly, the particular form adopted affects the amount of material used, and therefore some plan shapes must be more economical than others; but before touching on this it is necessary to bear clearly in mind that the plan-form of the Bellows, *because* it is so accommodating, is above all things liable to be controlled by certain other considerations which are gone into further on; see, therefore, at this point those various matters, particularly *Feeder*.

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n. Supposing none of these controlling reasons to be in force, the choice of the plan shape of the Bellows resolves itself into two—the *economy* of material and the *rigidity* of the Feeder.

o. The economy can, of course, extend only to the Ribs and their Leathering, for the amount of square area of the various Boards remains the same, whatever the *plan* adopted. It is hardly necessary to point out that economy, as aforesaid, will be obtained by the adoption of the *square* form. Thus a square bellows, containing 16 square feet, will have 16 lineal feet of ribbing, but supposing it 2ft. × 8ft., the amount of the ribbing will be increased to 20ft. lineal. The same thing, of course, holds good with the Feeder; supposing, therefore, that there be but one of these, the perfect square will always be the most economical as regards material of Ribbing and Leathering. But there remains the question of Feeder *rigidity*, and this is favoured by a rather long Feeder, for if the Board be wide in the direction across Lug, it is obvious that a stouter brace will be required under Board to prevent latter bending under the force of the stroke, and this additional vertical substance will, of course, involve additional vertical room. It is true a *Bridge-lug* (*see* in *Detailed*) may be used, but this involves additional expense. Also it must be remembered that a narrow Feeder involves loss in material just as with Receiver, only that in latter there being two sets or Folds, while in the former generally only one, balance remains in favour of Receiver being kept square rather than Feeder.

p. Design *Plan* of Bellows, therefore, according to circumstances and number of Feeders. A very small single-feeder Bellows may freely be square, if preferred, unless of very heavy pressure, for Feeder is sure to be rigid enough with moderate bracing; where good vertical height exists, have perfectly square by preference. With two Feeders the *plan* may by preference be *nearly* square—say ratio of 4 to 5—then Feeders will do with a comparatively small Brace at Lug; the brace long-wise of Feeder can always easily be any desired width at its *middle* without increasing vertical space required, at same time palpable economy in the Receiver ribbing and leathering will be effected. It will, of course, be understood that the Lugs, and consequently hinges, are here at broader side of Bellows. When Bellows has three Feeders it cannot easily well be square, for they would be reduced to too great narrowness, and this is one reason why more than two Feeders to one Receiver are discouraged; if Receiver is compelled on other account to be longish, this discouragement ceases, and when the Bellows are required to be very long in proportion to breadth three Feeders will be well, otherwise they might be wider Lug-way than from Lug-edge to hinge, which is, as just mentioned, bad as a rule. Generally speaking three Feeders will be required *only* with Winch or Machine blowing, and not always then (*see* 6, d. and e.).

q. It will, of course, be understood that this selection of particular area form is subservient to other considerations, as aforesaid; thus, for instance, to give the entire organ a square form on plan, solely for the purpose of obtaining a square Bellows, would be quite absurd, unless there were no other more important considerations involved (*see* SOUNDBOARDS).

r. *Relative area of Feeder and Receiver.*—It will be obvious that the Receiver should be larger than any single Feeder supplying it, for, otherwise, the ascent and descent of the Receiver become too *rapid*, and therefore liable to be unsteady; this is one great object in having more than one Feeder: and practically it is found that, if the united areas of the Feeders do not exceed that of the Receiver, the wind, with ordinarily good blowing, will be amply steady enough for all practical purposes. In small organs it will often happen that the Feeder area will exceed this ratio, and this even sometimes with single Feeder; of course this should be avoided if possible, and with this view the author, as will be seen, has recommended two Feeders in even the very smallest Bellows. (*See* also with *Conjoined Receivers*, 6, z.)

s. *Rise.*—It has already been demonstrated that additional rise in Receiver does not mean additional supply; 6in. ascent will be quite sufficient in most cases, but where the height is good, 9 may be preferred, only remember this will add 1¼in. to the width of each Receiver Rib (*see* 5, j.). When Winch Blower is used the 9in. may be considered desirable (*see* 20, l., No. 3). Higher than 9in. is never recommended by author, except with Machine-blowing, and then only when there is fear of a *sudden very large* demand running the wind out before the engine has time to resume its full speed, as in the Otto Intermittent (*see* 17, a.; also with *Conjoined Receivers*).

t. *Trunk entry.* When Band form of Bellows is used, Trunk can, as already said (4, e.), easily be attached or "led out" at any desired point. When Well kind is used the front of the Trunk will be determined by that of Well; and, as room laterally will here not (as a rule) be scarce, there is no necessity for laying down any precise rules. With Pan-bellows more care must be used, simply because the provision for Trunk will of course decrease area of Feeder, and it has already been seen (5, r.) that such decrease is unadvisable. It is obvious, therefore, that whenever Pan-bellows be not perfectly square the Trunk should, if possible, be at narrower side; thus the reduction of Receiver area will be less, for while its *set in* to accommodate Trunk will obviously be no greater, the *length* of the space thus secured will be less—thus less amount of waste room at side of Trunk. It may also be laid down that Receiver may desirably extend over free or Lug side of Feeder, so that the most effective part of latter throws directly up into Receiver. This is favourable to what has just been said, as Feeder-hinge better at narrower side as rule. *See* also with *Conjoined Receivers* (6, z.)

u. *Folds and Compensation.* Two Folds will be best in ordinary cases—that is, two pairs of Ribs; one pair or Fold will in all cases be inverted, not only to prevent the inward protrusion increasing the wind density as the Receiver descends; but to neutralise the effect of the wind itself tending to keep open the Receiver more when the latter is full.

v. Of course, *Regulators* must be used to maintain the folds always equi-distant.

w. The most convenient Fold to invert will in manufacture be found to be the one next the Top-board (in an Exhaust Bellows this "Top" will naturally become the lowest Board. *See* also with Conjoined Receivers (6, z.)

x. The Feeder ribs may also be inverted, if desired, in all cases (*see* also 17, g.).

y. *Waste Valve.*—This may be divided into two species—viz., the *Exterior* and the *Interior*. The former discharges the superfluous wind clear out of the bellows. The latter act by *retaining* open a Valve or Valves, admitting of communication between the Feeders and Receiver; thus, as one Feeder rises, the wind furnished by it escapes through the Receiver into the other Feeder which is descending at the same moment. It is hardly necessary to observe that in this case not only must there be at least two Feeders, but the space afforded or created during the descent of one must be *equal* to that—that is to say equal to the *feed*—supplied by the other; and for this purpose both or all Feeders ought to be alike in size and drop; and if three be used they must be driven by a shaft with an *equi-distant* three-throw, so that when two Feeders are rising together—as they constantly will be in such case—their motion will be but slow, while the *descending* Feeder is moving with *double* rapidity.

z. The Exterior Waste-valve may itself be divided into two kinds—(1st) when it is placed on the Upper-board; (2nd) when on the Middle-board—between two of the Feeders, unless latter detached.

The Exterior Valve *on Receiver* has every advantage except that of quietness and protection from droppings; as regards former a good Blowist never quite fills the Bellows, so this can go for but very little. With reference to latter it must be remembered that a valve may as easily foul from something being *blown* into it by the Feed as from droppings; and as the top of the Bellows is generally shielded by the other works, and access to valve—at all events with a rod—is generally insured, this objection also is of little moment. Bear in mind that the blowing-off often assists in the ventilation, and also tells the Organist when the Blowist is over-pumping. On the whole, therefore, this is decidedly the best form of waste-valve.

The Exterior Valve *under Middle-board* has only the advantage of protection from droppings; the slight value of this will be seen by preceding. On the other hand it has the very weighty objections of non-accessibility, and of decreasing the area of the Feeders. It should most certainly, therefore, as a rule be avoided.

[6, **a.**] The *Interior Valve* has the advantage of quietness and safety from droppings, but in every other respect it is defective; it is almost inaccessible, and has besides the very serious disadvantages of requiring both Feeders to be of one size, and of demanding additional Valves, thus increasing chance of leakage through Middle-board. It is true the Suckers have occasionally been made to do duty *also* for the Waste-valve; but this necessitates them being made large and solid, and merely *faced* with the soft substance; and such a form is very likely to be noisy, and also, unless properly guarded, liable to damage if Bellows happen to be turned bottom upward.

b. Except with use of a shaft driven either by Hand or Power, the necessity for both Feeders being of one size should of *itself* be an effectual bar to the use of this form of Waste-valve, for the blowist's *up*-stroke is so much weaker than his *down*, that an easy and economical Blowing-action *demands* that one Feeder shall be larger than the other; and although a moderate difference in this respect will not render the Interior valve impracticable, it must manifestly remain an *imperfect* contrivance.

c. The only case where the Interior Valve may be considered admissible is with an Intermittent Gas Engine (see that head in *Department* of BLOWING-ACTION), and funds at same time limited. In such case, as the speed of the Engine is automatically regulated by the work it has to do, it will "slow down" of itself as soon as it feels the decreased resistance of the Feeders; and thus the wind supply become *to a certain extent* automatically governed, *without* the expense of fast-and-loose pulley.

d. *Feeder.* There are several distinct considerations involved in Feeder, which had better be touched on separately. As regards *Number*, it may be laid down that a single Feeder should never be used except either it be a *double*-action one or space *very* confined: remember that two Feeders will counterpoise dead-weight of each other without any further trouble. With regard to confined space there is not *much* difference between the supply of two and of one, provided the area be same in both cases; still, the two Feeders will not give quite so much as rule because there will be the lost space *between* them, and also for the reason that it will not generally be so convenient to have a smaller one drop so low as a larger; but the gain in steadiness, owing to the decreased rate of speed at which the Receiver rises at *each* stroke, is so great that, as just said, two Feeders should always, even in the very smallest Instruments, be by preference used. The other exception, however, completely nullifies advantage of two Feeders, for it is obviously quite useless having two Double-action Feeders for purpose of gaining steadiness; since, Feeders acting both ways, the supply will be same (speaking broadly), whether given by ascent of one large Board or by ascent and descent at same moment of two of half the size—therefore, the additional cost of the two Feeders had better be saved. Double-action Feeders, however, will not be common.

e. It will, therefore, be apparent that in all ordinary cases the best number will be two.

When Bellows are very long in proportion to width three are sometimes used. An instance occurs at St. Peter's Chapel, Canterbury, by Jones, of London. But such a form of Receiver is, as already said, very inadvisable, and note even here two Feeders only will be better than three (provided Bridge-lug can be secured), *unless* a Foot-blower is desired, and there *yet* cannot—with only two Feeders—be one got sufficiently small, or the posit of Handle cannot be so that smaller Feeder comes right for Blowing Pedal. When Winch-Blower is used it is usual to have three Feeders, in order to equalise resistance; but with a Fly-wheel of sufficient weight this is not really necessary, and when area is very confined it is better, as a rule, to keep to two Feeders, and thus save the space between one pair. Of course, this is assuming the necessary Fly-wheel to be practicable. When machinery is made use of for Blowing, a Crank-shaft—similar to that just mentioned for Winch—is often applied (it is not really required with Hydraulic Motor), and in such case also three Feeders are often employed; but if the Engine have proper Fly-wheels, or latter in addition applied to shaft, two Feeders may here also do very well; if Gas Engine used in which the number of explosions is governed by the actual work or load imposed at the moment (as in the Otto and Langen Intermittent), it is sometimes desirable that the Feeders blow off into each other (*Interior waste-valve*), for then, the resistance being lessened, the Engine will slacken itself automatically, and thus in some cases the fast and loose Pulley (*see* 17, d.), with its chance of increase of wind-pressure, saved and avoided. It will be evident that this method is quite practicable with three Feeders, for, though two will be constantly feeding at once, yet at that moment they will *always* be Feeding *slowly*, while the third Feeder will be descending as *quickly as possible*—thus vent always provided for Feeders-in-action to blow into. See also further in "Exact Arrangement" (8, w, and on).

The two points of *Interior Valve with an odd number of Feeders, and of employment of Interior Valve with Intermittent Gas Engine as substitute for Automatic regulation* have been already mentioned; they are repeated because of their importance.

(*To be continued.*)

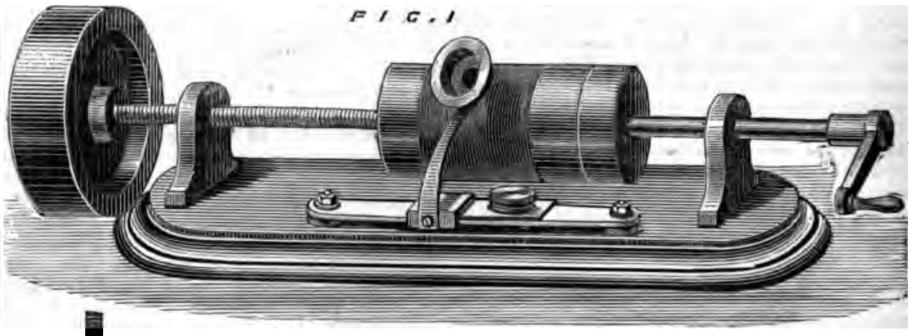
THE PHONOGRAPH.

TWO very successful exhibitions of the phonograph have been made in London, and there can no longer be any doubt that the new instrument has the "promise and potency" of great things in the future. We mentioned on page 622, last volume, that at a recent meeting of the Physical Society two phonographs were shown, one of which was constructed by that well-known mechanician, Mr. Stroh, and is, therefore, an improvement upon the original sent over by Mr. Puscus, Mr. Edison's agent. We reproduce from *Engineering* an engraving of the form adopted by Mr. Edison and that devised by Mr. Stroh, but our readers being already familiar with the principle of the instrument we need not occupy space with any lengthy description of its details. In Fig. 1 we have a brass cylinder mounted on a spindle carrying at one end a heavy fly-wheel, and at the other, a winch-handle. The spindle or axis has a screw-thread, and works in a screwed bearing, the pitch of the screw corresponding to that of a spiral groove turned in the face of the brass cylinder. Over the latter is laid a strip of tolerably stout tinfoil, and the vibrating diaphragm is adjusted so that its style or point will traverse a spiral line immediately over the groove in the cylinder. On turning the handle, and speaking to the diaphragm, a series of indentations are made in the foil, but it is of the first importance to maintain a regular rate of rotation, and have some means of recording what the speed actually is. To control to some extent the speed of rotation, Mr. Edison adopted the heavy fly.wheel seen in Fig. 1, but Mr. Stroh has devised an ingenious form of governor, shown in Fig. 2. In Fig. 3 is exhibited, in an exaggerated form, the indentations produced in the tinfoil by the style of the diaphragm, and it is assumed that the pointer, having produced them by vibrations of the diaphragm to which it is affixed, can also, when the action is reversed, reproduce exactly identical vibrations in the diaphragm, and consequently the sounds which gave rise to those vibrations. To look, however, at a piece of the indented tinfoil it would seem almost impossible that the minute and occasionally microscopic marks thereon should be capable of throwing a metallic diaphragm into a state of complex vibration, in which each oscillation is possibly of different amplitude to that which preceded or succeeded it; still, from the demonstrated necessity of making the repeating cylinder rotate at exactly the same velocity as the recording instrument (one instrument answers for both purposes), it is practically demonstrated that it must be the purely mechanical differences in the indentations that cause the diaphragm to repeat the sentences stamped upon the foil. The latter, of necessity, is made to lie very closely and smoothly on the cylinder, and is held in place by a brass cap at each end. The original instrument, as mentioned in our issue published on November 30th last, had, as the reproducer, a more delicate diaphragm than that employed to indent the tinfoil; but in the instrument shown in Fig. 1, Mr. Edison dispenses with the special reproducer, and makes the one metallic diaphragm answer both as receiver and speaker. The instrument made by Mr. Pidgeon has two diaphragms, one of paper and the other of metal, and at the recent meetings it was considered to give the better results of the two; but Mr. Edison prefers, we believe, to use only one diaphragm, and Mr. Stroh follows him—in fact, his instrument is the same with the exception that instead of the fly-wheel, he has introduced some very ingenious controlling mechanism. The speed of rotation must obviously be perfectly uniform to obtain the best results, but even with a fly-wheel it is very difficult, if not impossible, to secure an unvarying peripheral velocity; accordingly, Mr. Edison has adapted a clock-train movement as the driving mechanism, and so far with a considerable degree of success. Expanding the idea, he has had a clock constructed, which, instead of striking the hours, reproduces the tones of a voice which once indented the phonograph, and strangers are startled at hearing a clock say "Six o'clock, time for dinner," or "midnight, time for bed." In Mr. Stroh's apparatus, which is worked by hand, the fan or governor consists of two brass discs attached to the upper ends of two light levers geared together at their lower ends, and so arranged that they fly out symmetrically on each side of the axis of rotation of the vertical shaft. "When the instrument is started (by taking off the pressure of a small cork-lined brake-block, shown in the detail sketch, which passes against the cylindrical head of the fly-spindle), the discs fly out under the influence of centrifugal force, and the resistance of the air to the motion of the spindle is increased by the increase on the diameter of the path of rotation if the speed become too great." On the contrary, should the speed of rotation tend to fall off, a spiral spring draws the levers and the discs together, and they offer less resistance to the rotation of the spindle.

It will be understood that, although the governor is a much more useful appliance than the fly-wheel, it by no means insures perfect uniformity of motion, which apparently can only be obtained by means of clock-work. Numerous applications have been suggested for the phonograph, many of them extremely visionary.

It is, however, a most remarkable invention, the future of which cannot be foreseen.

FIG. 1



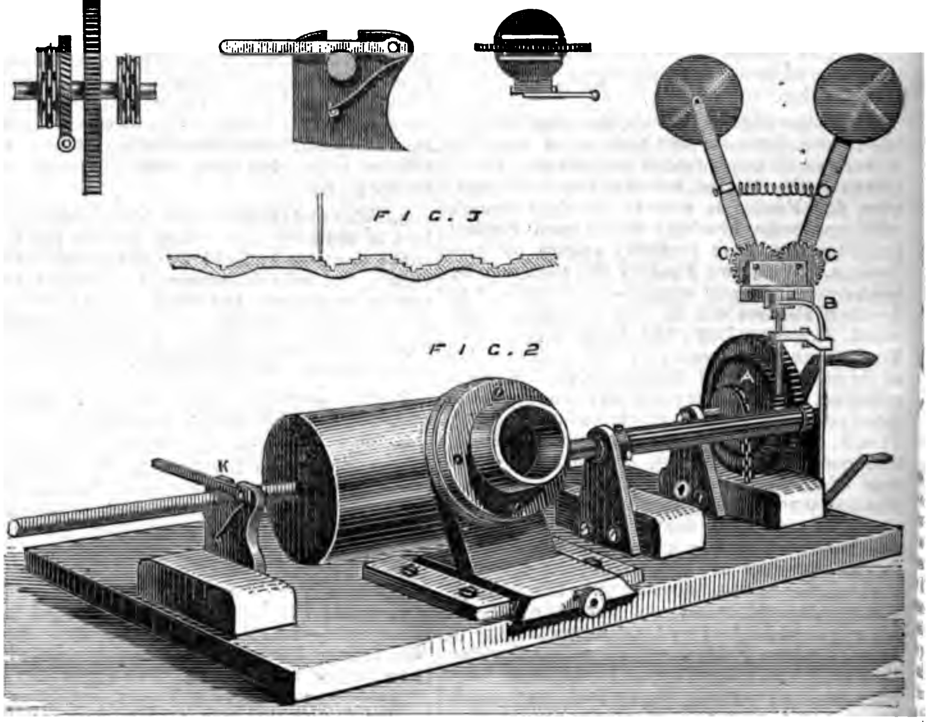
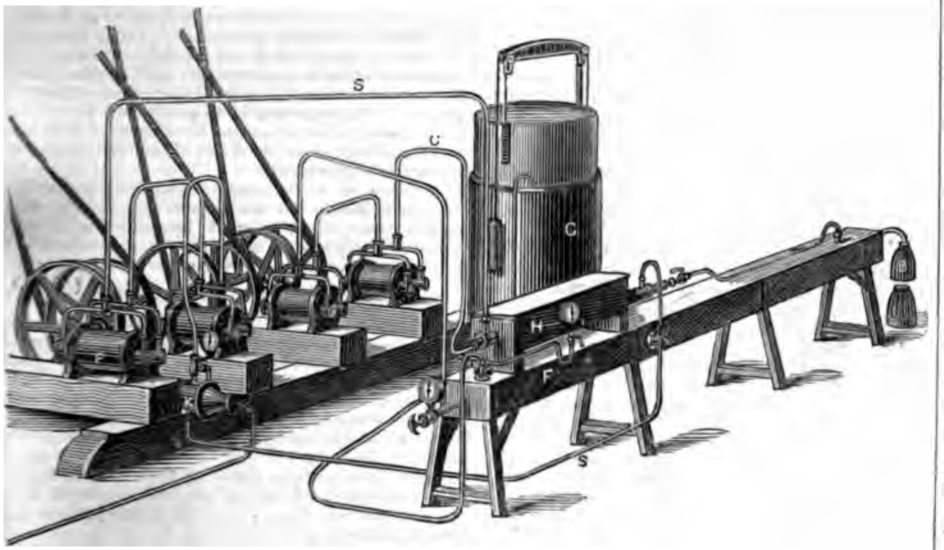


FIG. 3

FIG. 2

THE LIQUEFACTION OF THE GASES.

IN the annexed engraving our readers have a perspective view of the apparatus by means of which M. Pictet succeeded in liquefying the gases (see pp. 395, 417, Vol. XXVI.). The drawing is on a scale of about one-eighth of an inch to a foot, and the apparatus is arranged for the condensation of oxygen. B is the retort in which the gas is generated, and F is a wooden case containing a strong wrought-iron tube, in which the oxygen is compressed by the force of its evolution from the substances in the retort. Surrounding the small wrought-iron tube is a larger pipe or sleeve, containing liquid or perhaps solid carbonic acid, which enters by the pipe seen near the retort, B, and leaves by the pipe at the other end. . Between the larger tube and the casing there is a filling of non-conducting material. The case, H, incloses an almost exactly similar arrangement—a small pipe containing liquid carbonic acid passing through a tube in which sulphurous acid is circulating: G is a gasometer containing carbonic acid, and K is the reservoir in which the liquid sulphurous acid is stored. P represent a series of double-action pumps, employed in maintaining a vacuum and keeping up the circulation of the liquid gases. With these details and the description given (loc. cit.) it is an easy matter to trace the stages of the process. The pumps being set in motion by a steam engine liquid carbonic and sulphurous acids are forced into their respective tubes in the case, H. S indicates the supply and exhaust pipes containing the sulphurous acid, and C the supply pipe for carbonic acid connected to the compound vacuum-creating pumps. The sulphurous acid forced or drawn from reservoir, K, into the tube contained in the case, H, vaporises instantly, and is immediately taken by the pipe, S, to the pump, P, where it is again compressed and forced into the reservoir, after passing through the two compound pumps. Meantime the inner tube is full of carbonic acid, which is forced in through pipe, C, and which, under the influence of the refrigerating effect of the constantly vaporising sulphurous acid and a pressure of about 75lb. to the square inch, is reduced to the liquid state at a temperature of about 65 degrees below the zero of the Centigrade thermometer. The liquid carbonic acid passes thence into the tube or sleeve surrounding the oxygen pipe in the case, F. This tube is connected to the pumps, which remove the vapour as fast as generated, and consequently reduce the bulk of the contents of the tube to the state of solid carbonic acid. The latter is, however, constantly vaporising and absorbing heat, and so great is the degree of cold maintained that the oxygen contained in the tube passing through the mass of solid carbonic acid is, under the joint influence of temperature and pressure, reduced to the liquid state, and on opening the tap, seen near the manometer on the projecting end of the tube, the gas appears either as a jet of mist or as drops of liquid oxygen.



CARE OF THE MICROSCOPE.

A MICROSCOPE, when not in use, should always be kept well protected, either in its case or under a suitable cover. There is no more convenient mode of keeping a microscope than to stand it upon a cloth mat, and cover it with a glass shade. It is thus kept free from dust and vapours, and is always ready for use; but when it is kept in its case, and especially if it has to be screwed together, interesting, valuable, or even important objects will often fail to be examined, simply because too much time and labour are necessary to prepare for the operation.

A good microscope should be so carefully protected that it shall rarely require to be cleaned or dusted, as this wears off the lacquer and exposes the metal, which, when thus uncovered, soon begins to tarnish. When dusting or cleaning becomes absolutely necessary, chamois leather or a very fine old linen or silk handkerchief is most suitable. Never use coarse cloths, or those that have been lying about exposed to dust and dirt.

The lenses should be kept in their boxes when not in use, and when they are attached to the microscope great care should be taken to keep them from coming into contact with liquids. In order to prevent the latter accident as far as possible, never examine liquids unless when they are covered with thin glass. In the pursuit of micro-chemical studies the microscopist has frequently to deal with liquids that corrode metals, and even glass. In well-appointed laboratories *inverted* microscopes are used in such cases, but with ordinary instruments special means must be employed. The object should be laid on a large piece of thin plate glass, and the objective should be coated with oil. The rest of the metal work may be protected with oiled silk or thin indiarubber.

When liquids which corrode glass are used the front of the objective should be protected by means of a very thin leaf of the best mica, which may be attached either by glycerine or balsam.

These, however, are exceptional precautions. In ordinary work it is sufficient to see that the lenses and metal work are kept free from stains and finger marks.

Never touch with the fingers the surface of any lenses, either eyepieces or objectives, as this will be certain to soil them. Use soft camel-hair brushes to remove particles of dust, &c. Where dirt adheres more strongly use fine linen, *slightly* moistened with alcohol, and wipe dry with very fine chamois leather. Remember that alcohol, if used profusely, will attack the lacquer of the brass-work, and even dissolve the cement which holds the lenses together. When objectives are smeared with balsam the best cleansing agent is said to be kerosene oil. The piece of leather used for wiping lenses should be free from dust, and is best kept in a small box by itself, and used for nothing else. It must be remembered that the glass of which objectives are made is very easily scratched, being soft when compared with particles of sand and grit; consequently, when frequently wiped it soon loses that exquisite polish upon which its excellence of performance so much depends. What then are we to think of the directions given by the author of a popular work on the microscope, in which we are told to use a piece of leather, slightly impregnated with brick dust? No better method of destroying an objective could possibly be devised. Therefore, see that in wiping the *slightest* possible pressure is used, lest any particle of grit should make a scratch.

The exposed parts of all microscopes, as well as the objectives and their cases, are lacquered, to protect them being soiled by handling, but the interior of the boxes which hold the object-glasses are rarely so protected, and the black coating of the interior of bodies, draw-tubes, &c., is frequently not very firmly attached. Therefore, never touch them with the fingers.

After taking an objective out of its box, either screw on the cover of the box, or place the latter with its open end down. Do not stand it mouth up, so that it may catch all the dust.

When exhibiting the microscope to others great care is necessary to keep meddlesome fingers from soiling the glasses. Some people are never content when merely allowed to look at things—they insist upon handling them, and feeling them. To the young microscopist we would say that if any of your friends insist upon handling your objectives, eyepieces, &c., put up the instrument, and pack it away. A microscope carefully used is as good after fifty years as when first made, but we have seen an instrument suffer more injury in half an hour at the hands of a thoughtless and dirty person, than it would have sustained in twenty years in the hands of a careful microscopist.—*From "Practical Hints on the Selection and Use of the Microscope,"* by JOHN PHIN, New York.

SOME RECENT IMPROVEMENTS IN THE METALLURGY OF NICKEL.*—I.

By ALFRED H. ALLEN, F.C.S.

(Vice-President of the Society of Public Analysts.)

THE treatment of certain ores, and metallurgical products, for the extraction of nickel and cobalt, has, for a long time, been conducted chiefly abroad; and the very few English firms who have made the extraction of these metals a speciality, have, with more or less wisdom, done their best to keep their processes secret.

Till within the last few years the ores worked for nickel and cobalt have always contained both these metals, and one of the problems the metallurgist had to set himself to solve was, how most advantageously to separate these two metals from the other elements present and from each other. In their chemical behaviour, as is well known, nickel and cobalt present the closest resemblance; and, had it not been for the difference in the colour of their salts, it is quite possible that we might even now be confounding them.

In practice, the nickel and cobalt have usually been obtained in a matte, or regulus, containing very variable proportions of nickel, cobalt, copper, bismuth, antimony, arsenic, iron, sulphur, &c. In other cases advantage has been taken of the extraordinary affinity of nickel for arsenic—a fact which enables it to be separated from most other metals, and even to be quantitatively determined, as in Plattner's system of analysis by the blowpipe.

After a certain amount of concentration of the matte or speiss, by roasting, it has been usual to dissolve the material in acid, and proceed on the well-known lines for the separation of the metals. Thus the copper, arsenic, antimony, &c., have been precipitated by sulphuretted hydrogen, the filtrate treated with an oxidising agent, and the iron thrown down with chalk, or by the cautious addition of lime. On treating the filtered liquid with solution of bleaching powder, the cobalt was precipitated as peroxide, and the nickel was separated from the filtrate by addition of lime. This general plan has been varied by separating the iron and arsenic as ferric arseniate, and so on.

The methods, of which the above is an outline, are still employed with more or less modification, but the whole process of nickel and cobalt extraction threatens to be revolutionised by the discovery of deposits of nickel ore of a very extraordinary character in New Caledonia.

Although in works on mineralogy mention is made of oxidised minerals containing nickel, almost the only nickel minerals practically available, a few years since, were the highly complex sulphides and arsenides already referred to. In many cases the proportion of nickel contained in these ores is very small, ores with three or four per cent. being frequently worked.

The peculiarity of the New Caledonian ore is its almost absolute freedom from arsenic, copper, and other metals precipitable from acid solutions by sulphuretted hydrogen, with simultaneous freedom from sulphur. It is also remarkable that many specimens are almost wholly free from cobalt, and in no instance have I met with any considerable proportion of that metal.

The ore in question consists essentially of hydrated silicate of nickel and magnesium. Many specimens contain a considerable quantity of iron, which appears to exist partially as ferrous silicate. Most of the cargoes I have examined have contained a very appreciable quantity of chrome-iron ore.

Taking the silica, oxide of nickel, magnesia, and water, as the essential constituents of the mineral, the following formulæ may be deduced—RO, consisting in each case of NiO and MgO.:—

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* A paper read before the Chemical Section of the Society of Arts.

No. 1. $2RO, 3SiO_2 + 6 H_2O$.
No. 2. $RO, SiO_2 + \frac{3}{4} H_2O$.
No. 3. $10RO, 8SiO_2 + 3 H_2O$.
No. 4. $RO, 2SiO_2 + H_2O$.
[*]No. 5. $RO, SiO_2 + 2 H_2O$.
[*]No. 6. $RO, SiO_2 +$ (nearly) $2 H_2O$.
No. 7. $4RO, 5SiO_2 + 2 H_2O$.
No. 9. $2RO, 3SiO_2 + H_2O$.

The above figures afford abundance of choice to those desirous of establishing any particular formula, and sufficiently indicate the general character of the mineral.

Although silicate of nickel is met with in other places besides New Caledonia, the existence of considerable deposits of rich ore is, however, so far as is known, almost wholly confined to that locality. The same mineral has been found and even mined in Spain, in the province of Malaga, but the ore there found is much poorer than the New Caledonian mineral, as will be seen by the following analyses of the Malaga ore, which I made in 1875:—

Silica	37·48 ...	37·14
Alumina	34·38 ...	28·59
Oxide of iron, calculated as FeO	9·00 ...	12·21
Oxide of chromium	3·60 ...	4·37
Oxides of nickel (and cobalt) ...	3·98 ...	4·00
Magnesia	11·76 ...	10·91
Lime		1·53
Sulphur	traces ...	·13
	100·20	98·88

The mineral which is richest in nickel is of a bright green colour, in some cases almost rivalling the lighter shades of malachite. Between this and pure magnesian silicate there is every gradation, and, of course, the composition varies within very wide limits.

The mineral has been met with in other places besides New Caledonia, and has been variously named. Of course the analyses show great variations, and on that account it is difficult to attribute any satisfactory formula to the mineral.

The ore contained no copper or other metal precipitable by sulphuretted hydrogen in solutions containing free mineral acids, with the exception of traces of lead and arsenic. It will be observed that in this case there is no combined water. Whether the mineral had undergone any treatment before it came into my hands I am unable to say. Ore from the same locality has been described by M. Meissoniere as Pimelite, and found to contain 9·0 per cent. of nickel.

Of course, the ore actually obtained from New Caledonian mines is not always as rich as the specimens, the analyses of which are quoted in the above table; in fact, it has beed found difficult to insure cargoes of ore attaining the contract quality of 10 per cent. metallic nickel on the ore dried at 100° C. In an instance known to me, a cargo of ore was imported to England on the strength of an analysis showing the sample to contain 29 per cent. of metallic nickel, and only 3 per cent. of magnesia, whilst on arrival the bulk only assayed 12·3 per cent. of metallic nickel.

A large number of samples of New Caledonian ore have passed through my hands professionally, and I have, therefore, had the opportunity of becoming thoroughly acquainted with its composition.

The following analyses fairly represent the quality of the ore imported to this country. No. 1 contains a larger proportion of moisture than is usual, but the ores are remarkably hygroscopic, gaining 3 or 4 per cent. on exposure to a fairly dry atmosphere for a few hours.

	No. 1.	No. 2.
Silica	46·44 ...	40·45
Alumina	·06 ...	1·54
[*]Oxide of iron ...	1·83 ...	4·96
Oxide of copper ...	none ...	·03
Oxide of lead ...	none ...	·09
Oxide of nickel ...	15·33[†] ...	13·25[‡]
Magnesia	15·90 ...	24·62
Lime	traces ...	traces
Combined water ...	8·02 ...	9·40
Moisture	11·30 ...	5·60
	98·88	99·94

Although the analysis of such ores as the above is much simplified by the absence of many of the metals commonly associated with nickel, a really rapid and accurate method of assaying New Caledonian ore is still a desideratum. I have, however, used a process, of which the following is an outline, with considerable facility, and can recommend it as being thoroughly reliable and well suited for its intended purpose. Two grammes of the dried sample are fused in platinum with acid sulphate of potassium and a fragment of nitre. When decomposed, the contents of the crucible are treated with hot water, the residue boiled with hydrochloric acid, and then the whole filtered. The solution is nearly neutralised by cautious addition of ammonia, is next treated with ammonium acetate in excess, boiled well, the iron, aluminium, and chromium filtered off, and the precipitate redissolved in hydrochloric acid and again precipitated with acetate. The mixed filtrates and washings are heated to boiling, ammonia added till but little free acetic acid remains, and then a current of sulphuretted hydrogen gas is passed, the solution being kept constantly boiling.

In this manner the nickel (and cobalt) are completely thrown down as sulphides, and thus the difficult separation from magnesia is readily effected. The precipitate is washed with water containing ammonium acetate and sulphuretted hydrogen, and is then rinsed off the filter and treated with nitric and a few drops of sulphuric acid. When completely dissolved to sulphate, ammonia is added in large excess, and any small precipitate filtered off. The ammoniacal solution can be treated in two ways. It may be introduced into a platinum crucible, and the nickel thrown down on the platinum by the current from two cells of Grove's battery, a platinum plate being immersed in the liquid as an anode. The only precaution necessary is to keep the solution strongly ammoniacal, and allow plenty of time for the precipitation. The results are very accurate, with a tendency to be below the truth. Of late I have abandoned the electrolytic method for direct weighing of the nickel as sulphate. The solution of double sulphate of nickel and ammonium is evaporated to dryness, and the residue heated to dull redness. It is moistened with a drop of nitric and the same of sulphuric acid, and again gently ignited. The result is pure anhydrous sulphate of nickel, containing any cobalt (or copper) which might have been present in the original ore.

I am indebted to the kindness of several of my clients for the specimens of New Caledonian and other nickel ores arranged for your inspection. The following mineralogical description applies to the purer specimens of New Caledonian ore.

The mineral is amorphous and generally much fissured. The fissures are often filled in with white silica, which thus forms thin plates, crossing one another in every direction, and enclosing the green mineral between them.

In colour the mineral is of a bright apple-green. On immersion in water, some specimens fall to pieces with a crackling sound, the fragments having a conchoidal fracture.

The hardness is about 2½, and the specific gravity from 2·2 to 2·9. The streak is pale green. The mineral gives off water when heated. Fused in a borax bead on platinum wire, it gives the ordinary nickel bead.

The mineral usually occurs in veins traversing serpentine rock, and is associated with chrome-iron, steatite, and other minerals commonly occuring in serpentine. It also occurs as a green coating on the rocks. Veins are said to exist in which the nickel is wholly replaced by cobalt.

It is evident that a tolerably abundant mineral, containing no appreciable quantity of any foreign heavy metal but iron, is eminently adapted for the extraction of nickel, and consequently it has attracted considerable attention, and the economical extraction of nickel from it has been made the subject of at least half-a-dozen patents.

One of the chief of these is the patent of MM. Christofle and Bouilhet, of Paris. This is a wet process based on the solution of the ore in hydrochloric acid, oxidation of the iron by chloride of lime, precipitation of the iron by chalk, end cautious treatment of the filtrate with lime water, so as to precipitate the oxide of nickel and leave the magnesia in solution. In practice, however, the inventors find it preferable to use chloride of lime, employing lime-water merely for the conclusion of the precipitation. It is found impossible to prevent co-precipitation of the magnesia, so the patentees make a virtue of necessity, and boldly claim as part of their invention "the precipitation of a small quantity of magnesia in conjunction and in combination with the last traces of nickel, so that, in the presence of carbon and of sulphates contained in the oxide of nickel, a sulphurous scoria shall be formed during and in the reduction of the nickel."

I am myself the inventor of a method of extracting nickel from the New Caledonian ore, which method I believe to be based on sound principles, and that under somewhat altered circumstances it might be found of considerable value. These considerations must be my apology for laying it before you.

Being in the habit of frequently assaying samples of New Caledonian ore, I was struck with the facility with which it was decomposed by acids. For several reasons I had usually employed sulphuric acid for the decomposition, and the advantage of using this reagent instead of hydrochloric acid was thus very apparent. When hydrochloric acid is employed, a considerable excess of the reagent must be used, and the product is a highly acid liquid or jelly. The effect of sulphuric acid on New Caledonian ore is very remarkable. Thus, if I treat a known weight of the powdered ore with a quantity of sulphuric acid and water corresponding to an equal weight of brown vitriol, the action speedily begins (without application of external heat), the mixture swells up and quickly sets to a bulky, dry, porous mass, consisting of fine silica mixed with sulphates of nickel, iron, and magnesium. The action strongly reminds one of that by which "superphosphate" is manufactured. It is well to add a small proportion of nitrate of soda, so as to avoid the necessity of peroxidising the iron at a subsequent stage of the process.

It is next desirable to heat to redness so as to get rid of the free sulphuric acid. The product is a dry white powder.

The ignited product is next dissolved in a minimum quantity of water, by which means silica, chrome-iron, and any undecomposed ore are left as a residue, and the metallic sulphates are obtained in strong solution. The residue is allowed to settle as completely as possible, and the deep green solution is then siphoned off. As the metals present exist as sulphates, the addition of any compound of calcium is very objectionable, and hence I replace the usual dose of lime or chalk by magnesia obtained by igniting magnesite. The magnesite in the market contains fully 98 per cent. of real magnesium carbonate, and is therefore well adapted for the purpose.

It is desirable to know before hand the amount of iron present in the liquor, and then to add the theoretical quantity of magnesia necessary for the reaction:—

$$Fe_2(SO_4)_3 + 3MgO = Fe_2O_3 + 3MgSO_4.$$

I have found in practice that, if introduced in the form of fine powder, the ignited magnesite will do almost the calculated amount of work. It is desirable, however, to test the liquid towards the end of the precipitation, and to add a little more magnesia if necessary. Any excess will cause precipitation and consequent loss of nickel. I have proved experimentally that no nickel is precipitated as long as any ferric salt remains in solution. With the oxide of iron is precipitated any alumina or oxide of chromium which may be present, and the precipitate also carries down with it any silica or other suspended matters. The next step is to precipitate the nickel while leaving the magnesium in solution. This can be effected by several methods, of which the following are to be preferred.

Addition of an amount of calcined magnesite, exactly sufficient to precipitate the nickel, with simultaneous or subsequent treatment with sulphuretted hydrogen; the process being conducted at a boiling heat. The following is the reaction:—

$$NiSO_4 + MgO + H_2S = NiS + MgSO_4 + H_2O.$$

This reaction is not only perfect theoretically, but experiment has shown that precipitation of the nickel is complete without addition of any magnesia beyond the amount theoretically necessary. The method suggested itself after many unsuccessful attempts to prepare a sulphide of magnesium. The sulphide of nickel is obtained as a dense black precipitate not readily oxidisable. It may be converted into oxide of nickel and metallic nickel by the usual processes. An experiment on half a hundred-weight of New Caledonian ore showed that the above process was was thoroughly practicable.

The objection to the above mode of precipitating the nickel is, that it is obtained as sulphide, and thus requires further manipulation to fit it for reduction to metal. A glance at the above equation appears to indicate that, if the sulphuretted hydrogen were omitted, the nickel would be obtained directly in the convenient form of oxide, according to the equation—

$$NiSO_4 + MgO = NiO + MgSO_4.$$

Such, however, is not the case. The reaction which is so perfect with the aid of sulphuretted hydrogen is incomplete in its absence. Owing, probably to the affinity of magnesia for oxide of nickel, it is impossible completely to decompose a solution of nickel sulphate, even when the magnesia is added in considerable excess, and in the form of recently precipitated hydrate. This statement requires some modification, however, for by operating in a particular manner, I have found it possible wholly to separate the nickel from a solution containing nickel and magnesium sulphates merely by the treatment with magnesia, and in such a manner as to leave the liquid free from nickel, while the precipitate contains no magnesium. In this manner pure oxide of nickel may be extracted from the New Caledonian ore without employing any reagents besides sulphuric acid and calcined magnesite (and an insignificant quantity of nitrate of soda). This modification of the process has not hitherto been tested on larger quantities than 1lb. of ore.

CARDBOARD SLIDE FOR GELATINE FILMS.[*]

SINCE our last meeting I have employed my leisure in further efforts to diminish the weight and frangibility of the tourist's photographic

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[*] It is very probable that a portion of the water shown in these analyses was merely hygroscopic, and not water of composition.

[*] Calculated as FeO. [†] Equal 12·05 per cent. Ni. [‡] Equal 10·42 per cent. Ni.

[*] A paper by Rev. H. J. PALMER, M.A., read before the Liverpool Amateur Photographic Association.

impedimenta, and I have jotted down a few notes of the result attained in the hope that they may prove of interest to our meeting to-night. Which of us who has enjoyed the pleasures, or mourned over the discomforts, of photography in the field has not at times discovered to his horror that the focussing-glass has met with an accident, and can in nowise be replaced by impromptu ingenuity? This misfortune has befallen me on more occasions than one, and I am, therefore, in a position the better to appreciate the chance discovery of an efficient substitute for ground glass for the use of the tourist. No one would desire to supersede the ordinary focussing-screen in the studio; but something lighter and less breakable is clearly a desideratum for out-of-door work. The focussing slide before you was made by myself at the cost of about threepence, and it combines the qualities I have mentioned above. The following are the necessary directions for the production of a slide 9 x 7in.:—Soak fifty grains of gelatine in one ounce of water for a few minutes; add one drachm of fresh ox-gall, and one drachm of skimmed milk. When dissolved by heat and thoroughly mixed pass through the filter, and flow the solution over a clean and dry glass. Now place the glass upon a level stand, and pour the remainder of the gelatine upon it before the first coating has had time to set. As soon as it can be raised, it should be placed in a current of air and allowed to dry where no dust can settle upon it. A piece of moderately-thick cardboard is next to be divided with rule and compass into (say) four sheets of the required size; and from each of these the centre is to be removed with a sharp knife, so as to leave a margin on all four sides of half or three-quarters of an inch in breadth.

Three of these pieces are now to be superimposed, closely glued together, and placed under a weight till dry. I have named three as the number of layers to be used; but this obviously depends upon the thickness of the board, and the depth of the dark slide from the surface which touches the camera to that of the sensitive plate. As soon as the gelatine and cardboard are dry, insert the point of a knife round the edges of the former, and strip it from the glass plate. It may now be trimmed with a pair of scissors to the required size, so as to overlap the edges of the aperture in the cardboard by about three-eighths of an inch. Allow it to lie flat upon the glass, and bring down upon it carefully the surface of the thicker cardboard frame, upon which some strong paste has been sparingly spread. The whole may now be raised, the remaining cardboard pasted on the gelatine, the white surface bound nearty with leather or dark paper, and you have a focussing slide which will bear any reasonable amount of wear and tear, and which will weigh hardly as much as the glass of a slide of similar size. In order to give additional strength to the whole it will be well to pierce each of the corners and insert a small brass paper binder with double points before the final leather or paper covering has been employed. To prevent warping it is better to place a considerable weight upon the slide for some hours.

The cardboard dark slide I now produce has been prepared for use with my sensitive gelatine films, and is, as I have ascertained by frequent experiment, perfectly adapted for its purpose. The size of my wooden slides is 7½ × 5¼in., and accordingly, for a single slide, I cut with a penknife a sheet of cardboard of these dimensions to form the bottom of the slide. I next prepare a number of strips three-eighths of an inch wide, a number also of one-quarter of an inch in width, one piece of the size of the bottom with an aperture 7 × 4¾in., and another piece to form the shutter 4¾in. wide × 8in. The building-up of the slide was easily accomplished as follows:—Sheet No. 1 was placed on the table and three-eighth inch strips glued upon three sides of its upper surface, the opening in the fourth side being designed for the insertion of the sensitive sheet. Upon these strips half-inch widths were fastened, and the vacant side of the first layer was bridged over with a half inch strip of board. Next followed three sides covered with the three-eighth inch strips, the vacant end being left for the admission of the shutter. Lastly, over all I glued the piece containing the aperture; the shutter was cut from the cardboard and fitted into its place, the whole was covered and made neat with black paper and colour, a weight superimposed for the night, and in the morning I found myself possessed of a fairly-effective dark slide, of home make and of inappreciable cost. When the sensitive gelatine has been slipped into its place, I have a small piece of black card ready, which I insert from the inside, in the opening through which the gelatine has been passed. This dark slide was so easily made, and proved so efficient, that I set to work and made a double one of the same description, and also a double one for use with glass plates. The latter is not yet complete; but you will see that it has sufficient stability and strength to answer its purpose, and the method I have adopted for securing the sensitive plate in position without admitting light seems to me to be simple and satisfactory.

THE TECHNOLOGY OF PAPER-MAKING.—X.*

The Chemicals used in the Paper-mill; their Nature, Economical Use, and Methods of Valuation. The Recovery and Re-use of Soda as an Economical Process, and in its Sanitary Bearings. The Disposal of Washing and Machine Waters, so as to Minimise the Pollution of Streams.

THE valuation of bleaching powder involves more labour and manipulative skill than the testing of soda. The percentage of available chlorine is what has to be determined; and there are several methods of doing this, but two are generally in use, and I shall describe both of them. The reaction in both processes is an oxidising one; in the one ferrous oxide is converted into ferric oxide, while in the other arsenite is converted into arsenate of soda. In the iron process, as it is called, 39·15 grains of pure sulphate of iron are dissolved in about four ounces of water and acidulated with a drop or two of dilute sulphuric acid. Two hundred grains of the sample to be tested are rubbed up with water in a large mortar, and the solution made up either to 10,000 grains, or to a litre, according as English or French measures are being used. A burette graduated into thousandths and decimals thereof of the whole volume of the solution prepared, is charged from the mortar with the aid of a porcelain ladle. From the burette the bleach liquor is delivered into the iron solution contained in a vessel of about 12oz. capacity, until the iron is all changed into the ferric state. To ascertain precisely when this effect is produced, a little of the mixture is lifted on a glass stirring rod and dropped upon a solution of red prussiate of potash, which has been previously spotted over a white slab; on the two drops coming into contact, a blue or—as it approaches completion—green colouration will be the result so long as any of the iron exists in the ferrous state. When the iron is completely oxidised no such colouration will be produced. The iron used equals exactly five grains of chlorine, so that the calculation is a simple one. It is right to state that objection has been taken to this process, but I have not been able to discover wherein error is likely to arise in its execution more than in any other, unless, at one point where a slight loss—and with care it need be but very slight—occurs, owing to the liberation of chlorine in the gaseous state towards the close of the operation, resulting from the iron solution being acid. To insure satisfactory results—that is, results within 1·5th per cent. of the truth—the following particulars must be attended to:—1. The iron must either be quite pure, or its value must be ascertained and allowed for. 2. The weights and measures must agree among themselves; it matters little whether either of them have a precise value, so long as the smaller weights and divisions are aliquot parts of the larger. 3. A drop or two of acid is sufficient to add to the iron solution; more must be avoided. 4. Care must be taken to insure the complete solution of the soluble part of the powder, and the sediment should be uniformly diffused through the liquor, by stirring with the ladle previous to charging the burette. 5. The burette should be filled, the level adjusted, and the testing started without loss of time, so that the sedimentary matter may not settle in the burette before the operation is completed; of course, the iron solution will be ready, and the slab spotted, before the burette is charged. 6. While the bleach liquor is being run into the iron solution, the latter should be kept well stirred, and towards the close of the operation the liquid should be run in in small, successive quantities, with frequent testing.

The arsenic process is conducted as follows:—A standard solution of arsenite of soda is prepared by dissolving 139 5 grains of pure arsenous anhydride, and 400 grains of pure crystallised carbonate of soda, in 6 or 8oz. of water. This can be best effected by boiling and shaking for some time; when the desired effect has been produced, the solution is allowed to cool, and is then made up to 10,000 grains, or one litre. Ten grains, or 1 cc. of this solution, is equivalent to 0·1 grain of chlorine. The bleaching powder solution may be prepared precisely as I have already described. This method of making up the solution entirely in a large mortar is, I think, more easy of execution, and quite as satisfactory as that of transferring the solution and sediment with repeated rinsings to a measuring flask. One-tenth of the bleaching powder liquor is drawn by a pipette, and delivered into a small beaker. The arsenious solution is run into this from a burette graduated into cubic centimetres or grains to correspond with the other measures used. The operation is completed when a drop of the solution, lifted out upon a glass rod, no longer gives a blue or violet colouration when brought into contact with a slip of starch paper. The starch paper is prepared by soaking filter paper in a solution of iodide of potassium and starch. When dried it is cut into slips and preserved in stoppered bottles. No objection has been raised to this process, which, no doubt, gives accurate results, but it will be manifest that several of the precautions necessary to be observed in the execution of the iron process are quite as important in this. For paper-makers who have not the requisite laboratory appliances for delicate and accurate work, the arsenious solution could be prepared in the same way as recommended for the standard sulphuric acid.

The chemical agents which next claim our attention are the various aluminous compounds used to precipitate the resin from the resin soap, and also for preserving animal size from putrefaction. The nature and effects of alum and the various alum substitutes form perhaps the most important chemical study connected with the paper trade. The only valuable constituent of all these substances is soluble alumina; this agent is chemically companionised with sulphuric acid, forming sulphate of alumina, and it not unfrequently happens that there is more of the acid in the article than is required to form sulphates with the bases present; the excess is, consequently, a free and very active agent, asserting its presence injuriously in various ways, some of which have already been commented upon. Alum, which is the purest and best known of the agents referred to, is a crystalline substance, consisting of sulphate of alumina, sulphate of potash or ammonia, and water, forming what is known in chemistry as a double salt. The composition of the potash variety may be thus symbolised:—$Al_2 K_2 4 SO_4 + 24 H_2 O$; its crystalline form is that of the regular octahedron. The ammonia variety may now be regarded as little better than a chemical curiosity; the extensive development of the Strassfurt potash deposits have greatly cheapened this material, while, on the other hand, the largely increased agricultural demand for ammonia has raised its price enormously, thus placing it beyond the reach of the alum-maker. There is no cause for regret in all this, as the potash variety is the more regular and serviceable article of the two.

"Sulphate of alumina" consists essentially of sulphate of alumina, but is always more or less contaminated with free acid. This article is not, like alum, a chemical compound of definite composition; the amount of the soluble alumina salt varies through one or two per cent., while the other and worthless constituents are mixed up in all proportions. There is but little insoluble matter in this agent, and in this is found its chief difference from alum cake, which usually contains about 20 per cent. The latter has generally a smaller proportion of free acid than the former.

Alumino-ferric cake, which is a comparatively new aluminous agent, is manufactured from the mineral bauxite by a process which renders the exclusion of free acid from the product easy.

Knowing something of the uncertain composition and the infinite trouble sometimes caused by the extreme acidity of alum substitutes, I, in view of these lectures, asked all the paper-makers in the kingdom to send me samples of the aluminous agents they were using, that I might be enabled the more fully to investigate this subject. In response to the request, I received a great number of samples, and also a number of letters stating that the writers used nothing but alum crystals, the composition of which did not require investigation. The various makers' samples were arranged, and two ounces of each sample ground up together, to form one average sample; the result of analysis showed the various agents to contain sulphate of alumina, free sulphuric acid, and iron (see Table).

Maker.	Substance.	Sulphate of alumina.	Alumina.	Free sulphuric acid (H_2SO_4).	Iron calculated to Fe_2O_3
H. D. Pochin and Co.	Sulphate of alumina	40·34 =	12·10	4·72	·15
McArthur and Link	Sulphate of alumina	41·68 =	12·50	3·70	·13
H. D. Pochin and Co.	Aluminous cake	42·31 =	12·70	·30	·28
Cochrane and Co	Do.	38·34 –	11·50	2·06	·33
Winser and Co.	Do.	40·68 =	12·20	1·24	·25
Peter Spence	Alumino-ferric cake	48·21 =	14·46	none	·77
Foreign	Sulphate of alumina	48·54 =	14·56	none	none
Theoretical	Alum crystals	36·12 =	10·83	none	none

These results are instructive and require little comment on our part. All the British makes contain more or less iron, and all except Spence's alumino-ferric cake contain free sulphuric acid. The foreign make, of which I received three samples, is free both from iron and acid, and is certainly a very fine product, well suited to the wants of the paper-maker; I understand, however, that the price is such as to put it beyond the reach of the makers of all but the very highest classes of papers. It will be observed, that the cake made by Mr. Spence—who is so widely known for his scientific research, and his enterprise and success as a chemical manufacturer—contains a relatively large proportion of iron, which no doubt renders it less suitable for some of the finest white papers, but for news and most ordinary ones as this will not interfere with its value, which, as a sizing agent, must rank very high, owing both to its high percentage of alumina and the entire absence of free acid. Alum itself is singular in containing neither free acid nor insoluble matter, and in the uniformity of its composition, but it must not be forgotten that the sulphate of alumina in it, as well as in all the substitutes, is an acid salt liable to act upon strainer plates and machine wires if used in excess. The object in using sulphate of alumina in any of its forms in the sizing process is, as has been already indicated, to precipitate the resin of the resinate of soda. It must be borne in mind that that agent contains but a comparatively small proportion of soda, and that when more sulphate of alumina is used than is necessary to supply sulphuric acid to the soda, and thus precipitate the alumina, the excess retains its acid character. When the aluminous agent contains free acid, this will first act upon the resinate, forming a neutral soda salt, and precipitating free resin, which I have already stated to be undesirable in the pulp; using excess of such an agent both evils will accrue. By properly apportioning the precipitating agent to the resin to be precipitated, acid pulps may be entirely avoided. Of course this result can only be obtained in a satisfactory way when the precipitating agent contains no free acid; when it does, neutrality may still be secured, but always at the expense of so much resin being precipitated free. Both alum and alum cake contain a large percentage of water which some consumers seem to regard as an important matter, and choose those which contain least. This is a very absurd procedure; the fact of one cake containing 10 or even 20 per cent. of water more than another is of no consequence whatever; the question of real importance being which contains most soluble alumina and least free acid, and, secondary to this, whichcontains the least iron and insoluble or gritty matters. The estimation of alumina is a matter of some nicety, and not to be undertaken by any but experienced chemists. It cannot be done by any simple volumetric method, such as I have described as suitable for soda and chlorine, and even when estimated by a trained chemist in a well-appointed laboratory, great care must be taken to secure strictly accurate results. Alumina is precipitated from the filtered solution by ammonia, but the precipitate is liable either to be too light or too heavy, just as certain precautions are observed or neglected. For details of the process I must refer to Fresenius, or any of the other leading analytical authors.

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* Being the substance of the Cantor Lectures delivered before the Society of Arts by Mr. W. Arnott, F.C.S.

Of the minor chemicals we need only briefly notice hyposulphite of soda, or antichlor, used to neutralise the acidity of the bleached half-stuff. The action of this agent has already been described. The agent itself is composed of a sulphur acid containing a relatively large proportion of sulphur to the oxygen combined with it, and sodium oxide, with the constitution of which we are already familiar. Like most other crystalline bodies, its composition does not vary much; if contaminated to any serious extent it will be by the admixture of foreign crystalline substances, deliberately added to reduce its value. The strength of the oil of vitriol supplied to the mill will be ascertained by an ordinary hydrometer, while its freedom from colour will sufficiently indicate its purity for all paper-making purposes.

Before discussing the question of the disposal of the impure water discharged from various parts of the paper process, I may state that a laudable effort has been made by Mr. Wm. W Ladelle to reburn the waste lime resulting from the causticising process and the preparation of bleaching liquor. I have seen the process in operation, and while it has not yet established its claim to be a complete success, it is an effort in the right direction, and will, I trust, ultimately accomplish all that can be desired. The disposal of these waste products is really a vexing question, and I am sure we must all wish Mr. Ladelle and his co-workers success in their efforts to convert what is at present a gigantic nuisance into a useful agent.

Many and varied have been the schemes proposed for the purification of waste engine and machine waters. Let the fact that the millowners of the North Esk—who have already adopted every "practicable and reasonably available means" of purification—are going forward in the present session of Parliament with a bill to empower them to take a pipe to the sea at a cost of over £100,000, testify to the insufficiency of them all. No doubt much has been accomplished on the stream referred to. I have, myself, devoted nearly four years to the problem, and considering the extent of the industry and the smallness of the flow of water, the result is not to be despised; still, however, as the law of Scotland stands, the riparian properties are entitled to demand absolute purity, even at the expense of stopping the industry altogether. So long as common law is allowed full sway in this direction, the Rivers Pollution Prevention Act of the year before last will be a dead letter. The old law is far more powerful and certain in its action than the new. The latter aims at the purification of streams from manufacturing refuse, having a care that the industries involved are not unduly harassed, whereas the former comes down unreservedly upon all polluters, demanding immediate and complete cessation of the pollution at any cost.

I am convinced that no process of filtration is applicable to the purification of the waste discharges referred to, until at least the grosser portion of the impurities are removed, either by simple subsidence or by precipitation with chemical agents, and I am further convinced that purification by precipitation with chemical agents is a delusion. No doubt the sedimentary matter may be very thoroughly separated, and an apparently pure discharge be the result; but I have yet to learn of a process that will reduce the grains of polluting matter, soluble and suspended, per gallon to a lower point than a good settling system without any chemicals will do, especially if the effluent water from the settling system is passed through a simple ash filter before being discharged. Chemicals are not to be had gratuitously, and their application on a large scale involves both plant, steam, and labour. It is better, therefore, to spend a little more money upon a well-arranged system that will work itself, and require comparatively little attention, than a little less upon one that will involve a constant outlay.

Better than all the schemes of purification to which I have alluded, however, is that which begins in the mill itself. Let the boiling, cooling, and bathing liquids be so worked that the boiled materials may go into the engines so clean as to require little further washing; a better out-turn will be the result, and one-half of the pollution obviated; and let almost the whole of the machine water be collected and rinsed, which will often be done at a profit, and will also conserve the purity of the streams. If precautions are taken under each of those heads, the volume and intensity of the polluted liquids to be purified will both be reduced, and the object aimed at made more easy of accomplishment. An efficient settling system should be capable of containing from 24 to 36 hours flow' of the discharge; if the liquids are longer in the system they are apt to putrefy, especially in hot weather, with a result which is certainly no improvement upon the original condition of things. Every settling system should be provided with the means of discharging and draining the sludge as it accumulates. If the drainers be well constructed, the sludge should lift in a caked form, easy of removal to the rubbish heap.

NOTES ON THE TELEPHONE.—I.*

By R. M. Ferguson, Ph. D., F.R S.E.

THE articulate telephone is already an old story, though it has not been yet six months on this side of the Atlantic. So perfect is our network of intelligence, so complete our means of popular instruction, that few educated men are without some knowledge of the instrument, and many know all that is known about it. I have, therefore, to introduce no novelty to the society. So remarkable an invention still possesses, however, enough of interest to engross an evening. Its construction is so simple, and its performance so marvellous, that the interest in it will not soon die down. The telephone marks an era in invention, and the name of its inventor will ever remain familiar in the history of science. Two discoveries of cardinal importance have hailed from America at about the interval of a century, both equally unexpected, equally bold. The first was that of the lightning-conductor by Benjamin Franklin, and the other that of the telephone by Professor Graham Bell, both men in the first instance professionally non-scientific—the former being a printer, and the latter a professor of English literature. One would almost fancy, if they had been specially scientific, educated caution would have warned them off from such apparently unlikely and hopeless problems. "To rob the heaven of its lightning," as it has been put, "and to make the feeble voice of man speak to the uttermost ends of the earth," as it no doubt yet will do, seemed beforehand mere visionary projects. The telephone adds another to the inventions of non-technical men, of which history records so many and so striking instances. While we do not grudge America the credit of the telephone, we recognise with pride that the inventor is a native of this city, and that his respected father was an active member of this society.

An interesting discussion took place recently in one of our newspapers as to the difference of the genius of the German and English languages, in so much that the German language named the instrument Fernsprecher or Farspeaker, with native vocables, whereas such was the poverty or pedantry of the English language that we had to borrow from the Greek and call it telephone. It so happens, however, that the man that coined the word and invented the first telephone was Reis, a German schoolmaster, near Frankfort-on-the Maine. I exhibited his instrument before this society fourteen years ago, and the attention I paid to it then has been of service to me in deciphering what I imagine to be the true theory of the present telephone. I could not lay my hands on a Reis telephone, but I have extemporised one which is the same in principle. Reis used as a sending instrument a stretched diaphragm of skin, at the centre of which was a small plate of platinum. On the plate rested the leg—platinum shod—of a metal triangle, and the other two legs effected the poise and the galvanic connection of the arrangements. As the disc was agitated by the voice, the central leg of the triangle kept hopping on the plate, breaking circuit at each vibration. The receiving instrument was a knitting needle in a coil of wire placed in a sounding box. At each break it gave a magnetic tick, and these being emitted in the musical order given, reproduced the musical sounds. The sending instrument I have here is shown in Fig. 1. A copper wire, in passing through the skin, is fixed to it by sealing wax, and ends below in a fine platinum wire, or watch hair-spring turned up at the end, which rubs on a plate of platinum, P. The receiving instrument is also in effect Reis's arrangement, but will be afterwards described. It is the two-bobbin magnet shown in Fig. 3, with a tin box, B, three 3in. diameter, and under ¼in. deep, lying on its poles. The message can be heard from the poles alone. The box only strengthens it. To show you the advance in telephony, I reproduce the Reis sounds. One note by itself would scarcely be considered musical. It sounds rather like a harsh scratch when sounded by itself, and it only becomes musical by contrast with the sounds which follow. This harshness, which is exactly that produced also by the hopper, is due, among other causes, to this, that neither the hopping leg nor rubbing wire makes more than one connection at each break. This is beautifully shown by the Bell telephone. When put in the circuit of a very weak galvanic pair, and held up to the ear, it indicates a couple or a series of ticks, when I put one fine wire of the circuit on another, to close the circuit, although I take the utmost care to make, as I fancy, only one contact. The rubbing of the small hair-like wire on the plate of the present device effects also a make-and-break contact on the inequalities of the plate at each vibration of the diaphragm, accompanied with a sputter of irregular and, so to speak, unintentional contacts and breaks, which, as in the case of the hopper, mar the purity of the sound. There is one peculiarity of this rubbing arrangement. At times the rasping sound ceases, and a clear mellow musical note is produced; and just as you are going to catch the articulate sounds, the rasping returns, or the wire gets out of gear, and its action ceases. Such lucid intervals give us room to hope that not many months will elapse before the galvanic battery is yoked to the telephone. It will then rise from a whisper to a voice, and hold its own in telegraphic lines with other telegraphic instruments. I do not think I am fanciful when I say that I have heard articulate sounds at such times. If such actually were the case, it could only have arisen from sudden changes in the resistance of the circuit introduced by the rubber. If this yoking should ever prove successful, it will be as applicable to the Reis telephone as to Bell's, and the old knitting-pin will be able to tell an articulate tale in accents magnetic, though perhaps not so loud or distinct as its more perfect rival.

The Reis telephone only created temporary interest. The practical busy world pays little attention to such scientific toys. Some sixteen year roll over, and this rasping telegraph all at once develops into a plain-speaking practical instrument Had Reis been able to make a proper sending instrument, speaking telegraphy would have been now thing of the past. To Bell is due the merit—and small merit it is—of showing that the receivi instrument, if properly made, can also be a sendi instrument. I know that such is not the professo view of his invention, but I trust, before the eveni is over, to show that such is really his merit. point of departure was quite different from th and, in his own light, quite original, and, so far he is concerned, his invention is quite as much own as he claims it to be. The difference betw the two telephones is very much that between a who can only whistle and one who is in posses of all the refinements of speech and singing; but whistler has only to know his powers to come full possession of them. I shall now proceed describe the Bell instrument, and to give, so far understand it, the inventor's theory of it. This can be best done with the aid of the reflec galvanometer, an instrument which any one w naturally call in to his aid. I used it as earl October last in elucidating the telephone in course of my usual work. Fig. 2 is the diag usually given in explanation. The sending an ceiving instruments are fac-similes of each o and are connected by two wires, or by one wire an earth return, as in ordinary telegraphic circu

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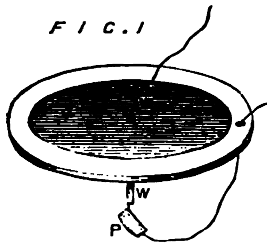
* A paper read at a meeting of the Royal Scottish Society of Arts, and published in the Engineer.

D D are two discs of very fine iron plate, about the size of a crown-piece, placed nearly but not quite in contact with the end of a soft iron pin attached to the pole of the bar-magnets, W, about 6in. long and ½in. in diameter. Bobbins and coils, C, of fine wire are put on the pins. The disc is nailed to or nipped by the wooden frame of the mouthpiece, or, according to use, the ear-piece of the instrument. When any one speaks in the mouthpiece of the sending instrument, vibrations are produced by the voice in the disc, which accordingly causes the disc to go backwards and forwards in front of the pin, which is virtually the pole of the magnet. This motion of the disc, by the well-known laws of magneto-electricity, induces electric currents in the coil of wire corresponding in strength with the extent of oscillation. These are sent to the receiving instrument, and, moving in its coil, increase or diminish the strength of its pole. The iron disc in front of it is alternately additionally attracted and let go as the currents are transmitted, and thrown into vibrations, which are precisely similar to those of the sending disc, and tell the same tale to the ear of the listener as the voice of the speaker. I have here a magnet with a coil at its end now connected with the galvanometer. You see as I move this piece of iron in front of its poles backwards and forwards how beautifully the spot of light reflected by the magnet mirror travels in perfect correspondence. We having only to fancy that instead of having a moving mirror we have a moving disc, and the theory of the instrument is complete. There is the most perfect correspondence between the sending and receiving instruments, and no distinction of poles as in a battery. The more perfectly they receive, the more perfectly they send a message. This explanation is beautiful and simple, and one would wish it true; it must always remain the popular one. Unfortunately, however, when narrowly examined, it is found to be a mere hypothesis, and to have as yet no experimental confirmation.

FIG. 1



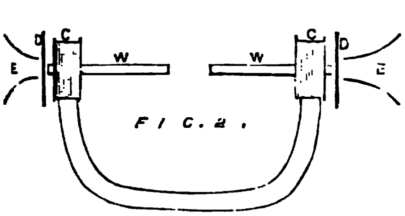


FIG. 2.

Before proceeding to give reasons for this I may mention some of the characteristics of the instrument. One's first attempts at telephone-making begin with hearing a voice at the receiving end with confused articulate sounds, conveying no definite word or meaning. Though the instruments are not up to the conversation point, songs can be well heard. The song stage is the lowest in the scale of telephone performance. As success becomes more marked in the construction, the voice is heard to speak, but apparently far off. When something like perfection comes, the voice sounds only a few feet off, and you would be inclined to look over your shoulder to see the speaker. External noise, however, very much modifies this, and what with silence and undivided attention would seem loud, becomes vague and confusing. Favourable position tells immensely in one's appreciation of the sound transmitted. In the present state of the instrument, silence is needed to insure hearing. I have, however, been able in some instances to hold a conversation amidst the noise of a class-room, and some instruments receive a song that is audible to one or two standing with their heads a few feet off. But generally there must be silence, and the instrument must be held close to the ear. To prevent the confusion that not unfrequently ensues when both speak or hear at the same time, there are two instruments used at each end; and when one gets a long message he puts both up to his ears, and then the message is given with great certainty. Some disappointment is felt that the telephone can only speak to one listener. This is unreasonable, for if one recollects how little of the whole energy of the voice of the speaker is given to the disc—it is, as it were, only one of his listeners—and then the message has to pass through a circuit of wire, every yard of which absorbs, though to a very small extent, this energy, it is surprising that even so much of it comes to the listener. Scientifically, what strikes one as remarkable about the telephone is its extreme delicacy. A telephone put in a galvanic circuit can indicate very clearly the makes and breaks of contact. I have here a tiny galvanic cell, consisting of two finest iron and copper wires, ·007in. in diameter, immersed ½in. apart for about an inch in distilled water, and when I rub loosely one terminal wire of the circuit against the other, so as to make and break contact, the friction of the wires, inaudible to one standing near, is clearly rendered by the telephone, and that in a circuit of 700 ohms. This signifies that this inappreciable galvanic pair can telegraph audibly through fifty miles of ordinary telegraphic wire. I show you the effect of this pair on the galvanometer; it scarcely moves the spot of light. Such excessive delicacy almost baffles conception, but your astonishment will be moderated when I tell you that the amount of force necessary to make a telephonic disc sound is next to nothing. If you press the disc of a telephone to your ear you can hear, though faintly, the grating of the end of the finest human hair made to rub against it, so exquisite is the sounding power of iron and the sensibility of the ear. No wonder, then, that the induction of neighbouring wires in a telegraphic circuit, caused by the faint electric echoes of ceasing currents, is not only sufficient to affect the telephone, but quite to overmaster it. Another remarkable point is the small amount of magnetic power requisite for working the instrument. Professor Bell found that the residual magnetism of a soft iron electro-magnet was quite sufficient. In the form of the instrument which I have made with a horse-shoe magnet, with pole pins at right angles to the plane, I can attach and detach an armature of soft iron. One would fancy that the attachment of the armature would divert the magnetism from the pins, but its removal or attachment does not produce the faintest quiver or variation in the sound sent or received. The fund of magnetic power of an ordinary shilling magnet is thus immensely in excess of the requirements of the instrument.

Patent inventions, though protected in the money-making and practical world from imitation, are not exempt from scientific criticism, and it is in this spirit alone that I proceed to indicate some observations I have made as to the *rationale* and form of the telephone. Such of them as are dependent on the ear as a measure of sound I give with some diffidence. The ear, as a judge of loudness, is somewhat capricious. Corporal and external factors enter into its indications. I have sometimes begun with a sound, apparently far off, and by a little training of the ear found it to become wonderfully strong; and again, I have begun with what sounded very loud, and yet, though everything was as before, I could not afterwards hear it so well. I have tried to make experiments as nearly at the same time as possible, and if my results are wrong, it is not for want of care. I would make one other remark about them, and that is, that they are by no means complete. Any forms of apparatus I suggest are almost haphazard, and are by no means the best possible. The principle, not the actual form of them, is all I can speak of. I would, in the first place, take exception to the vibrating theory of Bell—viz., that it is the vibrations of the disc to and from the pole of the magnet, in excursions proportionate to the intensity, pitch, and quality of the vocal sounds, that electrically affects the instrument; and in so doing I only express the dissatisfaction with it of almost every one who deals with the telephone. The mere vibrations of the iron disc are insufficient to account for its action. I admit there is vibration both at sending and receiving instruments, and that is indicated by both when the plate falls foul of the pole. The sound is a rattle exactly like a vibratory motion interfered with. I have even observed, or fancied I observed, that when the fundamental note of the plate was sounded, the succeeding note was blurred by its prolongation. It must, moreover, be admitted that a metal or elastic disc of any kind can reproduce, by its vibrations, all the tones of the human voice. This is abundantly proved by the mechanical telephones that are at present so popular.* These, however, as regards size, and thickness, do their work precisely as we should expect vibratory membranes to do, and are no exception to the ordinary laws of acoustics. But in the Bell telephone you have no such simple rule. The size of the disc does not increase its power, and its thickness does not smother the sounds. Beyond a certain size the disc falls off in its work instead of improving, and a message can be received, though with some difficulty, through a disc 1in. thick. The success of the construction seems to lie in smallness—in confining the action to as thin and as small a disc as is consistent with the action of the mouth and ear. It is an acoustic instrument, *sui generis*, and its smallness seems to point to molecular as well as vibratory action. The following experiment seems to me to imply this.

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* On the evening when these notes were read a Fellow of the Society suggested to me as a test of vibration to attach mechanical telephones to Bell discs. This was done with paper discs 1in. in diameter stretched on tin tubes, and with sewing threads 1ft. long glued to the Bell discs. When the threads were held taut, a conversation could be managed fairly through this compound mechanical Bell system. This, however, is beside the question discussed here, for these paper discs equally well told the magnetic ticks in the iron of the core of the magnet afterwards described.

TURNING A CUBE IN A LATHE.*

PICKING up an exchange the other day, we noticed among other remarks on lathe-work, one (evidently written by misconstruction after reading "Holtzapffel"), stating that the usefulness of this prince of machine tools was limited to the production of curved surfaces, or plane surfaces having curved outlines. So far from this being the case, the lathe may be used not only for circular, eccentric, or oval turning, boring and drilling alone, but for planing, slotting, circular, and jig sawing, and for forming perfect cubes or pyramids, and objects of fancy shapes, such as cubes having long conical projections from their faces, &c. But simply to disabuse of the impression that the lathe-formed work has of necessity all, or even any, curved outlines, we will describe the process of turning a cube or "die" in a lathe.

FIG. 1.

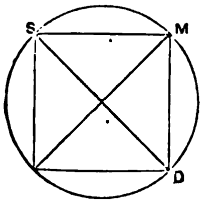


FIG. 2.

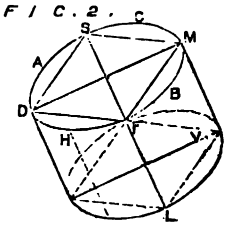


FIG. 3

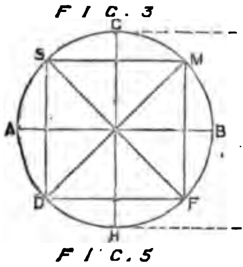


FIG. 4.

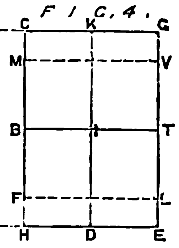


FIG. 5

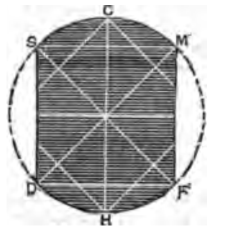


FIG. 6

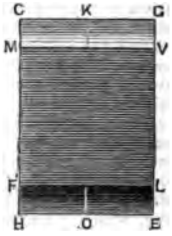


FIG. 7

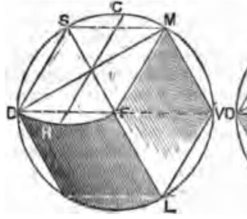
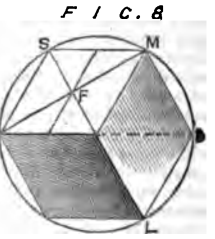


FIG. 8



A cube may be formed from either a sphere or a cylinder, but as a true sphere is more difficult to make and to chuck than a cylinder, we will first consider the formation from a cylinder of wood, metal, or any substance turning neatly and without splintering. First, describe a square in a circle, or draw a circle around a square, as in Fig. 1. The circle will represent the end of the cylinder, and the square one face of the cube. The side, S D, will show the length of the cylinders large enough to form a cube with a side, S D. Then with great care turn a cylinder of diameter, D M, and height, S D, taking care that its sides are perfectly parallel and both the ends square with the axis; "scribe" a circle about it *exactly* half its height (making C K = K G, as in Fig. 3). Describe two more diameters, A B, C H, midway between D M and S F, thus dividing the circular ends into eight equal parts. Then draw lines, M V, B T, F L, &c., as shown in Fig. 4. Chuck the cylinder so that the intersection of the lines, B T, K O, shall centre truly (as tested by a point tool held at the intersection, I, and which will make a dot if the revolving cylinder be properly centred and chucked, but a circle if not). Now, commencing at centre, cut away down to the lines, M V, F L. This will give a perfectly square face, M V F L, which will be one face of the cube. Take out the work, chuck it with this square face inwards, truly centred, and cut away again down to the lines, S D, &c., giving the form shown in Figs. 5, 6, and 7. Again chucking, cut to the line, M S, and repeating for the opposite face, cut to D F, and the cube will be complete, as in Fig. 8. If cut with sharp tools it will require but little finishing.

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* From the *Polytechnic Review*.

It is apparent that to cut a cube of a given size, there must be used a cylinder whose diameter shall be the *diagonal* of the *side* of the cube. To turn a cube from a sphere the latter must have a diameter equal to the *longest* diagonal of the cube. In calculating these lengths, is employed the principle that the diagonal of a square is equal to the square root of double its side; thus to get a 1in. cube we must have either a cylinder of a diameter, $DM = \sqrt{2}\ (= 1{\cdot}414)$, or a sphere of a diameter, $DV = \sqrt{2{\cdot}818}\ (= 1{\cdot}678 +)$. In a future article we may describe in detail the process of turning triangular and square pyramids, &c.

SCIENTIFIC SOCIETIES.

SOCIETY OF ENGINEERS.

AT a meeting of this society, held March 4, Mr. Robert P. Spice, President, in the chair, a paper was read by Mr. J. Walter Pearse, on

Water Purification, Sanitary and Industrial.

Having recounted the characteristics of most of the ordinary filters, the author gave some particulars of M. Le Tellier's hydrotrimetic purifier, which was described as removing the hardness from water by throwing down the lime, which was afterwards intercepted by filtration through charcoal. A jet of lime water is made to mingle with the stream from the supply pipe, and the percipitated lime is afterwards arrested, by filtration. M. Le Tellier has also invented a high-pressure apparatus on the same principle, for dealing with large bodies of water used in manufacturing processes, and for purifying the feed-water of steam boilers above 20 horse-power. On the same bed-plate are fixed two close vessels, the smaller containing the lime water or other reagent, and the larger the mechanical filter for arresting the precipitate, the two vessels being connected by an injector. The supply, which must have a pressure due to a column of at least 10ft. in height, enters by an inlet pipe, and most of it passes through the injector into the filtering chambers. A portion, however, descends another pipe, and issues through perforations at its lower end, keeping a disc, which is supported by a spiral spring, in a state of continual trepidation, and thus assisting the combination of the water with the re-agent, previously inserted. The rush of the main supply through the injector draws along with it the lime water from a small pipe, and the two pass together into a vertical tube, which is traversed by pins set alternately at right angles to each other, for bringing about a more intimate union. A valve also admits atmospheric air for aiding in the process. Arrived at the filtering chamber, the lime is thrown down to be removed periodically through a cleaning pipe, and the pure water passes through the filter tubes into the purified water reservoir below, whence it is drawn through a pipe by a pump or injector in connection with the engine and the boiler. The filter proper consists of wrought-iron tubes, perforated with holes, and covered by discs of felt, which are compressed between cast iron plates screwed up with a gun-metal nut. The lower ends of the tubes are conical, and fit into sockets screwed into the plates which separate the unfiltered water chamber from the filtered. The number of the tubes varies with the size of the apparatus; but the filtering area of each tube is very large in comparison with the space it occupies, being equal to the height multiplied by its circumference. Each tube may be lifted out of its socket for cleaning or replacing. A cleansing of the whole apparatus is also effected by turning steam into the outlet pipe, which heats the water in the lower chamber and forces it through the tubes and felt, expelling any impurities which may have collected there, to be washed away by rinsing with clean cold water. This apparatus is largely employed by manufacturers on the Continent; and, when used for potable water a second filtering medium of vegetable charcoal is added. Mr. A. Durand Claye, director of the laboratory of the Ecole des Ponts et Chaussées, Paris, made some experiments with the Le Tellier filter purifier in 1875, and found that water of 24 deg. of hardness was reduced to 5 deg. after passing through the apparatus, while the solid residue was reduced from 3·31 grammes to 0·92 gramme, a gramme being equal to 15 grains.

A PUNCH for cutting letters, &c., out of paper, leather, and other material has been invented by Mr. J. A. Hitter, jun., of St. Martinsville, La. The cutting face is detachable, and acts upon an elastic cushion, the whole tool being of scissors shape.

SCIENTIFIC NEWS.

BESIDES the expedition to Utah, the expenses of which are paid by M. Bischoffsheim, the French Academy of Sciences is sending M. Fleurias and M. Lemercier to observe the transit of Mercury in the neighbourhood of Payta, on the coast of Peru. M. Fleurias had charge of the mission to Peking in 1874 to observe the transit of Venus.

The labour involved in reducing and working out the observations of the transit of Venus made by the German expeditions is found to be greater than was anticipated; an extra vote of £500 is required, and the results will not be made known for some time yet.

Mr. L. Smith, of Rochester, N.Y., writing to the *Science Observer* (Boston), states that while comet-seeking on December 12 he witnessed a brilliant shower of meteors, which must have been the Geminids. He estimates roughly that from XIV. h. to daybreak four observers could have counted at least 1,000 shooting stars. He also noticed a remarkable paucity of telescopic meteors, for, during a watch of 4½ hours, he saw only two with certainty, and suspected one other, as they crossed the field of his glass.

The first National Entomological Exhibition was opened last week at the Westminster Aquarium, no fewer than about 900 cases, the property of 250 collectors, being exhibited. The exhibition was got up by the entomologists themselves, and all the principal members of the body sent in cases. Thus Lord Walsingham exhibited a splendid collection of caterpillars on the woods and leaves they attack; and Dr. Harper with micro-lepidoptera, Dr. Power with beetles, and Mr. Champion with bees, respectively exhibited the finest known collections of these classes. As a "show of insects" the exhibition was doubtless successful, but science benefits little, if at all, by gatherings of this kind.

Mr. Joseph Paget has offered a prize of £50 for the best dry process, and a committee of the Photographic Society has been appointed to arrange the details.

An anonymous friend of humanity offers a prize of 6,000 francs, to be awarded in 1880, for the most useful application to the healing art of M. Pasteur's discoveries. The Academy of Sciences will make the award.

Prof. Pierre Picard, of Lyons, will probably succeed M. Claude Bernard in the chair of physiology at the Collége de France. He was formerly for several years assistant to the famous physiologist.

The telephone is in daily use between the Exhibition buildings, Paris, and the office of the Ministry of Commerce, the wires being carried through the sewers or laid beneath the road. The electric light is being used extensively at the works on the Trocadéro, and at a lecture given by M. Jamin eight Jablochkoff's candles were successfully supplied in one circuit.

Herr F. Siemens, of Dresden, has succeeded in remedying the tendency of hardened glass to shatter itself without any apparent reason. He has discovered that the unpleasant effect is caused by over-hardening, which can be detected by the prevalence of violet tints exhibited by the polarisator when the glass is examined.

An ingenious form of ventilating valve for use on board ship has been invented by Mr. J. Sheppard, formerly manager to Messrs. Napier and Son. The valve, which has an opening to the atmosphere 2in. in diameter, is fastened inside the outer plating of the vessel, and is connected to a pipe which passes up between the frames and opens into the cabins. There is a slide to regulate the quantity of air, and a screw-cap to close the orifice when desired. The chief feature of interest is, that the valve is so constructed as to pass air freely, while it excludes the water. The valves have been fitted to the Dublin Castle, mail steamer, and are reported to answer their purpose in a very satisfactory manner.

The Guion line have ordered of Messrs. Elder and Co. a new Transatlantic steamer, to run between New York and Liverpool. Next to the Great Eastern she will be the largest vessel afloat, being between 500ft. and 600ft. long, with a tonnage of about 6,000, builders' measurement.

At a recent meeting of the Musical Association, Dr. Stone exhibited a Schiebler's tonometer made with ordinary tuning-forks, a clarionet with 19 notes to the octave, and a bassoon with additional notes.

The Midland Railway Company last week commenced running a train of carriages on the Pullman system between London and Manchester. This train is fitted with the Smith's vacuum brake.

Professor Hagenbach, of Basle, has given up the use of baths and packing in the febrile diseases of children, and employs salicylate of soda. The drug is administered towards evening, and when possible on an empty stomach. A decided fall of temperature occurs within three hours.

At the meeting of the Geological Society on March 6 an interesting paper on the "Geology of Gibraltar," by Prof. A. C. Ramsay and Mr. James Geikie, was read. The chief rock is a pale grey bedded limestone, overlain by shale containing beds and bands of grit, mudstone and limestone. Fossils are rarely met with in the latter, and have never been found in the shales. The only recognisable fossil obtained from the limestone was Rhynchonella concinna, which would make the beds of Jurassic age. All round the rocks are platforms, ledges and plateaus, evidently the work of the sea which would serve to show that the rock has been depressed and then re-elevated. A discussion followed the reading of the paper the authors saying that there was some reason to think that Europe must have been again united to Africa after the first separation.

The report of Major Fielden, the naturalist of the Arctic Expedition, is now nearly completed, and will shortly make its appearance as a Parliamentary paper, together with some interesting additional remarks by Sir George Nares.

The twin-steamer Express, built at Newcastle-on-Tyne for the Channel passage between Dover and Calais, was tried last week from Coquet Island to the Tyne. The distance is 22½ miles, and was run in one hour and twenty-two minutes. The trial was, therefore highly satisfactory.

Since it was proved that there is electricity in the air, both in time of storms and under ordinary conditions, many physicists have sought its origin. It has been chiefly attributed to vaporisation of water, but this now seems doubtful. Thus, in tumultuous boiling which no doubt causes electrification, solid or liquid particles are thrown against the walls and where this cause of friction is avoided every trace of electricity disappears. And a very slow evaporation must furnish very little electricity. M. Mascart has lately approached the subject from another point, and studied the influence of electricity on evaporation. He placed a number of basins of water or moist earth under conductors of grating form, connected with a Holtz machine, which was driven by a water engine and inclosed in a case the air of which was kept dry. The basins, too, were inclosed in a case in which the air was regularly dried. The conductors were kept at constant potential. The evaporation was always increased under this action, whatever the sign of the electricity; in some cases it was even doubled. If the temperature vary considerably in the inclosure in which the basins are placed the influence of the electricity is entirely veiled.

The French Société Protectrice de l'Enfance offer a prize of 500f. for replies to the following questions: Within what limits should the State interfere to protect the child? By what means might it increase the population? What advantage may it derive from societies protective of infancy? The Berlin Verein zur Deforderung des Gewerbfleisses offer prizes in connection with the following among other subjects: Production of an untransparent red enamel on gold, silver, copper, and bronze; production of substitute utchouc and guttapercha; best series -manganese alloys; a method of easy ination of glycerine in beer to 0·05 per esistance of heated iron to pressure and ; investigation of aniline black.

tal accident occurred lately in the Hotel, in Paris, through derangement of the hoists. The hoist had risen to rd story to receive a lady who wished to l. She entered (forming the third per- At the moment of opening the escape ock for the descent of the piston, the instead of following the piston in its ard movement, was raised by the -weight, and struck the top of the so violently that the chains of the -weight broke. Thereupon the cabin ecipitated to the bottom of the shaft nashed. The three occupants were The reason of rupture of the connec- tween the cage and the piston at the letting the water escape will perhaps idated at the inquest.

ld telegraph, recently devised by a artillery lieutenant, M. Ackermann, and a telelog, has the following general ment: — The receiver is a simple magnetic bell, with single strokes, is kept in a circuit with constant current. ld in a box attached by a hook to the and when the man carrying it wishes al he presses a knob, interrupting a contact. The cable contains two in- copper wires and a hemp cord to give essary resistance. The whole is wound nen band and tarred. It is wound in of 200 m. on a drum of sheet metal. ttery consists of 20 elements in a case compartments; the zinc cylinders are l fast to the wooden cover, while a dish, filled with blue vitriol, lies at the of each compartment. A 25 per cent. of Epsom salts is used as filling d. The battery will act at 3,000 m. e. The signals appealing to the ear, s of the person are left free for other s, such as defence.

recent paper on the telephone M. Du considers the effect to depend on ns of the magnetic bar in the receiving ent on variation in the intensity of the s traversing the bobbin. There occur tions and dilatations of the magnetic les through successive magnetisations magnetisations. The plate merely hens, by its reaction on the polar ity of the magnetised bar, the magnetic produced in the bar. The superiority of l currents over voltaic in telephonic ission, he thinks, is due to their instan- Considering that, according to de la Rue's researches, the currents d by vibrations of the voice in ordinary nes represent in intensity those of a element traversing 100 meg. ohms of ce (or 10 million kilometres of telegraph m. in diameter) one can see that the or less intensity of the currents used in nic transmission can enter very little phonetic effects produced.

esistance of the air to the motion of the the torsion balance does not seem to eived any serious attention from the ex- ters who have measured the mean density globe with this balance. It has, how- considerable effect in regular and rapid of the amplitudes of oscillation. This n demonstrated by MM. Cornu and *Comptes Rendus*), who find (1) that the des or distances of two successive ons decrease in geometrical progression; that the epochs of the elongations are metical progression. A theoretical ence from these laws is, that the resist- he air is proportional to the first power gular velocity of the lever.

t time ago, on the representations of vre and Soret, the Swiss Government ctual measures for the preservation of locks, scattered over the ground in and. The French territory also con- large number of such blocks, which, are rapidly disappearing, being broken ilding purposes. Geologists have been oved at the fate of these interesting objects, and MM. Falsan and Chantre lately appealed to the French Academy to come to the rescue. A report on the subject by M. Daubrée recommends the adoption of measures similar to those in operation in Switzerland.

The *Société d'Acclimatation* in Paris, has recently had sent to it by Mr. Seth Green, superintendent of the fisheries in the State of New York, a considerable number of ova of *Salmo fontinalis*, an excellent trout of North America, which, by reason of the superior rapidity of its growth, will be a valuable acquisition. The eggs arrived in perfect condition. The society had employed one of the refrigerating apparatuses of M. Tellier, inventor of the *Frigorifique*, whose system has of late been so extensively used in transport of fresh meat from America. The eggs have been confided to the care of some of the most competent members of the section of pisciculture.

Recent statistics show that Germany (with a population of about 42 millions), in the five years, 1866 to 1870, paid on an average, per head of the population, 17·22 marks for the five substances—sugar, coffee, tobacco, beer, and brandy (beer 8·80m.); whereas in 1874 and 1875 the average was 28·18 marks per head (beer 14·88m.). The total average consumption in 1874 and 1875 was 1,184 millions of marks, over the half of that sum being spent in beer. There has been an annual increase of about 461 million marks in the expenditure on beer.

Two Russian doctors lately treated the case of a girl 12 years of age, who had been bitten in the hand by a mad dog. The wound was cauterised immediately with nitrate of silver. In eight days the cicatrisation was complete. Seventeen days after the bite the first symptoms of hydrophobia appeared. The doctors prescribed inhalation of 3 cubic feet of oxygen. The effect was immediate, and in two hours and a half the patient was quite calm. Two days after fresh symptoms of the malady occurred (difficulty of swallowing and breathing, convulsions, &c.). A fresh inhalation of oxygen for 45 minutes again counteracted these. There remained only a slight difficulty of breathing, and this was overcome by means of monobromide of camphor, the use of which was continued for three weeks. The girl recovered perfect health with the exception of having aphonia—a morbid consequence of diphtheria.

Some idea of the enormous food consumption of a city like Paris will be obtained from the following figures, which have lately appeared. In the year 1877 the Parisians devoured 20 million kilogrammes (odd) of poultry and game, 133 million kilos of butcher's meat (19 kilos pork), 25 million kilos of fish, 2 million kilos of oysters, 15 million kilos of eggs, and 14 million kilos of butter. The consumption of drinks was 4 million hectolitres of wine, 106,000 hectolitres of pure alcohol and liqueurs, 89,000 hectolitres of cider, and 206,000 hectolitres of beer.

From experiments recently described to the Paris Academy by M. Richet it would appear that the gastric juice, by its dissolving action on caseine (and perhaps by another action still unknown), causes lactic fermentation to take place with surprising activity and rapidity. The gastric juice of fishes acts like that of mammalia, but it requires a temperature of 35° to 40° C. to be able to coagulate caseine. It cannot be doubted (says M. Richet) that in the feeding of new-born children the spontaneous acidification, almost complete, of the milk they take plays a very important rôle in sparing the young organism the cost of an abundant acid secretion. The oxygen of the blood, too, contributes (as direct experiments have shown) to increase the rapidity of the fermentation.

Useful Cement.—Dissolve five or six bits of gum mastic, each the size of a large pea, in as much spirits of wine as will suffice to render it liquid. In another vessel dissolve in brandy as much isinglass, previously softened in water, as will make a 2oz. phial of strong glue, adding two small bits of gum ammoniac, which must be rubbed until dissolved. Then mix the whole with heat. Keep in a phial closely stopped. When it is to be used, set the phial in boiling water. This cement perfectly resists moisture, and it is said to be able to unite effectively two surfaces of polished steel.

LETTERS TO THE EDITOR.

◆◆◆

[We do not hold ourselves responsible for the opinions of our correspondents. The Editor respectfully requests that all communications should be drawn up as briefly as possible.]

All communications should be addressed to the Editor of the ENGLISH MECHANIC, 31, *Tavistock-street, Covent-garden, W.C.*

All Cheques and Post-office Orders to be made Payable to J. PASMORE EDWARDS.

*** *In order to facilitate reference, Correspondents, when speaking of any Letter previously inserted, will oblige by mentioning the number of the Letter, as well as the page on which it appears.*

"I would have everyone write what he knows, and as much as he knows, but no more; and that not in this only, but in all other subjects: For such a person may have some particular knowledge and experience of the nature of such a person or such a fountain, that as to other things, knows no more than what everybody does, and yet, to keep a clutter with this little pittance of his, will undertake to write the whole body of physicks: a vice from whence great inconveniences derive their original." —*Montaigne's Essays.*

◆◆◆

ORGANIC CHEMISTRY.

[14109.]—THE principal objection to the definition of organic chemistry as the "Chemistry of the Carbon Compounds," rests apparently on its including certain substances such as the oxides of carbon, mineral carbonates, metallic carbide, &c., which ought properly to be classed as inorganic. But if we look into the mode of formation and origin of these bodies, it will be seen that every compound containing carbon, with one exception, and probably even carbon itself, is derived, directly or indirectly, from organic sources. If, as is supposed, our planet primarily existed in the nebulous or gaseous state, there being excess of oxygen present, the carbon must all have been in the form of carbon dioxide, or of carbon vapour, if the temperature was above the dissociating point of that gas. On the subsequent liquefaction and solidification of the mass of the earth, no mineral metallic carbonates could have been formed, as they are all decomposed at a red heat, and consequently the whole of the carbon must have remained in the atmosphere as carbonic acid gas, which must, therefore, be the source of all our carbon compounds.

The oldest rocks known to geologists are the Laurentian strata of North America, and a few isolated patches in several other parts of the world supposed to be chronologically identical with them. The existence of living organisms at such a remote period of the earth's history is shown by the presence in these strata of beds of graphite and limestone, which, in themselves, are truly inorganic, but which geological evidence goes to prove are both derivatives of vegetable or animal life, the former being the ultimate product of the metamorphism of coal by heat and pressure, and the latter the result of similar agencies on the calcareous skeletons of marine organisms. The organic origin of coal and ironstone being undisputed, it may be seen that carbon dioxide is the starting point of all our carbon chemistry, and that the great bulk—if not the whole—of our mineral carbonaceous products are derived from it through the agency of animal and vegetable life. Looked at from this point of view, "Organic Chemistry" and the "Chemistry of the Carbon Compounds" may be taken as synonymous; but, as I will try to show, it would simplify matters greatly, and place the science on a better footing, if another system of definition could be adopted.

While people have been ransacking their brains in a vain endeavour to discover or invent an exact definition of the branch of science known as organic chemistry, they seem to me to have overlooked the fact that "Organic Chemistry" itself is not a term which ought to be used to designate what is now understood by it. In the early days of the science, the term "Organic Chemistry" had a perfectly definite signification, comprehending, as it did, only those substances which were either found in the organised structures of plants and animals, and produced, as was supposed, by the influence of the "vital principle," or which were derivatives of such products. The idea that no organic compound could be formed except by a living organism was shown to be utterly fallacious by the discovery of Wohler, in 1828, that urea, an essentially animal product, could be built up from purely inorganic materials. This marked the commencement of a new era in chemical science, and chemists, now no longer trammelled by the theory that the "vital principle" was in some way necessary to the formation of such compounds, widened the field of their investigations, and produced, synthetically and otherwise, an immense number of new compounds all containing carbon, to which they still applied the name "organic," the characteristic element in both classes of compounds, natural and artificial, being the same. It is this growth of the chemistry of carbon compounds from the elements of the old "Organic Chemistry" that has led to the retention of the name of that from which it is derived, and not from anything in the science itself. The term, therefore, "Organic Chemistry," ought to be restricted to its original signification of animal, vegetable, or physiological chemistry, and let the "Chemistry of the Carbon Compounds" be substituted for what is now known as organic chemistry. Instead of a small part giving its name to the whole, it is certainly more scientific and becoming that a comprehensive designation be given to the whole, which will include the part, and so do away with the necessity of making one definition answer for both.

Another reason why a line of demarcation should be drawn between them is, that an organic chemistry is not necessarily restricted to carbon compounds, as it might be possible to build up an exceedingly complex system of chemical compounds on a basis of some other element. As shown by Mr. Hannay, in a paper read before the Glasgow Philosophical Society, chromium and manganese may be made to form series of very complicated compounds by using carbon disulphide and tetrachloride as solvents, and working in an atmosphere of carbon dioxide. The object of this is to exclude air and moisture, by both of which they are immediately decomposed. Carbon, on the other hand, seems to be peculiarly adapted for forming compounds of the most complicated character, which, as a rule, are undecomposable by water, and therefore is the best, if not the only element, upon which a system of organic chemistry could be based in a world like ours, where air and water play such an important part. But the power of forming complex compounds being a property common to other elements, under conditions different from those existing on the earth, one can easily understand that living organisms, built up of totally different constituents, may exist in "other worlds than ours"—in circumstances under which organic life on a carbon basis would be impossible. Another exceedingly interesting point to notice is, that carbon is the only element which forms a perfectly stable *gaseous* oxide, without any tendency to pass into higher or lower states of oxidation, thus fulfilling, as no other element could, a necessary qualification for the position which it holds on our planet. If the theory of "spontaneous generation" could be confirmed, all this might be held up as a magnificent illustration of life of a particular type, developing itself from the inorganic materials, and accommodating itself to the conditions by which it is environed. But as the evidence at our disposal disproves rather than confirms this theory, we must either conclude that all this marvellous adaptitude of life to matter is the result of chance—or that it has been elaborated after the design of a Great First Cause, the Divine Author of all that is of Order, and consequently of Beauty, in the material Universe. **Jup. Rex.**

ASTRONOMICAL.

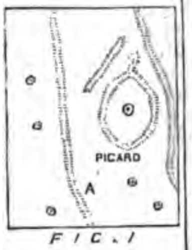
[14110.]—I have not been able to look for the stars Mr. Espin named in Orion and Hydra, partly through the bad weather, and also other causes. Once I tried, but like "Mac," could not make out the trapezium p α Hydræ at all. Last night, however, I am sure I found it. Clouds came over, in the tantalising manner they usually do, a few moments after, but I saw at once five stars. Two were much smaller than the others; perhaps "Mac" could not catch them, and that prevented his recognising it as a trapezium. At the first opportunity I shall try it again. Is there a white star in the same field as the crimson star in Lepus, *f* it, about the same size? I think I found the crimson star lately, but am not sure, as I certainly do not see red stars easily. I think white stars strike me most, a kind of steely blue next, then deep orange, and, lastly, red. Mr. Webb gives a good many red stars in the two clusters in the sword handle of Perseus, but I see none of them—all the stars look peculiarly white to my eye. As to the colours of most of the objects that Mr. Webb gives, I see nothing of them. I suppose there is nothing that would so much depend on the condition of the eye as seeing colours of stars. Would it not be interesting, and probably profitable, to compare the colours which various observers see in the same stars? Also, have not small companions to larger stars, as a rule, got a blue shade, especially if the larger star be at all of an orange tint?

Has any one noticed that Sirius is more blue this season than usually. It has seemed so to me, and I have heard others remark it also. **Brickwall.**

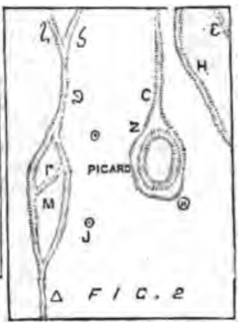
I.C. μ^{16}.

[14111.]—If Mr. Sadler has an opportunity of seeing Keith's "Use of the Globes," edition 1834, or either of the later editions, he will find a plate of the moon in which the objects are placed in the latitudes and longitudes "determined by Tobias Mayer." In this there is no object shown in the place of I.C. μ^{16}, but Picard appears surrounded by light, which is extended towards the N.N.W. No such light as this now exists—is it a misplacement of I.C. μ^{16}?

I give two figures of this region. The first is from a diagram of Mr. Neison's, dated July 27, 1877, and the other, Fig 2, from my diagram of the eastern portion of the Mare, taken 1877, Sept. 24d. 9h. There seems so little agreement between the two figures that one would scarcely take them to be both of the same object seen under evening illumination. As to Mr. Neison's diagram, the conviction comes somewhat forcibly that he has misplaced the ridge which I have marked A on Fig. 1. Now for my own figure (2). The great ring, M, in the forked and serpentine ridge Δ θ so very closely resembles Schröter's DD (see Fig. 1, p. 624) that it appears to be what he saw, but described somewhat differently.



F I C . I



F I C . 2

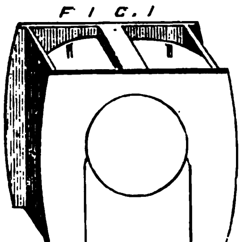
The craterlet, I, occupies the site of the white spot, I C. μ^{16}. One interesting feature about Picard is the platform Z Θ upon which it is situated, but which is not shown in any other sketch which I possess. As to the visibility of the light spot, I see, by glancing over a table of about 57 observations, that its brightness gradually increased, during the first three days after crossing the terminator, and retains its maximum lustre until about the seventh day after crossing. After then it gradually gets fainter and fainter. The size (area) of the spot varies in a manner which is at present inexplicable to me. I hope this note or two may prove acceptable to Mr. Sadler.

Southampton, March 8. **Frank C. Dennett.**

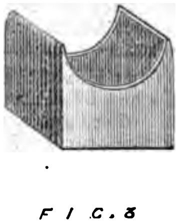
G. E. R. LOCOMOTIVES.

[14112.]—A short time ago a correspondent sent to the English Mechanic a brief account of a day's inspection of the Great Eastern Railway works at Stratford. It consisted, I believe, of a description of the machinery, and a short account of the nature of the work produced thereby. It is my intention, as I have not only been a visitor at the works myself, but have been numbered among the workmen, to give a detailed account of the erection of a locomotive, and to state briefly the machines used in the construction of various parts of it. With appliances for the manufacture of these engines, there is, I believe, no workshop more completely fitted than that about which I am writing. No expense is spared by the company in securing the best machinery, and in adopting every modern improvement in material and methods of work.

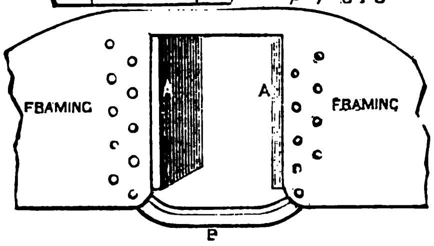
F I C . I



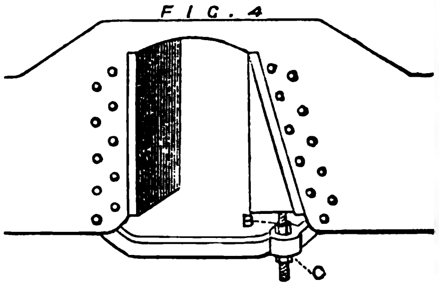
F I C . 2



F I C . 3



F I C . 4



Several of the more recent purchases of ma
are of American manufacture, and they are n
of extremely clever design, but the work pi
by them is exquisite, and they are also so
fully finished that it often seems a pity th
have to be subjected to the rather rough tre
to which they are doomed. However, they a
to be used, and if in such use they get a fe
these are at least honourably won.

Before I enter into the construction of
motive it is necessary that I should give th
ing of a few technical terms in the formatio
framing and some of its adjuncts that I
obliged to use. The "axle-boxes," Fig. 1,
the bearings on the axle of the wheels, th
smaller bearings generally go by the name of
The "keeps," Fig. 2, are those parts which
the portion of the axle-box projecting be
axle, and are kept in their places by two st
pins, driven from one side of the axle-box
the "keep" to the other. They are general
of cast-iron. The "rubbing pieces," A A,
are those portions of iron between which t
boxes slide. The "hornstays," B, Fig.
pieces of iron placed below the axle-boxes, an
to either side of the framing under the r
pieces. The front and back part of the engi
also the wheels supporting the same, are de
by the terms leading and trailing. I think t
all the technical terms that need be menti
regards the framing of a locomotive. Those
engine are the same as those of any
stationary engine.

In the erection of a locomotive, as in eve
else, it is necessary to have drawings of eve
even to a bolt or rivet. In these drawings i
seen that the foundation, or, as it is tec
known, the framing, is the first thing to
sidered, as all other parts are but as adj
this. This (the framing) is cut, or rather
out of from ¾ to 1in. sheet iron, the shape
varying of course according to the nature a
portions of the engine for which it is inten
in this paper I shall confine myself to on
express engines so well known on this line.
and four frames are cut at the same time
to save time, as such vast pieces of iron ar
easy to be pulled about.

After having been roughly punched out
placed under a large double shaping machi
almost entirely for this purpose, where they
to their proper finish. They are then plac
large face-plate, and accurately fitted with
bing pieces, which have in the meantin
planed to their required size (which vari
much), some thirty or forty at a time. The
pieces of the driving wheels of this kind o
are very often made with a wedge to form
as will be seen in the figure. It is made wit
screw, A (Fig. 4) projecting from the bott
and passing through the hornstay, which
made rather longer at this point to preven
ness. It will be perceived that by screwing
nut, B, at the top of the hornstay, the we
necessarily proceed upwards, thus tighte
axle-box between the two rubbing pieces;
adjusting, the check nut, C, will prevent an
shake. **Ambid**

(*To be continued.*)

LOCOMOTIVE INJECTOR.

[14113.]—It is some time since I promise
an account of some experiments with a new
worked entirely with exhaust steam, but I
been able to obtain full particulars, so I will
myself with placing before your readers t
result, which I can testify as being bel
actually obtained, having ridden on the en
seen it in operation. Boiler pressure, 120l
sure of steam from exhaust, 6lb.; injector
dry. **H**

CONTINUOUS BRAKES — THE INGHOUSE AUTOMATIC BRA

[14114.]—I have read with great inte
very able article, p. 542 of last volume,
important subject of continuous brakes,
clearly places the brake question bef
readers.

In my drawing, p. 578, Vol. XXVI., I
omitted to illustrate the Westinghouse br
to the engine wheels, as it can be better u
when shown upon a larger scale. Fig. 1
elevation, and Fig. 2 the cross sectio
Westinghouse automatic brake as fitted
driving and trailing wheels of a couple
engine.

Two brake cylinders and apparatus, as
the drawing, are used—one placed upon ea
the engine. This arrangement avoids the
tion which would be involved if only one
were used, and also it provides for an eve
tion of the brake to both pairs of wheels
circumstances.

The diagram which I now send is so cl
render any lengthened description unn

The action of the Westinghouse automatic brake was fully demonstrated in my letters, pp. 578 and 627 of last volume. Air is admitted beneath the piston in the brake cylinder, E; the piston, piston rod, and the connecting links, L, are raised about 3in., this at once causes the two eccentric-faced levers, N, to force the two brake blocks against the wheels and apply the brake. The nut, S, upon the cross head is used to adjust the brake as the brake blocks become reduced. In some engines this arrangement is slightly modified—the adjusting screws being placed close to each brake block. It will be noticed that the brake blocks are fitted at a considerable distance below the centres of the wheels. This avoids any undue strain being placed upon the axle boxes and side rods. Of course the wheels must never be skidded. When the brake is taken off, the weight of the piston and links releases it without the use of springs.

I mentioned in my letter, p. 216 of last volume, that much difference of opinion still exists as to whether brakes should be applied to engine wheels or not. I am very glad to see that the objection which has for so many years existed to brakes on engine wheels is fast dying out, and large numbers of engines are now fitted, and working exceedingly well, with these brakes. The advantage of engine brakes is very great indeed, as such a large proportion of the weight of the engine rests upon the driving and trailing wheels. These brakes have also more than twice the retarding power than when the engine is reversed; they can, too, be instantly applied, and do not damage the engine. This fact has been proved in America, also by Mr. Drummond on the North British Railway, and by several other companies.

FIG. 1.

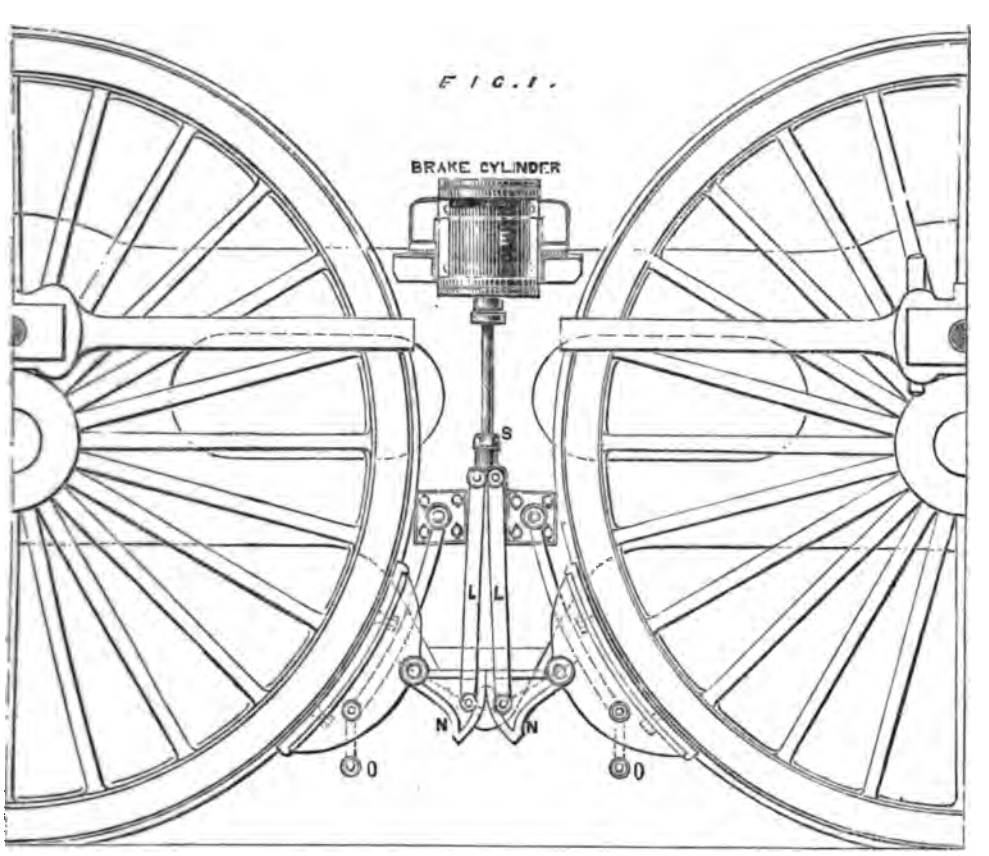
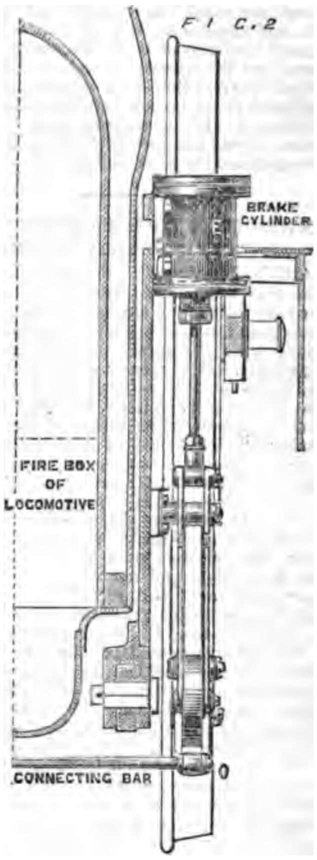


FIG. 2



On the other hand, to reverse an engine takes several seconds, and also places a very great strain upon it. I have known several cases where the driving axle has been bent or broken through reversing the engine when running.

In my letter, p. 627, I mentioned the experiments which have been made at Derby. They are being continued during the present week (11th to 16th of March inclusive). There are three trial trains—the Westinghouse automatic, the Sanders' vacuum, and the Smith's vacuum. Most valuable information is being obtained, and the question of brakes upon the engine wheels is receiving considerable attention. The engine working the Westinghouse train, No. 802, made several stops, with the automatic brake working upon the tender and train only (the engine brake being disconnected); the engine brake was then reconnected, when the distance run after the brake was applied was reduced by a very considerable number of yards. These experiments are still being conducted to-day, March 14th. The results obtained show that in every trial the Westinghouse automatic has proved itself to be the best brake.

I mentioned in my letter, p. 224 of Vol. XXVI., that the Midland are joint owners with the Great Northern and Manchester, Sheffield, and Lincolnshire Railway Companies of the Cheshire lines. The Cheshire lines joint committee have fitted nearly all their passenger joint rolling stock with the Smith's vacuum brake, because the joint trains are worked by the Manchester, Sheffield, and Lincolnshire Company's engines, which have this brake. For some time past this has caused great inconvenience to the Midland traffic, more especially when carriages fitted with the vacuum brake were required to run in the middle of the Midland main line trains fitted with the automatic brake. To avoid this inconvenience the Midland fitted their engines and carriages required to work the Liverpool, Manchester, and Derby traffic with the vacuum brake. This in some measure obviated the inconvenience caused by the difference of brake systems on the Cheshire lines, but made it still more apparent at Derby and Trent, as through carriages run on many of the express trains between Liverpool, Manchester, and London. The Midland Company have therefore lately decided to work all the express trains between London, Edinburgh, and Glasgow, and also the express trains to Leeds and the North, with the Westinghouse automatic brake, and all the express trains which run between London, Liverpool, and Manchester only are to be fitted with the vacuum brake—for instance, the 10 a.m., 12 noon, and the Pullman express at 5 p.m. from London. This decision came into force on Monday last, March the 11th. Your correspondent, "Finem Respice," p. 605 of last vol., seems to imagine that the Westinghouse brake causes inconvenience when shunting takes place, and when disconnected from the engine. This is not the case, as before carriages or the engine is uncoupled, or the brake tubes disconnected, the tap, F, on either side is closed to prevent the escape of air and consequent application of the brake; also a tap is placed under each auxiliary reservoir. If this is opened the air escapes, and the brake is at once taken off. The question of cost has been decided upon the North British and other railways. The vacuum is cheaper in first cost than the Westinghouse, but the Westinghouse is the best brake, and much the cheapest to maintain.

Your correspondent, "Willesden," p. 627, makes a statement as to the stops made by the chain brake upon the London and North Western Railway, which certainly requires corroboration before it is received as an engineering fact by your readers. He says "at 60 miles an hour the train can be stopped in 10 seconds, and that at 35 miles an hour the trains stop in half a dozen yards." I have myself worked this brake, and have also been present at experiments made with it, and certainly no such results were given. Also, let us turn to the Newark brake trials. The chain brake, at a speed of 47½ miles an hour, took 29 seconds to stop, and ran 1,337ft.—trial No. 18. In trial No. 31, even with the engine reversed, at a speed of 50¾ miles an hour, 1,096ft. were run.

Upon p. 627 I mentioned the expected discussion in the House of Commons, on March 1st, upon the brake question. Unfortunately this could not take place, as the President of the Board of Trade stated in the House, on February 28th, that he had not received the replies from the Railway Association. Further papers upon the subject were placed upon the table of the House on March the 5th.

March 14th. C. E. S.

COLLIERY CATASTROPHES.

[14115.]—The correspondents who wrote on this subject, which led to my letter (14046), nearly all argued the improbability of gas causing the floor of mines to be lifted up. I therefore endeavoured to prove to the contrary, and did not consider it at all necessary to make any allusion to the case of thill being forced upwards by the pressure of the overlying strata through the removal of coal. "P. M., Chester" (let. 14100), must therefore not take it for granted that I was not aware of this coincidence from the fact of my not mentioning it in my letter, as it is one which is common to all mines. "P. M., Chester's," supposition as to these two causes acting simultaneously is erroneous. It is certainly possible for them to do so, but cases of this kind must be exceedingly rare as we never hear of them, and we have always found the true cause of the uprising to be attributed to either the one or the other, not both.

I take "C. M.'s" meaning, with regard to gas not exploding by reason of its purity (not a very correct expression to use) to be that in consequence of an insufficient quantity of air, the mixture is not sufficiently diluted to render it explosive.

"C. M." is most certainly mistaken when he supposes fire-damp will explode without the introduction of flame. Common house gas will; but, as "P. M., Chester," says, it is not fire-damp. This latter gas requires a much higher temperature before it will explode than the former does. T. E. J.

[14116.]—Being a constant reader of your valuable paper, and a practical miner, I have taken great delight in the discussion on colliery catastrophes, but I am surprised to see how imperfectly they are understood. "A Lover of Pure Air" wants to make us believe that gas won't light when we fire a shot—why don't he try it? When I was a boy there was a great deal of gas in a pit I was working at, and I had to stand at a pool of water with a cloth, and run to the man when I heard his shot fire, for him to extinguish gas. He very seldom missed firing the gas, and it was fun for me when he used to let me get it out. It was no easy thing to do this sometimes. "G. S. W." speaks of pent-up gas lifting the floor up; it is not gas that does this, as I could prove. But I don't want to trespass on valuable space. W. A. Carins (letter 13986) is right. If I am not mistaken, the discussion is all about side issues, and the main point is lost—*i.e.*, the prevention of colliery catastrophes. I think shot-firing in gassy pits is very dangerous, but I do not think it is the cause of all the explosions that happen. When there is an explosion, there has been negligence or ignorance, or it could not have happened. When there is an adequate amount of ventilation to render harmless all inflammable gases, are we safe? I have known a pit fired from a shot and there never was gas seen in the pit, or there was no cavity where pent-up gas might have come from. What was the cause of so great an explosion, for there were three men killed, and the doors and shoppings blown away? In my opinion, the owners or their agents are to blame for nine-tenths of all the accidents that happen. On the 5th inst. there was an engine-tender overwound the cage at No. 3 High Blantyre, Scotland, and six men were thrown down the pit. I think the manager ought to have been put in prison for culpable neglect of duty, instead of the engine-tender, for not having the safety detaching hook on. It is impossible to over-wind the cage when the detaching hook is on, yet not one-third of the collieries use them yet, just because of a little expense. It costs owners nothing for dead men. If our legislators would attend a little more to "British interests" at home instead of imaginary ones abroad, we should be all the better for it, and might make men do their duty that have charge of hundreds of their fellow-men. Some may say we have Government inspectors, but their work is a dead letter as they do it at present. Again, to-day (March 9) we have a terrible colliery explosion near Glasgow—it is almost sure to be "accidental." We shall never improve till owners and managers are responsible for their negligence. **Snyder.**

CONNECTION OF HARMONIUM REEDS WITH PIANO WIRES.

[14117.]—I have read "Gnikrod's" remarks, and notice that a soundpost has no mechanical action other than its own on any other substance—that is, a soundpost can only convey a previously actuated motion, which, through a soundpost, becomes sympathetic. It is merely a vibratory conductor. Now, if the substance it impinges or presses upon is of the same nature as itself, the sympathy is maintained without any augmentation of force; but if the substance in its formation is in opposition to the sound-generator friction ensues, and a reinforcement of vibration may be expected. This reinforcement is reaction, and is a question of leverage, as, if we wish to lift a weight, we move the centre to do so more easily—this is a figure illustrating the reason why the soundpost of a violin is put away from the bridge, and not directly under it. The proper place for "Gnikrod's" post or connector would be just behind the root or lever of the reed, and on its soundboard. We can go no further without another soundboard to attach to the other end of post, and, if we had this, the result would only be sympathetic and not mechanical on the piano wire of the second soundboard. The post could not act on the wire in any other way, because there would be no reinforcement. Then take away the post, and let the circle of sound belonging to the harmonium reed act sympathetically on the wire. It is said that a spiral wire, when tuned to pitch, has a wave-like form, and that this is the best for sympathetic vibrations. Having come to the best condition to sound together without mechanical appliances, let us connect the two mediums together so that the action may be made a reaction. This can be done by joining (with a filament of silk, &c.), the end of the reed to middle harmonic of the wire. In this case there would be no increase of sound but only a fullness; yet, if the attachment was made to a harmonic section of the wire (say a fifth), reaction would ensue and increase of sound. The effect, however, would never be like separate reeds and strings, for one mechanical action will not move both in a direct manner. "Istriel" thinks it a pity that strings are not bowed with chamber organs, but I can assure him that a finger-key'd viol is superior in tone and power to all chamber organs, and costs ten times less money. I have not brought my instrument to perfection yet, but give me a string and soundboard long enough and I'll match any organ pipe. **Fiddler.**

TELEPHONIC ADJUSTMENT.

[14118.]—One would almost think that we had had enough of telephones, and that the subject is well-nigh exhausted, but I am one of those who think there is much in store for us yet if we only look in the right direction. It seems almost absurd to hear querists constantly stating that they cannot make their instruments work, considering the extremely simple nature of Bell's telephone. To these and perhaps to many more of our readers, my remarks on telephone adjustment may prove acceptable.

Several had stated their method of adjustment by battery, explaining that we were to listen for a clicking noise when the instruments were coupled up, which changes to a buzz upon the contact of the plate and the magnet being broken. This method I first pursued, but instead of getting a clicking noise as I expected I got a peculiar scratching sound, and that only when the circuit was completed by the wires being hooked to each other loosely. This scratching is in a rather high key, but as soon as the magnet leaves the plate (by screwing up) the note changes abruptly to about an octave lower. This is the primary thing to notice.

After having adjusted them in this way, we (myself and friend) threw a line wire across a street (about 30 or 40 yards) to two upper windows, making contact with earth by the gas pipe. The instruments then spoke perfectly.

At times we heard a scratching noise exactly similar to that obtained by the battery, and we were at first puzzled and vexed to know whence it proceeded, as it interfered materially with the speaking. At last we found it to be the result of the two wires inside the room (we had used uncovered ones) touching each other. It struck us we might utilise this fact for adjustment, and we at once readjusted our telephones, making them to speak exceedingly clear and distinct, the voice apparently only a few yards away. The scratching proceeding from one end of the circuit was heard in both telephones.

The next question is, what can this scratching be? It is evidently the intermittent breaking of a current of electricity, for when speaking is carried on at the same time it is intermittent also. Can it be that there is some residual current in the wire, which is at the bottom of the telephone altogether? I may say we not only got the sound by a Wheatstone bridge, but also when we connected the circuit itself up loosely.

Our latest experiment has been to put a human body in the circuit and speaking was still heard, although very feeble. With two persons very loud sounds only may be heard.

Leeds, March 11th. **W. J. Lineham.**

TELEPHONIC SOUNDBOARD.

[14119.]—The following is only an idea of mine. The phonograph sounds out over a space of many feet. Why does not the telephone do so? When the phonograph is used the second time, is the wire point in soundboard removed or allowed to remain? Well, suppose the telephone has a point *a la* phonograph, would that, adjusted as to its own length and proximity to the magnets, increase the sound? An iron soundboard might be (and perhaps is now) too rigid, but I think the point should be hard and the sounder elastic. **Fiddler.**

TELEPHONES.

[14120.]—I have been trying some further experiments with the telephone. On trying the alphabet I find the indistinct letters are *b, c, d, e, h, p, t*, but I suppose this would depend on the distance between the plate and the magnet. I have also made a telephone with a horseshoe magnet, something between Bell's and Dolbear's, but I cannot report favourably on it. The sound cannot be produced by vibrations of the metallic plate, as I have heard the sounds very distinctly with my ear touching the plate, which would surely stop vibration. There is certainly no occasion for taking the varnish off the ferrotype plate. **No Sirrah.**

A SIMPLE PHONAUTOGRAPH.

[14121.]—I have just constructed a very simple phonautograph for recording the vibrations caused by the voice, and as it is perfectly successful so far as it goes I venture to send you a description of it, thinking that perhaps some such instrument may be of use to some of your numerous readers, who, like myself, are just now interested in anything bearing upon sound in relation to telephony. I am not professing to describe the best way of making a phonautograph, but simply to state how I made a very primitive one from materials at hand, which gives perfectly satisfactory results.

The vibrating diaphragm is a piece of white kid stretched over one end of a short tin tube 1¾in. in diameter. To the centre of this, on the outside, is attached a sewing needle, the eye end being first stuck into a little bit of soft wood, and thus glued on to the diaphragm. The point of the needle for about ¼in. from the end is bent at a right angle. To multiply the effect of the vibrations, and make them more "legible," I took a stocking needle about 2½in. long, and ran it through a piece of soft wood, about ½in. square, to within ½in. of the eye end, and bent the other end of the needle for about ¾in. at a right angle. Through the piece of wood on this needle must be also inserted an ordinary sewing needle at right angles to the former, to form a pivot for the whole to work upon. These are almost all the parts required. I put them together on a light piece of deal about 20in. by 4½in.; an inch from one side of this runs a shallow groove, ¾in. broad, the whole length of the board, in which the smoked glass slides travel, whilst the vibrations are traced upon them by the point of the long needle. To make this groove perfectly smooth and level it is lined at the bottom with glass. Over the groove is supported the pivo needle, working in two little slips of soft metal, and its foot resting upon glass, the bent point of the long needle thus swinging freely from side to side in the groove. All that now remains is to fix the tube with the diaphragm, and connect its needle with the short end of the stocking needle. I hollowed out the board to bring the needle affixed to the diaphragm on a level with, and within about 3-16ths of the end o the long needle when the point of the latter is in the middle of the groove. A very thin slip of wood through which the point of the short needle and the eye of the long one are passed, firmly connects the two, and yet is not too rigid to allow of the perfec communication of vibrations. The instrument i now complete, excepting that at the long end of the board I have a small grooved pulley, which, by mean of a thread, draws the slides under the needle with tolerable evenness. The glass slides are 8in. long and ⅜in. broad, and have a little bit of leather glue on to the end to give a hold for the hook at the end of the thread. The point of the long needle must b adjusted (by sliding the small wooden block up o down on the pivot) until it rests upon the surface o the slide, and to keep it steadily pressing a sligh spring acts upon the top of the pivot needle.

On singing or speaking into the tin tube, and at the same time drawing a smoked glass slide under the needle, we have a perfect record of the various vibrations thus caused, and their infinite variety and marvellous delicacy are astonishing. The best way to observe them is in the microscope, with a low power; they are also effective if thrown by a magic lantern on to a screen.

I should like to have said something upon the figures and their production, but have already, I fear, trespassed too much upon your space. I would just add that, if any one should feel at all inclined to make use of the foregoing hints in constructing a phonautograph, but would first of all like to see a slide from the instrument, I will gladly forward one on receipt of an application to my initials at the Post-office, Rochdale.

Rochdale. **J. R. H.**

P.S.—I should be very glad if any one would tell me how to fix the smoked glass slides permanently; I have tried photographic varnish, but the result is not satisfactory.

IMPROVEMENTS IN BICYCLES—MAKING CHEAP BICYCLES.

[14122.]—Now that the bicycling season is coming on, a few words on the improvements which have been made in these machines may be welcome to many of "ours." There have been sweeping changes in some firms. Take the Coventry Machinists for instance: they have taken out patents for hollow forks, tires, handle bars, axles, and hubs; and the spokes are a combination of the nipple and spider—that is to say, instead of a loose nipple to fasten the spoke in the hub, the wires are drawn thicker at the end intended for the screw, thus obviating the chance of breakage. They are also fitting roller bearings, the case or box of which opens with a hinge, facilitating the cleansing of them. A new kind of spring is also introduced, having a buffer of indiarubber. A 50″ light roadster weighs 35lb. Their racing machines are a novelty, being made with triangular backbone and forks (hollow)—a 54″ guaranteed to weigh not more than 25lb.

Another startling innovation is introduced by the Surrey Machinists Company, whose patented "Invincibles" for 1878 are made with 200 spokes in the front wheel and 50 in the back! Fancy drilling 500 holes for a pair of wheels, and tapping 250! The spokes are very light, and are fitted in the rim by nipples, and headed in the nave or hub. The front fork is made out of a piece of hollow drawn steel tube, cut up lengthwise to form the fork legs, to within 3in. of the top; in this part is fitted the Stanley head and steering; the backbone and fork is one piece, the fork being made by slitting up the backbone a suitable length, and then putting on a step. The cranks are detachable. A 54″ racer of this build is guaranteed to weigh not more than 20lb. Some of our readers may recollect a few months since, when writing about hollow forks &c., I uttered a prediction that we should be rushing about on 54″, weighing 20lb. Behold, now, the idea verified!

John Keen (the Champion) has also obtained patents for improvements. He builds his "Eclipse" with from 60 to 100 spokes in the driver, and uses hollow forks, and makes the backbone and fork in one piece by continuing the backbone down one side of the back wheel, and claims to have a dust-proof bearing for it. Ball bearings are adopted for the front wheel. His racers are similar, but lighter—a 54″ weighing about 23lb. Then we have Carver's hollow spokes, detachable cranks, and safety pedals, which cannot slip, and new roller bearings, wherein the rollers are free to revolve without touching each other, and at the same time cannot cross or lock. The "Centaur" (Coventry) is fitted with movable saddle, detachable cranks, all bearings—after Humber's plan—spider wheels, and dustproof parallel bearings to back wheel. These are the principal improvements up to date. The same form and mode of propulsion remain, and I think will as long as the bicycle exists. Our readers will see that makers have not been idle during the winter, and it seems difficult to imagine what next, and next?

In reply to "Pound a Week" I will give an article or two shortly on the subject he wishes. Meanwhile let him save his money, and get some rubber tires, ⅞ front and ⅝ back; also steel rims and backbone, and a bar of best Low Moor iron, 1½ wide by ½ thick, and 8 or 9ft. long. Get 40 nipples drilled for No. 9 wire, and 16 for No. 10; also lock-nuts for the same. Procure 30 yards of charcoal iron wire, and 5 yards ditto, No. 10. Discard the old parts of bicycle. Order steel rims and backbone at one place—front wheel 54", back 20", and the maker will bend the backbone to fit. I should recommend Druce, of Sheffield, for these, as I know they are reliable. Order the backbone 1¼" thick at one end, ⅝" the other. Let me know what your resources are for making. Are you a mechanic, blacksmith, or what? If not, are these available and good? **Fred. L. Striffler.**

THE ETHERS.

[14123.]—The ethers may be divided into the ethers of the monohydric, dihydric, and trihydric alcohols. The ethers of the monohydric, dihydric, and trihydric alcohols bear the same relation to the corresponding alcohols as the metallic oxides bear to the metallic hydrates.

The ethers of the monohydric alcohols are represented by the general formulæ $(C_nH_{2n+1})_2O$, $(C_nH_{2n-1})_2O$, and $(C_nH_{2n-7})_2O$, the methyl, vinyl, and phenyl series respectively. The ethers of the dihydric alcohols represented by the general formula $C_nH_{2n}O$, the ethylene series. The ethers of the trihydric alcohols, represented by the general formula

$$\left\{\begin{array}{l}(C_nH_{2n})_2O\\(C_nH_{2n-1})_2O\\(C_nH_{2n})_2O\end{array}\right.$$

The alcohols and ethers may be regarded as formed on the type of water, thus: $\left.\begin{array}{c}H\\H\end{array}\right\}O$ $\left.\begin{array}{c}CH_3\\H\end{array}\right\}O$ methylic alcohol, and $\left.\begin{array}{c}CH_3\\CH_3\end{array}\right\}O$ methylic ether.

In the case of the alcohols one atom of hydrogen is displaced by the monad positive radical, while in the ethers both are displaced. The ethers of the monohydric alcohols are formed by substituting a positive monad radical in place of the hydrogen of the hydroxyl—thus: $\left.\begin{array}{c}C_2H_5\\H\end{array}\right\}O$ is ethylic alcohol, and $\left.\begin{array}{c}C_2H_5\\C_2H_5\end{array}\right\}O$ is ethylic ether, formed by substituting C_2H_5, the positive monad radical ethyl, instead of the atom of H in the HO.

Sometimes a different monad positive radical from that contained in the alcohol is substituted instead of the hydrogen of the hydroxyl—thus: $\left.\begin{array}{c}CH_3\\H\end{array}\right\}O$ methylic alcohol becomes $\left.\begin{array}{c}CH\\C_2H_5\end{array}\right\}O$ methylic ethylic ether by substituting C_2H_5 in place of the H of the HO of the methylic alcohol. This is termed a mixed ether.

These ethers are formed by distilling the alcohols of the series $C_nH_{2n+1}HO$ with H_2SO_4 in two stages—thus: $C_nH_{2n+1}HO + H_2SO_4 = HC_nH_{2n+1}SO_4 + OH_2$ and $HC_nH_{2n+1}SO_4 + C_nH_{2n+1}HO = (C_nH_{2n+1})_2O + H_2SO_4$.

These ethers can be converted again into the corresponding alcohols by treatment with H_2SO_4 and distilling the sulpho-acid with water—thus: $(C_nH_{2n+1})_2O + 2H_2SO_4 = 2HC_nH_{2n+1}SO_4 + OH_2$ and $HC_nH_{2n+1}SO_4 + OH_2 = C_nH_{2n+1}HO + H_2SO_4$.

The methyl series contains the following ethers—viz., methylic ether $(CH_3)_2O$, ethylic ether $(C_2H_5)_2O$, butyric ether $(C_4H_9)_2O$, amylic ether $(C_5H_{11})_2O$, methyl-ethylic ether $CH_3C_2H_5O$, methyl-amylic ether $CH_3C_5H_{11}O$, ethyl-butylic ether $C_2H_5C_4H_9O$, ethyl amylic ether $C_2H_5C_5H_{11}O$, &c.

Of the vinyl series only allylic ether $(C_3H_5)_2O$ is known.

In the phenyl series we have phenylic ether $(C_6H_5)_2O$ and benzylic ether $(C_7H_7)_2O$.

There are three ethers of the diyhdric alcohols—viz, ethylene oxide C_2H_4O, propylenic oxide C_3H_6O, and amylenic oxide $C_5H_{10}O$. Of the trihydric alcohols only glycylic ether

$$\left\{\begin{array}{l}(CH_2)_2O\\(CH)_2O\\(CH_2)_2O\end{array}\right. \text{ is known.}$$

Ethylic ether is prepared by heating a mixture of sulphuric acid and ethylic alcohol in a flask provided with a thermometer to a temperature of about 140°C. A continuous supply of alcohol is maintained through a funnel into the flask, the H_2SO_4 acting apparently by its presence only, so that the same acid is capable of converting a large quantity of acohol into ether.

Water and ether distil over into a bottle in two layers, the water below and the ether above. To purify the ether from alcohol and other impurities it is agitated with dilute sodic hydrate.

The alkali neutralises any sulphurous acid that may be present while the water combines with the alcohol. The upper layer of the liquid then consists of ether with a little water, which may be separated by allowing it to stand a day or two upon quicklime. It is then distilled in a warm bath, and condensed in vessels surrounded by water at 0°C.

There are two stages in the reaction: (1) the conversion of the sulphuric acid into ethyl, sulphuric, or sulphovinic acid, and (2) the decomposition of a fresh supply of alcohol into ether by this sulphovinic acid, thus:

$$(1)\quad \left.\begin{array}{c}Et\\H\end{array}\right\}O + \left.\begin{array}{c}H\\H\end{array}\right\}SO_4 = \left.\begin{array}{c}Et\\H\end{array}\right\}SO_4 + OH_2.$$

$$(2)\quad \left.\begin{array}{c}Et\\H\end{array}\right\}SO_4 + \left.\begin{array}{c}Et\\H\end{array}\right\}O = \left.\begin{array}{c}C_2H_5\\C_2H_5\end{array}\right\}O \text{ or } \left.\begin{array}{c}Et\\Et\end{array}\right\}O + H_2SO_4.$$

If, as it has been supposed, ether is formed by the abstraction of water from two molecules of alcohol by the sulphuric acid, the acid would become more dilute; but this is not the case. Moreover, if the sulphovinic acid, instead of being acted upon by ethylic alcohol, is acted upon by amylic alcohol, ethyl-amylic ether is formed, and not ethylic and amylic ethers separately, which would occur if the sulphuric acid simply acted by abstracting water. This ether is a transparent, colourless, mobile, volatile fluid, has a powerful and peculiar odour, and a hot taste. Its molecular weight is 74, and one litre of the vapour weighs 37 criths. It boils at 35°C, and fuses at −31°. Its specific gravity is ·74, and the specific gravity of the vapour compared with air is 37 × ·0693 = 2·564. When inhaled it produces intoxicating effects, causing sleepiness and insensibility, and it was used as an anæsthetic until superseded by chloroform.

The liquid is highly refractive. It is very inflammable, burning with a yellowish white flame forming water and carbonic anhydride, and requires six times its volume of oxygen for complete combustion, thus: $C_4H_{10}O + 12O = 5OH_2 + 4CO_2$. When mixed with air or oxygen it forms a dangerous explosive mixture, and care should be taken not to have flame of any kind in the vicinity when the vapours are condensing. When unconfined it vapourises so quickly as to produce intense cold. It is consequently used to produce artificial cold. A mixture of ether and solid carbonic anhydride produces a temperature of − 110° C., which is the greatest cold yet produced, excepting one of − 140° C. It can be mixed with alcohol in all proportions, and an equal bulk of water dissolves about ⅒ of its volume of ether. It is decomposed, when passed through heated porcelain tubes, into aldehyde and carbon, and at a lower temperature olefiant gas and acetylene are produced. When it is kept in a vessel in which there is air, acetic acid is formed by the absorption of oxygen. With H_2SO_4 it forms sulphovinic acid—with HNO_3 it forms oxalic and acetic acids and carbonic anhydride. With HCl, HBr, and HI it forms hydrochloric, hydrobromic, and hydriodic ethers. It is decomposed by sodium and potassium, hydrogen being given off.

It is decomposed by dry chlorine into dichlorinated ether $(C_2H_3Cl_2)_2O$ and perchlorinated ether $(C_2Cl_5)_2O$. It dissolves oils and fats, nitric oxide, ammonia, I, P, S, and auric, ferric, mercuric, and platinic chlorides. It also combines with acetic, butyric, caproic, venanthylic, pelargonic, and cupric acids, forming ethers named after these acids.

Haloid ethers are compounds of the alcohol radicals with the negative or chlorous elements, Cl, Br, I, F, or CN, which take the place of the hydroxyl.

From the monohydric alcohols are obtained the following series of haloid ethers, having the general formulæ—$C_nH_{2n+1}Cl$, $C_nH_{2n-1}Cl$, and $C_nH_{2n-7}Cl$. From the dihydric alcohols are obtained haloid ethers of the forms $C_nH_{2n}HOCl$ and $C_nH_{2n}Cl_2$.

From the trihydric alcohols are obtained haloid ethers of the forms, $C_nH_{2n-1}HO_2Cl$, $C_nH_{2n-1}HOCl_2$, $C_nH_{2n-1}Cl_3$, and $C_nH_{2n-1}OCl$.

As the monohydric alcohols only contain one semi-molecule of hydroxyl they form but one haloid ether. As the dihydric alcohols contain two semi-molecules of hydroxyl the negative element can displace one or both semi-molecules of hydroxyl, and thus form two classes of haloid ethers. As the trihydric alcohols contain three semi-molecules of hydroxyl the negative element can displace one, two or three semi-molecules of hydroxyl, thus forming three classes of haloid ethers. A fourth class is formed by substituting, instead of the three semi-molecules of hydroxyl, one of oxygen and one of the negative element.

Ethylic chloride, C_2H_5Cl, is prepared by saturating C_2H_5HO with HCl, and heating the mixture in a flask for two hours at 100°C., when EtCl forms the upper layer. It is passed through warm water and over calcic chloride, and into a tube kept cool by a freezing mixture, when it is condensed to the liquid state. It is prepared by heating a mixture of two parts of EtHO, three of H_2SO_4, and four of NaCl in a retort connected with a receiver, surrounded by water at a temperature of about 20°C., in which any water or alcohol passing over is condensed, and EtCl passes on to another flask cooled by water at 0°C. It is also prepared by heating phosphorus trichloride and anhydrous ether in a sealed tube to a temperature of 193°C., when phosphorus anhydride and ethylic chloride are formed thus: $3\,(C_2H_5)_2O + 2PCl_3 = 6C_2H_5Cl + P_2O_3$.

Chlorides of zinc, tin, &c., acting on ethylic alcohol produce this haloid ether. It is a colourless liquid having an agreeable odour, and is very volatile. Its molecular weight is 64·5, and a litre of its vapour weighs 32·25 criths. It has a specific gravity of ·87, and boils at 12°C. The flame produced by burning its vapour has a greenish tinge. Alcohol dissolves it freely and water slightly. When it and an alcoholic solution of potassic hydrate are heated in a sealed tube to 100°C., ethylic ether and potassic chloride are formed thus: $2C_2H_5Cl + 2KHO = 2KCl + OH_2 + (C_2H_5)_2O$. When it is passed through a red hot tube hydrochloric acid and olefiant gas are produced thus: $C_2H_5Cl = HCl + C_2H_4$. And when its vapour is passed over heated caustic potash, olefiant gas, potassic chloride, and water are formed thus: $C_2H_5Cl + KHO = C_2H_4 + KCl + OH_2$.

Ethyl iodide, C_2H_5I, is prepared by placing one part by weight of phosphorus in a retort with condensing apparatus, and a glass globe fitted into the tubulature with a tube and tap. And two parts by weight of alcohol are poured on five parts of iodine, and the solution poured into the globe. The phosphorus is melted by heating the retort in a water-bath, and the alcoholic solution of iodine is allowed to flow in small quantities into the retort. The first portion of the distillate is used to dissolve any iodine remaining undissolved in the vessel in which the mixture was made, and is transferred to the retort and the distillation continued. Or the phosphorus and alcohol are placed in the retort, and the iodine, dissolved by ethyl iodide, is allowed to flow into the retort slowly during the distillation. Or the alcohol is poured into the retort, and a little iodine added, and phosphorus introduced, very little at a time, until the solution becomes colourless. More iodine is added, and then a little phosphorus, until quantities in about the above proportions have been introduced. The violent action in the retort is moderated by putting the bulb in cold water. This mixture is distilled as before. The distillate is washed with water, digested in calcic chloride, and redistilled to obtain pure. It is a heavy colourless liquid, having a molecular weight of 156, and a litre of the vapour weighs 78 criths. Its specific gravity is 1·95. It boils at 72° C. When kept in a bottle not well stoppered it turns brown from the liberation of iodine. It also turns brown by the action of light. It is generally employed in the preparation of ethyl compounds. When it is put with water in a tube and the tube sealed and heated to about 150° C., it is decomposed into hydriodic acid and ether. Zinc decomposes ethyl iodide in a sealed tube, the radical ethyl being formed. When a mixture of ethyl and methyl iodides in equal quantities is treated with argentic oxide, ethyl-methyl ether is produced, thus: $C_2H_5I + CH_3I + OAg_2 = 2AgI + C_2H_5CH_3O$. When this iodide is heated with argentic oxide in a sealed tube, ether and argentic iodide are formed, thus: $C_2H_5I + OAg_2 = (C_2H_5)_2O + 2AgI$. When it is boiled with argentic oxide and water, argentic iodide and alcohol are formed, thus: $2C_2H_5I + OH_2 + OAg_2 = 2C_2H_5HO + 2AgI$.

The etherial salts correspond to the metallic salts of acids. The base must always be organic, but the acid may be either inorganic or organic. They are generally formed by heating together an alcohol and an acid, when water and an etherial salt are formed. The reaction is exactly parallel with that occurring when an ordinary basic oxide and acid are brought together, thus:—

$$KHO + NO_2HO = NO_2KO + OH_2 \text{ and}$$
$$C_2H_5HO + NO_2HO = NO_2C_2H_5O + OH_2.$$

However, they differ from the metallic salts in being soluble in alcohol and scarcely soluble in water, and in being generally uncrystallisable. Besides, they are generally volatile liquids having an aromatic odour. It is generally advisable in their preparation to act on a potassic salt by a sulpho-acid of the radical. The etherial salts are decomposed by water and alkalies, just like the metallic salts, thus:—$C_2H_3COHO + OH_2 = C_2H_5HO + HCOHO$, and $CH_3COEtO + KHO = EtHO + CH_3COKO$.

The monobasic acids form one etherial salt with each monohydric alcohol, two with dihydric alcohols, and three with trihydric alcohols. The dibasic acids form two series of etherial salts with monohydric alcohols, the normal, and acid. The tribasic acids form three series of salts, with monohydric alcohols, one normal and two acid.

Acetic ether CH_3COEtO, is prepared by mixing three parts of strong H_2SO_4 with two parts of alcohol and standing aside for a day. Melt some sodic acetate, allow to cool, and put four parts of this in small pieces in a retort. On this pour the mixture, and set aside for a day, and distil when the ether is given off thus: $2C_2H_5HO + 2CH_3CO\,Nao + 2H_2SO_4 2OH_2 + 2HNaSO_4 + 2C_2H_5C_2HO_2$.

It is dried with calcic chloride and redistilled. It may be prepared by distilling three parts of H_2SO_4 and eight of dry plumbic acetate, thus : $2C_2H_5HO + Pb2CH_3CO_2 + H_2SO_4 = 2C_2H_5C_2H_3O_2 + PbSO_4 + OH_2$. It is a colourless liquid, boiling at 74°C. It has a pleasant odour, and a burning taste. It dissolves resins and essential oils. It dissolves calcic chloride, forming a crystalline compound, which, on being heated, gives off the pure ether. Potassic hydrate decomposes it into alcohol and potassic acetate, thus : $CH_3COEtO + KHO = EtHO + CH_3COKO$.

Butylic ether, C_3H_7COEtO, may be prepared by shaking two parts of butyric acid, and two of ethylic alcohol, with one part of H_2SO_4, when the mixture on standing separates into two layers, the upper being butyric ether. Agitate the ether with water, and afterwards distil with calcic chloride. It may also be prepared by distilling together alcohol, sulphuric acid, and sodic butyrate—thus : $C_3H_7CONao + C_2H_5HO + H_2SO_4 = HNaSO_4 + OH_2 + C_3H_7COEtO$. Or by distilling calcic hydrate, alcohol, and sulphuric acid. Its molecular weight is 116, and a litre of its vapour weighs 58 criths. It is a liquid having a specific gravity of ·9, and boils at 119°C. It has the odour of pine apples, and is extensively used in confectionery for flavouring creams, custards, and ices. It is also used in doctoring bad rum. When inhaled it produces headache and irritates the air tubes of the lungs. It is sold as artificial pine apple oil, and is used in the manufacture of compound perfumes. **Hugh Clements.**

MR. BREAREY'S FLYING MODELS.

[14124.]—Since the famed or fabulous dove of Archytus, I suppose that flight has never been so satisfactorily demonstrated as at the Hartley Hall, Southampton, on the 6th February, upon the occasion of Mr. Fred. W. Brearey's lecture on "Aërial Navigation, before the members of the Polytechnic Institution."

Many forms of flight were there shown, the success of which was enhanced by the spacious hall in which the experiments were conducted. The model, however, to which Mr. Wenham alludes in letter 14083, March 8th, deserves more particular attention, which by the bye it did not fail to receive at the time, as signified by the applause which kept the lecturer dumb upon the platform for some time. This model, measuring 12½ feet from tip to tip of wing and 8 inches wide, traversed the whole length of the hall, and even towards the end of its flight made a considerable rise. The stroke of the wings was short and rapid, and accompanied with great fluttering noise. It must have struck many amongst the large audience that the means were here indicated of obtaining a fulcrum upon the atmosphere by man himself, as proposed by your correspondent.

Oxford-street, Southampton. **W. Williams.**

SOME ODDS AND ENDS.

[14125.]—Miniature Plants.—Slice the top off a carrot which has been kept all the winter, and place in a saucer with a little water. In a few days it will put forth young leaves. Or take a bunch of wheat ears, with four or five inches of stalk left on, and soak in water. Then place in a glass of water. Before long each grain will send forth shoots. This makes a very pretty ornament. It should be immersed in water every few days.

Toothache, to Cure.—An old-fashioned and very effective remedy is tincture of pyrethrum. Take a little on end of finger and rub on the gum where aching. With perseverance I have always succeeded in allaying the pain.

Bed Sores.—Those who have had much experience in nursing invalids will know how difficult it is to keep the skin whole when the sufferer is obliged to remain in the same position in bed for a long time. The skin should be examined from time to time, and where any redness appears the place should be rubbed with a slice of lemon. This will effectually prevent the skin breaking, and does not cause any sensation of smarting unless there is a sore place, in which case, of course, it would be cruel to apply it.

Chilblains.—Rub for ten minutes every night before a hot fire with common brewer's yeast. Chilblains ready to break have been known to be cured by this simple process.

Ginger Beer.—3½lb. loaf sugar; 2oz. bruised ginger; 1½oz. cream of tartar; juice and rind of six lemons (squeeze and slice); and 4 gallons of boiling water. Let it stand till "new-milk-warm," and then add 3 tablespoonsful of yeast (spread on toast and allowed to float). Let it stand all night, then strain and bottle. It is fit to drink in two or three days. **Glatton.**

PYROTECHNY.

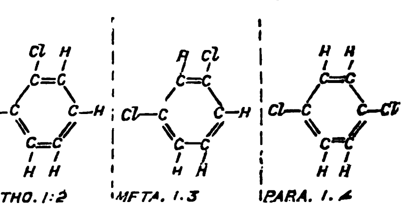
[14126.]—I have entirely dispensed with the use of powdered shellac in coloured fire compositions by the following *modus operandi* :—In preparing, for example, a composition containing chlorate of potash, nitrate of strontia, and shellac, I take the required quantity of ordinary shellac, and having added an equal weight of the strontia salt, fuse the mixture at a low temperature; when cold the fused mass is easily reduced to a fine powder, and the remaining ingredients may now be added. The principle is applicable to almost any formula, and as shellac in powder is an expensive article, and somewhat difficult to obtain, perhaps the above hint may be useful to amateurs who, like myself, reside at a distance from a large town. **Hy. C. Parlour.**

ISOMERISM OF METHYL AND ETHYLIC HYDRIDE.

[14127.]—If Mr. Clements (letter 14062, p. 625) will refer to Dr. Frankland's lecture notes he will, at p. 37, Vol. II., find the following passage :—

"There is some difference of opinion as to whether these compounds (hydrides of the radicals of the methyl series) are identical or isomeric with the radicals of the methyl series. Thus methyl and ethelic hydride both contain C_2H_6, and ethyl and butylic hydride both contain C_4H_{10}. The graphic formulæ exhibit no difference between these pairs of bodies respectively." . . . "Some experiments in connection with this subject appear to show that these compounds are isomeric. A difference between methyl and ethylic hydride can only be conceived on the supposition that the four bonds of carbon have not equal values in combination—an hypothesis which is not altogether unsupported by facts."

The formula of dichlorbenzene is $C_6H_4Cl_2$, and the graphic representation indicates the existence of three isomers, according to the positions of the two chlorine atoms in the benzene chain, thus :



All these varieties are known; they differ from each other chiefly in their melting and boiling points. A study of these formulæ will show Mr. Clements the meaning of my phrase, "a compound in which the union is effected by the bonds 1 : 2, will be different from a compound in which 2 : 4 are the joining bonds." I, of course, did not mean that two or four bonds of carbon were involved in the union, for only one bond of each atom is involved. If my friend is still in the dark on this subject, I will be glad to explain it by graphic representation. An argument in favour of the theory that the four bonds of carbon are not of equal value in combination, is found in the existence of two bodies, each having the formula C_2H_5Cl. One of them is a gas at —18° C. The other boils at 12 5° C.

Wm. John Grey.

COAL AND CORAL IN THE ARCTIC REGIONS.

[14128.]—In the first paragraph of letter 14079, "Amara" has undertaken to combat an argument I never raised. Nothing in letter 14018 should have led any one to think that I supposed that "gravity would prevent the condensation of gaseous or liquid matter from commencing in the coolest parts —viz., at or near the surface." I had expressly stated in the second paragraph of letter 13850, that "congelation would take place most readily at the poles."

I cannot think that my supposition would "forbid platinum, gold, &c., occurring at all in the external crust, confining all such heavy elements to the solid nucleus," because metals generally under favourable circumstances have such strong inclination for forming combinations with oxygen and alloys with other substances that they would be deposited in various forms as ores, crystals, &c.

In answer to "Amara's" third paragraph I do mean seriously to say that there is a sense in which the compression caused by gravitation must be "greatest at the surface and become nil at the centre." To endeavour to make good this assertion, perhaps I may be allowed to restate the law of gravitation as laid down by Newton. "Every particle of matter in the universe attracts every other particle with a force directly proportioned to the mass of the attracting particles and inversely to the square of the distance between them." If we suppose a globe as large as our earth to be perfectly spherical and of some homogeonous material, so that every segment of it should weigh exactly the same— if we further (for the sake of argument) suppose the centre of such a globe to be cut away in a circular cavity of 100 miles (or 100ft.) in diameter, and a solid ball, 80 miles (or 80ft.) in diameter, to be placed exactly in the centre of the cavity, by Newton's law it would remain suspended in the centre with equal space all round, and no inclination to press to either side; but if we suppose similar cavities to be cut out nearer the surface the smaller globes would, in these cases, press towards the greatest mass of matter in their vicinity, and this pressure would be greater the nearer the cavity was brought to the surface of the globe, because there would be a greater mass of matter towards the centre of the globe than towards the surface. In this sense "the compression produced by gravitation would not be the pressure of overlying rocks," and would not be greatest where the thickness of the rocks above is greatest.

I do not think any of the suppositions of the remaining portion of "Amara's" letter are justified by what I have said. We need not expect to find all volcanoes acting simultaneously, although I believe it is admitted there is strong sympathy shown between them on some occasions. Waves do not all run in one direction, either above or below the surface of the earth. As Humboldt long ago pointed out, "earthquakes are distinguished by rapidly succeeding vertical, horizontal, or circular (gyratory) oscillations. The shock is propagated chiefly in a linear direction by undulations, having a velocity from 20 to 28 miles in a minute, and occasionally in circles or ellipses of commotion. There are districts which belong to two intersecting circles."—"Cosmos," p. 191.

I am sorry to spoil the joke of the old lady and the rivers, but although I have never said or thought the mountains had formed the volcanoes, I must entirely dissent from the counter proposition of "Amara's" that the volcanoes have formed the mountains or other than a small proportion of them. If by "volcanoes" internal force is meant, which may arise either from a wave of the molten matter or from pent-up gases driven forward by such waves, I could agree.

I thought I had stated my proposition clearly enough that all the materials of which the earth is composed originally existed in the form of gases. I suppose if masses of molten granite were forced up through the sedimentary strata at the present day, forming new Alps, "Amara" would call the new comers rocks of the *latest* date. On my theory their present position, beneath the aqueous strata, would entitle them to rank as of greater antiquity than the rocks they displaced, or even of the solidified granites, through which they would also have probably forced their way.

It is difficult to ascertain exactly what the average pressure of the atmosphere has been during a long series of years over Great Britain, as observations taken once only in 24 hours are very imperfect and only admissible at all on the principle of errors in the one direction, correcting those in the other; but from the best information I have been able to obtain, it appears that the barometer stood higher in 1875 than it had done at any time since the records commenced in 1774. The accumulation is but slowly passing away, and earthquake-waves, assuming they do rise from this cause, need not be looked for, as "Amara" seems to suppose, daily.

As to what may be the thickness of the crust, Humboldt thought it might be 20 miles. This is probably under the mark. The pressure from within it is impossible to estimate, as the expansive force of imprisoned gases would, in most cases, be local, but the difference of external atmospheric pressure indicated by a difference of three inches of mercury, of which "Amara" appears to think but slightly, would be more than 2,600,000 tons per square mile.

The presumption is that an earthquake wave that would affect this country would arise on the other side of the Atlantic.

The master of a British ship has this week reported that on Jan. 29, in lat. 4·20 N., long. 21·45 W. (West Coast of Africa), he saw several submarine volcanoes throwing large columns of water about 100ft. into the air. Of course, such a circumstance is by no means unprecedented, but it is at least significant.

9th March. **W. G. Wenley.**

[No practical good will result from any further discussion of this matter.—Ed.]

MICROSCOPICAL.

[14129.]—I readily admit that not either myself or any one else has brought forward a clear and definite plan of measuring apertures correctly. I have not, however, yet done with the question, in which Drs. Nicholls and Bull have taken part in a gentlemanly spirit of inquiry. Want of leisure has prevented me from completing the experiments suggested by their remarks, by which I will give a clear demonstration of spurious aperture from extra rays, included by all the usual modes of measurement.

I note the insinuation of "Essex" that my desire is "to reduce the angle of other people's objectives." From the number of his writings on matters microscopical it is easy to gauge the depth and value of his knowledge on the subject; but, irrespective of this, I decline controversy with any one writing under an assumed name, and, further, the sheer contradiction and personality in his style of argument point him out as one to be avoided in discussion. "Essex" asks me a question, in characteristic style, concerning the "Binocular Eyepiece" described in "Hogg on the Microscope," to which I answer. This he says that he himself has attempted to put in operation and failed, and so would have it believed, for this reason, that the whole is a fallacy, and "not even a possible expedient!" At the time I gave ample demonstrations that by a properly-constructed adaptation it was possible to bisect the final emergent pencil at the eyepiece, and get a small object in both eyes with pseudoscopic or stereoscopic effect. Other forms of binocular microscopes then occupied my attention, so I proceeded no further with this. The idea has since been greatly improved upon by others, and "Binocular Eyepieces" intended for single tube microscopes are catalogued by American opticians, and some of my microscopical friends possess them. A "Binocular Eyepiece" is manufactured here by Mr. Ahrens, one of which he has recently presented to the Royal Microscopical Society, where it is accessible for the inspection of fellows desirous of seeing it. My own plan gave but a small field of view, and was pseudoscopic. In those of others this defect has been overcome by the aid of a form of erecting glass, and the arrangement works equally well with either high or low powers. **F. H. Wenham.**

VOLTAIC THEORY.

[14130.]—FOR some months past I have been investigating the "contact" electrical charge developed on iron and copper, and find that the electrical relations of these metals depend on the atmosphere surrounding them. In air iron is positive, on account. I believe, of its greater affinity for the oxygen of watery vapour, &c., in air. In air containing sulphuretted hydrogen copper is positive on account of its greater affinity for the sulphur. The similarity of the causes at work in these experiments and their analogues with liquid electrolytes is obvious. I should be glad if any fellow-reader can refer me to previous accounts of experiments on this subject.

Belfast. **J. Brown.**

LUCAS'S PARADOX.

[14131.]—I FEEL myself honoured by Mr. Lucas's letter (14085, p. 630, last volume), although I must say that I am unable to reconcile the paragraphs it contains; but this is doubtless owing to my own obtuseness. Of course the two triangles forming the rhomboidal vacancy, extending diagonally across the rectangle, have a common hypothenuse; therefore these triangular vacancies are in contact with each other throughout, and moreover an hypothenuse (in a plane triangle) *must* be perfectly straight, and the lines forming the squares apparently coincide when the outside boundary of the figure is made rectangular. Mr. Lucas then says he should be glad to compare his calculations with mine, "with a view to determine the exact proportion between the square and the parallelogram which would yield the straightest diagonal with the least distortion, or, in other words, what proportion would give a rhomboid of minimum altitude to be disposed of." But it is the continuation of this sentence that I cannot understand. I am to note that the rhomboid, whose area I calculated by logarithms, "does not exist in the puzzle which is published in a very neat and correct form by the London Stereoscopic Company." All I can say to this is, that either the puzzle published by this company differs altogether from the description given by "C. W. F." on p. 479, or that this description has been incorrectly given, for in the figure there shown the vacant rhomboid does and *must* exist for the reasons stated in my letter (p. 532), otherwise we should have 64 square inches of inelastic material covering 65 square inches of space, which is absurd.

To come, then, to the calculations I have made to discover the proportions which would give a minimum of distortion, I find that, for Mr. Lucas's arrangement the square of 64 squares is the best, and that any other number gives a vacant (or twice covered) rhomboid of great proportion. In this the altitude is ·117042, or little more than one-tenth of the side of 1 square, and the area is, of course, 1-65th of the entire rectangle; in other words the paradox is the most "atrocious swindle" in its present state. By Mr. Lucas's arrangement I mean that, where in the square figure a fundamental square of 1 or more squares is taken in the lower right corner, from the upper left corner of which a right line is taken to a point in the top of the figure distant from its left top corner, the same number of squares as in the side of such square taken. Also a horizontal right line is taken in prolongation of the top of such square across the figure. Lastly, a diagonal right line is taken across the lower rectangle so formed. There may be other methods of division which might lead to analogous results, but I have simply investigated this particular arrangement. The simplest and next best scheme is a square of 9 squares, where what I call the fundamental is 1 square. As will be seen below, the vacant rhomboid is 1-10th, but, on the other hand, it is more simple to make. To take squares of even numbers first, the best results I tabulate as follows:

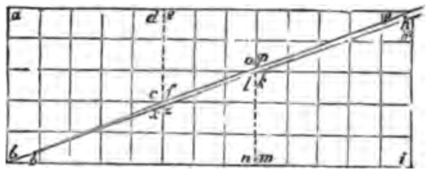
Side of square.	Fundamental.	No. of squares in square fig.	No. of squares in rectangle.	Proportional difference.	
4	1	16	21	$\frac{5}{21}$	rhomboid vacant
6	2	36	40	$\frac{1}{10}$	do. do.
8	3	64	65	$\frac{1}{65}$	do. do.
10	4	100	96	$\frac{1}{24}$	do. twice covered

To find resulting squares in rectangle, I made the following formulæ:—Let a represent side of square. Then, if a be an even number, the number of squares in rectangle is $= (1\frac{1}{2}a + 1)\left(\frac{a}{2} + 1\right)$; but if a be an odd number it is $= (1\frac{1}{2}a + \frac{1}{2})\left(\frac{a}{2} + \frac{1}{2}\right)$.

Side of square.	Fundamental.	No. of squares in square fig.	No. of squares in rectangle.	Proportional difference.	
3	1	9	10	$\frac{1}{10}$	rhomboid vacant.
5	2	25	24	$\frac{1}{24}$	do. twice covered
7	3	49	44	$\frac{5}{44}$	do. do.
9	4	81	70	$\frac{11}{70}$	do. do.

Rye-hill Park, March 9. **George Bell.**

[14132.]—I WONDER that none of your numerous correspondents have hit on the solution of this paradox. Explanation is very plain on the simplest mathematical or geometrical principles.



In section of upper portion of 8 by 5 squares, the diagonal passes through a space of 2 by 5 squares as b to c (or k to h) an inclination of 2 : 5. In lower section of 3 by 8 squares, the diagonal runs through 8 squares and 3 in height, and inclination is 3 : 8. The difference is $\frac{2}{5} - \frac{3}{8} = \frac{16}{40} - \frac{15}{40}$.

The proportion is 15 : 16, or a gain of $\frac{1}{16}$ in the latter case, between the inclination of the two diagonals. $\frac{1}{16}$ gain in each section of 8 squares $= \frac{8}{16} = \frac{1}{2}$ square, the same amount of gain in the lower section of the 8 squares $= \frac{8}{16} = \frac{1}{2}$ square. Total gain of space $\frac{1}{2} + \frac{1}{2} = 1$ square. Now, in arranging the 4 segments, making the apparent 13 × 5 squares, there is an open space or slit left blank along the diagonals of different inclinations, which are united in reverse order, and making a large obtuse angle at the junction opening up from b to c (or x), and reversed order from g to p (or h to k) till the opening reaches a height of $\frac{1}{5}$ square. Slide up $b\ x$, keeping the same angle of indicator 3 : 8 (*i.e.*, keeping $b\ n$ 11 to $m\ i$ the base) till it reaches opposite $p\ g$. You have a section of 5 parallelograms $\frac{1}{5}$ height $= 5 \times \frac{1}{5} = \frac{2}{5}$ squares, as marked by dotted lines k to n. The portion, $f\ o\ l\ x$, is 3 squares, each $\frac{1}{5}$ deep, and running through 1 square $= 3 \times \frac{1}{5} = \frac{3}{5}$; $\frac{2}{5} + \frac{3}{5} = \frac{5}{5} = 1$ square gained by vacant space, occasioned by diagonals at angle $\frac{2}{5}$ opposite to those of angle $\frac{3}{8}$ till having passed at each end through 5 squares the parallel lines of angle $\frac{3}{8}$ run 11 through 3 squares. **J. K. Jennings.**

Langham, Oakham, March 11.

[We have devoted all the space we can spare at present to this and similar paradoxes.—ED.]

DISTILLATION OF SHALE.

[14133.]—LEAVING "Justitia," whom I do not know, to reply for himself, I should feel obliged if "Jup. Rex." would quote the passage in which my theory of the formation of coal has, he thinks, been anticipated. I had hitherto supposed that theory—which I have termed cumulative resolution—to be exclusively my own. All modern tables of products of the distillation of coal are extensions and corrections of a compilation made by Hegman in 1863. The one published in my "Manualette" was revised and extended to within about two months of the date of publication. **Edmund J. Mills.**

Anderson's College, Glasgow.

REPLIES TO QUERIES.

◆

*** *In their answers, Correspondents are respectfully requested to mention, in each instance, the title and number of the query asked.*

[31732.]—**Preparing Wood for Polishing.**—As the original querist in reference to this, I must thank the several correspondents who have so kindly interested themselves in the matter. I may add that I sized one part of my job, and tallowed and plastered the other part, and I must say I was better pleased with the latter process, but the former was used on new mahogany, the latter on old. This may have made a difference. I shall not forget the weak glue process next time.—C. O.

[31781.]—**Midland Locomotives.**—To "G. L. P."—I hasten to acknowledge that I have been mistaken as regards the necessity for reversing some locomotives previous to their going ahead, as I had not taken into consideration the amount of "lap" which is now in vogue for high-speed engines, and which is sufficiently explained in the letters of J. Baines, S. Mayer, and others, on p. 607.—A., Liverpool.

[31800.]—**Spring Mattress.**—The answer of "F. E. W." (p 631), appears to be by a practical hand, but I think his method might be improved upon. Some years ago I had a full-sized spring mattress made almost exactly as "F. E. W." directs, but in about a year or two the "strong strings" connecting tops of springs broke in many places, through contact and friction with rusty springs. The "strong canvas" cover, too, wore into holes where resting on the springs. Any one can imagine the consequences, but the reality must be "slept upon" to appreciate it. My improvements were:—1. To substitute stout webbing for the strings, interweaving the lengths with the widths, and both with tops of springs, and nailing the ends to outsides of frame. That was done 8 or 9 years ago, and the mattress has required no repairs since. I don't know whether the plan is new or not, but I should suppose not, as it is such an obvious improvement. Yet I have seen good (*i e.*, dear) spring chairs and couches done on the string method. Webbing, of course, costs a few shillings more. 2. To substitute a piece of felt carpet for the "strong canvas" to cover the springs. 3. To have the hair stuffing made up into a thin separate mattress, to lay on springs, instead of "tacking down all round." Thus the springs can be easily got at, when requisite.—DAGHBERT.

[31854.]—**Mixing Borax with Starch.**—Seeing that this has not been answered quite accurately by two gentlemen, I give my own knowledge, which I base upon experience. The purpose of adding borax to starch is to thin (not thicken) it, and so admit of the linen being more evenly starched than if the starch were gelatinous and thick. The borax does not cause the linen to be stiffer, nor yet more limp, but it produces gloss. As to preventing sticking I cannot speak confidently. In nine cases out of ten sticking is caused by the iron being too cool. The iron should be so hot as to form a stratum of steam between itself and the linen, though not so hot as to scorch. I have not tried all starches, but, as far as I know, potato is the only starch which will "thin" with borax. It may be easily recognised by pressing the finger on it (being in a powder), when a peculiar crackling will be noticed, which cannot be described, though most readily felt. The only objection I have to potato starch is, the fact of linen stiffened with it being hygroscopic, and requiring to be kept in a dry warm place. The plan adopted here is to mix about a quarter of a teaspoonful of borax to every 2 teaspoonfuls of starch. There is one large maker who manufactures and sells potato starch whose name I forbear to mention, lest some "good-natured friend" should consider this a puff, and say as much.—W. S. TRAVIS.

[31878.]—**Bogie Tank Engines on the S. and D. Joint Railway.**—In my previous communication on this subject I simply confined myself to a refutation of the statement made by "C. E. S.," that engines had been built for the above-named line at Nine Elms, and to a doubt as to the accuracy of his statements that any such engines had been built at Derby. That refutation I maintain, and that state of dubiousness with respect to Derby still exists in my mind, only in an intensified form. I know nothing about the S. and D. engines to which "C. E. S." refers as roaming over the country between Manchester, Brent, and Clapham Junction, and fail to see what that has to do with the question at issue, which is a simple matter of fact—namely, whether or not any S. and D. engines have been built at Nine Elms. In denying the truth of the alleged engine-building operations at Nine Elms, I will go a step further, and inform "C. E. S." that not only have no engines been built at Nine Elms for the S. and D. line, but that no engines of any kind or for any purpose whatever have been built at Nine Elms since 1874, which was long anterior to the transfer of the S. and D. line to the joint owning companies. Some S. and D. engines have lately been built by a Bristol firm, and this is what "C. E. S." may possibly be running his head against; but I think I may fairly retaliate upon "C. E. S." his not over courteous advice, that he "should first make himself acquainted with facts" before venturing to contradict so positively one who always knows what he is writing about, and who never writes about anything but what he thoroughly understands. That is the principle upon which this writer always acts, and he thinks it is a proper one, and defies either "C. E. S." or any other correspondent, past or present, to establish a charge of inaccuracy against him, and thus cause the faintest blush to rise and suffuse the face of—THE NEW CLOCK.

[31809.]—**Oil for Flute.**—"H. G. M." is quite correct in supposing that no oil is requisite for the pads of the Boehm flute. I am no flute-player, but I know that no leather will remain soft and pliable long which is exposed to alternate wetting and drying. My experience with glycerine led me to recommend the trial of it for the purpose. Should "H. G. M." have an opportunity of trying it, perhaps he would kindly let us know the result.—W. S. TRAVIS.

[31945.]—**Time of Fall to Sun.**—The simplest way of finding this is as follows:—Let t be the time of falling to the centre from a distance a, and let T be the time of one revolution round the sun at the same distance; then, by the well-known formulæ we have—

$$T = \frac{2\pi a^{\frac{3}{2}}}{\sqrt{\mu}} \text{ and}$$

$$t = \frac{\pi a^{\frac{3}{2}}}{\sqrt{\mu}\, 2^{\frac{3}{2}}} = \frac{T}{4\sqrt{2}}$$

by the first formula, or supposing $\frac{T}{4}$ to be 91·314 days, we get $t = \frac{91{\cdot}314}{\sqrt{2}} = 64{\cdot}57$. The above method is the simplest, inasmuch as it only requires that the length of the year should be known, and, therefore, frees the result from such errors as might arise from a wrongly assumed value of the sun's distance, &c., as well as what might arise from complicated multiplications and divisions. Mr. Vino seems to think that the time which a planet would take to fall to the sun's centre is one-fourth of its periodic time. This, however, is not correct; the true rule is to divide one-fourth the periodic time by the square root of two. Treating it in this way we get a result pretty closely agreeing with that in Chambers's "Descriptive Geometry," which was perhaps obtained by a different method.—W. G. P.

[31976.]—**Compound v. Ordinary Condensing Engines.**—The relative advantages of these engines must depend upon the primary pressure employed in the boiler. For pressures under 20lb. per square inch there is scarcely anything to be gained by compounding engines, and in cases where this has been done, by the adaptation of an additional and larger cylinder, disappointment has been the result, unless the boiler pressure has been considerably increased at the same time. I was once acquainted with a manufacturer who adopted the converse of this course. He possessed a condensing engine of 20 h.-p., which, from the addition of extra machinery, gave out insufficient power for the work it had to perform. The pressure in boiler was low, and it was not thought advisable to increase it; accordingly an independent non-condensing engine, working with about 60lb. steam, was put up at some distance from the other to act as an auxiliary. The exhaust steam from this engine was conveyed into the boiler of the condensing engine, to be used up again therein, and the statement made to me by the proprietor was, that only about half the quantity of feed water was then required in the latter engine, and more than half the fuel saved. If steam is employed in a condensing engine at a good economical working pressure—say, 200lb. per square inch—a compound engine becomes a matter of necessity, for if this steam is to be expanded some fifteen times, the shock and strain caused by letting the whole pressure on to a single large piston would be so great that enormous strength and weight of parts would be required to stand it. But there is a loss in full expansion from these high pressures which partly neutralises their advantages. The mere act of expanding, or as work performed, in itself produces a degree of cold which reduces the final volume and pressure. This may be partly compensated for by heating or steam-jacketting the cylinders, by which heat will be absorbed by the steam during expansion therein. But a preferable method is to carry the steam from the high-pressure cylinders into an intermediate tubular chamber of considerable capacity, like a secondary boiler, which may be heated by the waste heat from the furnace. From this it is conveyed perfectly freed from condensed water, and in a heated and fully expanded state, into the low-pressure cylinder. I introduced these engines previously to the year 1862, and obtained a prize medal for the one exhibited at the International Exhibition in London at that date. I usually made the large cylinder about four times the capacity of the small one, with the same stroke in each. These, by properly regulating the expansion in both, gave off nearly the same power with a boiler pressure of 150lb. per square inch. The two cylinders worked cranks at right angles on the same main shaft, and the pressure in the interheater was nearly uniform if made of sufficient capacity. It was often argued that there must be a loss of power by expanding the steam from the high-pressure cylinder into a large interspace in the passage to the low-pressure one; but such is not the case, for if the expansion in the high-pressure cylinder is so adjusted that the terminal pressure at the time of exhaust equals that maintained in the interheater, there is no interval or sudden jump from a higher to a less pressure. Several pairs of these engines have been fitted to sea-going steamers, with a boiler pressure of 150lb. to the square inch. They invariably had surface condensers, which performed their duty perfectly with a steady vacuum. A small quantity of soda is introduced with the feed water in order to protect the boiler from the corrosion consequent on using pure water alone at the pressure and temperature. One pound of soda for each ton of coal consumed is the proportion now used. Zinc was originally tried, but was abandoned on account of the expense and trouble attendant upon its use, and it is now an acknowledged fact that a pound of soda is quite as effective in preventing boiler corrosion as a pound of zinc.—F. H. WENHAM.

[31994.]—**Pompeii.**—A good work is "Pompeii," &c., &c., edited by Thomas H. Dyer: G. Bell and Sons, York-street, Covent-garden, London, 1875.—G. J. W.

[32036.]—**Wheel-Making.**—"J. L. B.," in his query addressed to me, p. 608, No. 675, gives the most unique explanation of the cause of dishing wheels that ever I heard. Is he not aware that, however much a wheel is dished, the axle is bent downwards, so that the bottom spoke of the wheel would be perpendicular on level ground? There are no ruts and ditches he speaks of in London, and yet wheels are dished here. If his theory were true, 'bus-wheels would only require to be dished on the near side, the streets being convex, and they keeping continually on that side. I cannot see much advantage in the contrivance given by "J. B. C." for boring stocks. It would take longer, and he would soon spoil his twisted bit when it came upon the iron bolt through the centre. How would he get pressure upon the brace? The trueness of the mortices depends more upon the work of the buz than the boring, and with very little practice one could bore true without such an appendage, and I am sure much quicker.—F. W. SHEARING.

[32116.]—**Polishing Backs of Leather Bindings.**—Please read "glaire" for "glazed."—ZAEHNSDORF.

[32119.]—**Speed of Trains.**—The following classes of locomotives are used on the L.N.W. Railway for the working of the Irish mails:—No. 1. "Lady of the Lake" class, 7ft. 6in. drivers single, dimensions of which have appeared before. No. 2. Webb's new coupled 6ft. 9in., 4 wheels coupled, cylinders 17 × 24; in fact, same build as Precursor class, for dimensions of which see ENGLISH MECHANIC, Vol. XXIV., p. 317. No. 3. Ramsbottom's 4-wheel coupled 6ft. 6in., cylinders 16 × 24. The following is the working of the engines for the week ending Saturday, March 23, 1878. The figures (1), (2), (3) refer to which class the engines belong:—

DOWN.—7.15 a.m. ex Euston.

Euston to Crewe.

Date.		Name.		No.
March 25	...	Princess Beatrice (2)	...	2,190
26	...	Salopian (2)	...	2,193
27	...	Avon (2)	...	2,189
28	...	Precedent (2)	...	2,175
29	...	Alma (2)	...	2,185
30	...	Penrith Beacon (2)	...	2,187

Crewe to Holyhead.

March 25	...	Waverley (1)	...	806
26	...	Pioneer (3)	...	1,212
27	...	Shah of Persia (3)	...	942
28	...	John Ramsbottom (3)	...	1,211
29	...	The Queen (3)	...	1,213
30	...	Clarendon (3)	...	787

8·25 p.m. ex-Euston.—Euston to Stafford.

March 25	...	Stephenson (1)	...	279
26	...	Soult (1)	...	804
27	...	Monarch (1)	...	230
28	...	Stephenson (1)	...	279
29	...	Soult (1)	...	804
30	...	Monarch (1)	...	230

Stafford to Holyhead.

March 25	...	Monarch (1)	...	230
26	...	Stephenson (1)	...	279
27	...	Soult (1)	...	804
28	...	Monarch (1)	...	230
29	...	Stephenson (1)	...	279
30	...	Soult (1)	...	804

The following engines, all belonging to No. 1 class, are working the up mails during the current week (as above):—

Wellington, 218	...	Outram, 719
Russell, 111	...	Lily, 222

N.B.—The working of the 7.15 ex Euston to Crewe. The engines named will work the train, though probably not in the order given.—EGERIA.

[32129.]—**What is It?**—The jelly-like substance found in fields, &c., is, I should think, frog-spawn. It usually occurs in damp places, unless thrown about by boys, and consists of a great many somewhat globular masses, each having a dark speck in the centre. Near the sea, jelly-fish are sometimes found on the fields, having been carted in with seaweed as manure. They are sometimes stranded on the coast in great numbers.—J. H. C.

[32141.]—**Picture Frames.**—After reading the method proposed by "C. W. P." for jointing up picture frames I venture to assert that no one could put one made of German moulding accurately together in such a fashion. The method as described by me is that daily in use in some of the most extensive concerns in this town, and I have ma
hundreds myself as thus described. It is the
of "shooting" each end on the opposite sid
one is "shot" lying on its back, and the o
is then "shot" with its gilt edge down, wh
reverses any error in the plane, and so ta
frame out of winding by dividing the errors
the joints. This is one of the wrinkles so u
amateurs. There is another which may bene
one, simple as it is. It is impossible to sq
any article if the square is caused to follow e
continuously round, as the original error is
each time. The square must be applied to t
site sides alternately.—A., Liverpool.

[32141.]—**Picture Frames.**—A very good
clamping picture frames was given in No.
you can make an arrangement yourself
minutes, which will be all you can wish.
piece of any wood, 9 or 10in. long, and 2½ squ
rebate one angle 1¼in. deep and wide, no
off the opposite angle, and cut the piece i
pieces of equal length. Having accurately
your frame lay it upon your bench, and pu
the pieces of wood at each corner, the re
course, fitting upon the angle, and wind a
quarter inch cord twice round the frame,
corner pieces, and tie it at one corner. N
four pieces of smooth wood, 6in. long, and
thick as a carpenter's pencil, insert them
the cords, one on each side of the frame,
twisting the cord with them you can make it
as you like, and, having seen that your mi
good, and your frame does not wind, lay it u
bench, and pull out the bits of wood without
ing the cord or corner pieces, lift out the fra
put a little glue upon the mitres, and re
quickly as possible in the same position as
before, replace the pieces of wood, and give
a few turns, adjust your angles and tighten
off any glue with a sponge and warm wat
leave it to dry; you may then brad them, or,
still better, make a fine saw kerf in each an
insert a bit of thick veneer with glue.
tallow on the bits of wood will prevent the
ing to the frame. I make lots of frames t
and never have any difficulty.—H. A., Lisbo

[32150.]—**Angling.**—Salmon-spawn is a
lent bait for trout and chub. Cheese past
some old Cheshire cheese and the crumb
bread, and mix them up to a tolerable degre
sistency; this is good for chub. White brea
Knead crumbs of white bread, dipped in h
the palm of your hand until it attains a g
sistency; it is good for tench, carp, roach, a
Wheat paste: Get some new wheat, rem
husks, and then crush in a mortar; then po
milk or water over it, and gently simmer th
sition. When cold, it will be something lik
Put a small piece on the hook. Sheep's bl
saffron make a good paste for roach, blea
perch, and trout. Another: An excellent pa
be made by dipping the crumb of new white
the liquor in which chandlers' greaves h
boiled, and adding a little of the greaves, an
ing up till stiff; this is first-rate for barbel.
mixing up the above be sure to do it wi
hands.—TELESCOPE TELE.

[32162.]—**Noiseless Gear for Lathes.**
the slow motion is working, are the lever
fixed? I cannot quite make out how the sa
($f\,g$) are connected to the lever (P). A
would make all quite clear, as it is rather
in my paper of last August. And what w
about the cost of the apparatus to an
lathe, with pulley fixed on mandrel? And
say the stem (I), to which the top of the lev
are jointed, rises and falls in the bed (K
lathe-head. I cannot make it out.—TE
TELE.

[32168.]—**Latitude and Longitude.**
number of feet in a geographical mile, men
my reply, page 611, No. 675, was obtained fro
tables. Deductions from Airy's and Capta
Clarke's dimensions of the earth give res
6,086·5ft. and 6,087·2ft. as the approximate
to a geographical mile.—FULL AND BYE.

[32170.]—**Pianoforte Playing.**—A
pianoforte compositions, published by Forsy
Regent-street, edited and figured by Charl
would be suitable for "F. H."—F. F. C.

[32170.]—**Pianoforte Playing.**—"Fi
reply to "F. H." is the most misleading
have ever seen in the ENGLISH MECHA
recommend Beethoven's sonatas to a beg
equivalent to putting Virgil (in the origi
the hands of a child just learning to spell.
aside the so-called "sonates faciles," com
Beethoven's boyhood, it is as difficult to
simple air" as to discover "the mysteries f
he is so famous," whatever that may mean
hoven's sonatas should be taken after Hay
Mozart's; and a course of J. S. Bach wo
tainly help to smooth the way to a work
as a whole, is the crowning glory of c
pianists, as it is the slough of despond to
approach it without due preparation. Equ
chievous is "Fiddler's" doctrine as to m
precision. Mozart said there were three gre
sites for a good player, the head, the heart,
tips of the fingers, meaning, by the last,
ability. If there were no necessity for this w
not see so many great composers occupyi
time and thoughts with the production o

technical pieces; and I hold that a course of mechanical exercises is a necessary preliminary to the study of classical music. "Fiddler" says to "F. H." do get Beethoven's sonatas; my advice is that of *Mr. Punch* to persons about to marry, "don't." At least, not for the next two or three years. I trust "Fiddler" will forgive me for contradicting him; and I am sure he will eventually agree with me if he will peruse the book I have recommended to "F. H." —viz., "The Art of Pianoforte Playing."—NE SUTOR.

[32178.]—**More Telephones.**—I have found it answer fairly well to twist the wires together as "Junction" suggests, but why not make sure of the job by soldering? This can easily be done in the following way, which I first saw mentioned in these pages, and which I have frequently used with success: Clean the ends of wire to be joined with emery cloth and twist together; now take a piece of tinfoil about as big as a man's thumb-nail, and putting a pinch of powdered resin on it, wrap round joint, the resin being inside. Hold in flame of candle till the resin takes fire, and when it is burnt out the joint is made.—GLATTON.

[32180.]—**Throstle Bobbin.**—In reply to "Overlooker" (p. 633, Vol. XXVI.), as to whether a full or an empty throstle bobbin runs the fastest, I quite agree with him when he says, "If it ran quicker when full of yarn it would snarl or go slack." But, as regards the drag caused by the action of the bobbin upon the washer cloth, I entirely disagree with him, inasmuch as the drag or friction is only increased by extra weight of bobbin, assuming that the washer cloth is all of the same kind.—30 YEARS' EXPERIENCE.

[32212.]—**Old Oak.**—Oak may be made to assume the appearance of age, and figure almost invisible before being beautifully brought out, by exposure to the vapour of ammonia for from 24 to 48 hours. I have recently coloured two new ends for an old oak cabinet. I kept them in a box for two days, with two large saucers containing each about a wine-glassful of liquid ammonia—the liquor ammoniæ fortissimus of the shops—changing the liquid about every twelve hours, or as soon as it had nearly lost smell. The colour is permanent, and quite through the board (¾in. when planed). If the work cannot be exposed in this way, I should suggest the employment of powdered carbonate of ammonia, mixed with powdered quicklime, and applied dry. This would disengage the gas slowly. It should be covered with oilskin or varnished paper to prevent loss of gas. Should the second plan be tried, I shall be glad to hear the result. Do not put the liquid on the wood, as the result would be a failure. The colour is much improved by a dressing of linseed oil, made a very deep red with alkanet root.—JUX.

[32214.]—**Violoncello.**—Varnish is put on an instrument to prevent the wood absorbing moisture. If you remove the varnish the 'cello will become heavy in weight, and dull in tone. Therefore varnish or polish over the place, and never mind appearances. I should transpose some airs into the bass clef, and play them.—FIDDLER.

[32216.]—**Boiler.**—We have three Galloway boilers the same size as yours, and they go first along the sides of boiler, then under the boiler to chimney. Galloways set their boilers up in this way.—C. O.

[32218.]—**G.N. Railway Engines.**—I believe that 264 is the only one of Messrs. Fowler's 7ft. coupled engines which has not been altered; the remaining five, numbered 265 to 269, being now converted into "single" engines. I am informed that these are the only 7ft. coupled engines which have been built for the G.N.; and should like to know if this is the case. They had outside bearings and cranks. The later patterns, with coupling rods working on the wheels direct, have, I believe, 6ft. 7in. wheels.—G.

[32235.]—**Refuse Fish for Manure.**—The preparation of fish manure is somewhat as follows:—Exposure to hydraulic pressure to extract the oil, and then a slow drying in stoves constructed specially for the purpose. "Fish" will find an exhaustive description in Bertram's "Harvest of the Sea," with some data as to the financial value of same.—W. S. TRAVIS.

[32241.]—**Conjuring.**—The way this trick is done is as follows:—The rose is permanently dyed red. Before the trick is performed the rose is placed in a wide-mouthed bottle containing liquid ammonia, which bleaches it. It is then taken out, and shown to the audience as a white one. It is then fanned, which causes the vapour of the ammonia to evaporate, and it returns to its original red colour.—HATY.

[32277.]—**Diatoms.**—I believe I have the same diatom under the name A. Kittoniæ, so named after Mr. F. Kitton, of this city, a very clever microscopist. If Mr. Smith (see p. 22) would kindly send me a small quantity of the diatomaceæ, I should like to compare my slide with his.—G. W. BRADY, Carrow Works, Norwich.

[32282.]—**Violoncello.**—Please get a new nut and tail-piece, both of ebony, and placed at a good elevation, when, unless the sides are loose, the remedy will be complete—good strings, too.—FIDDLER.

[32285.]—**Indiarubber Binding.**—Thanks to "Polaris;" but the information he gives is not what I want. I have tried his plan, and it does not answer. It appears there are two kinds of this binding—one with the simple indiarubber, which is worthless; and another done with a cement (the composition of which I want to know), which will stand for years fair wear and tear. I once asked my bookbinder what this cement was. He said it was a mixture of glue and indiarubber, which was all "bosh," as such a mixture, as a cement, could not be made.—JAMES ROSE.

[32285.]—**Indiarubber Bindings.**—Please refer to Nos. 551 and 553 (1875).—ZAEHNSDORF.

[32289.]—**What is a Metre?**—From reading your paper I find that many of your readers do not quite understand the French metrical system now in vogue in many European countries. The following may be of interest to them, explaining why the exact measures were adopted:—When the great Revolution broke out in France the French savants wished to profit by the blow which it gave to all effete institutions, in order to substitute for the numerous measures then in use a unique system of measurement, every part of which should be taken from one fundamental unit; and in order that this new system should have more chances of becoming universal, so as to make the confusion arising from the use of different measures to cease, it was thought necessary to take its basis from Nature—the dimensions of the earth. But in order to fix the length of the fundamental unit on which the whole system was to rest it was necessary to know exactly the length of a complete meridian. Some French astronomers accordingly measured the meridian of Paris right across France. This great operation was accomplished in 7 years (1792-1799) in the midst of the storms of the Revolution. From the measurements obtained the length of a complete meridian round the earth, through both poles, was calculated, and the 40-millionth part of it formed the metre—the fundamental unit of the new metrical system, which was introduced into France at the end of 1801. From this metre (the unit of length) the units of surface, volume, capacity, and weight are derived, and all the other measures are multiples or submultiples of these. The units of the multiples have Greek names prefixed and of the submultiples Latin names; thus: multiplying, deca means 10 times; hecto, 100 times; kilo, 1,000 times; myrio, 10,000 times. Dividing: deci means $\frac{1}{10}$th part; centi, $\frac{1}{100}$th part; milli, $\frac{1}{1000}$th part. Length: The unit of length is the metre; it is the 10-millionth part of the distance from the pole to the equator measured along the surface of the ocean.

1 metre = 39·37079000 inches
= 3·28089917 feet
= 1·093633056 yards.

Sub-multiples.
1 millimetre = $\frac{1}{1000}$th metre,
10 millimetres = 1 centimetre = $\frac{1}{100}$th metre,
10 centimetres = 1 decimetre = $\frac{1}{10}$th metre,
10 decimetres = 1 metre,

10 metres = 1 decametre,

Multiples.
10 decametres = 1 hectometre = 100 metres,
10 hectometres = 1 kilometre = 1,000 metres,
1 kilometre = 1,093·633056 yards.

This will serve as an example how all the other measures are named. Surface: The unit of surface is a square metre.

1 square metre = 1,550·05910079893 square inches,
= 10·76429035277 square feet,
= 1·19603326142 square yards,
100 square millimetres = 1 square centimetre, &c.
1 square metre = 1 centiare,
1 square decametre = 1 are,
100 square hectometres = 1 square kilometre,
1 hectare = 11,960·3326142 square yards
= 2·4711431 acres,
1 kilometre = 247·11431 acres.

The multiples and submultiples of the "are" are generally used. Volume: The unit of volume is the cubic metre.

1 cubic metre = 61,027·051612369490 cubic inches
= 35·316580794295 cubic feet
= 1·308021510909 cubic yards.
1,000 cubic millimetres = 1 cubic centimetre,
1,000 cubic centimetres = 1 cubic decimetre,
1,000 cubic decimetres = 1 cubic metre = 1 stere.

The multiple and submultiples of the stere are used generally. Capacity: The unit of capacity is the litre.

1 litre = the capacity of a cubic decimetre
= 0·22009668 gallons
= 1·76077344 pints
1 kilolitre = capacity of 1 cubic metre
= 220·09668 gallons.

Weight: The unit of weight is the gramme.

1 gramme = the weight of the cubic centimetre of distilled water at 39·2° Fahr., its point of greatest density
= 15·4323487 grains,
1 kilogramme = 1 000 grammes
= weight of a litre of distilled water
= weight of a cubic decimetre of distilled water
= 15,432·3487 grains
= 35·27394 ounces
= 2·2046212lb. avoirdupois.

—C. B. M.

[32289.]—**What is a Metre?**—A metre is, by definition, 443·296 "lignes" of the "Toise of Peru," the toise being a standard bar which is correct at a temperature of 16·25° C., corresponding to 61·25° F. A toise = 76·734402 inches, the inch being $\frac{1}{36}$th part of the English standard yard at temperature 62° F. Hence we hear a metre = 39·370432 inches (Lieut.-Col. Clark on "Comparison of Standards," Philos. Trans. Royal Society, 1866, 1875). The British Commission on Standards found the commercial metre to be equal to 39·38203 inches. The standard kilogramme, called the "Kilogramme des Archives," = 2·20462125 standard platinum pounds (Professor W. H. Miller on "Construction of New Standard Pound," Philos. Trans., Vol. 146, p. 893). The kilogramme is correct at temperature of maximum density of water, under atmospheric pressure of 760 millimetres of mercury, and in latitude of Paris. The point of maximum density of water is commonly spoken of as 4° C.; but Professor Miller takes 3·945° C., which was the result obtained by Messrs. Playfair and Joule. This latter temperature corresponds to 39·101° Fahr. If the density of water under atmospheric pressure and at 4° C. be taken as unity, then we have its density at 0° C. (corresponding to 32° Fahr.)

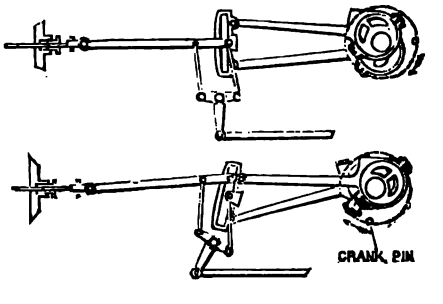
0° C. = 0·999871 } Rosetti's results.
4° C. = 1·000000 }

According to Kupffer's observations, as reduced by Professor Miller, the absolute density of water (in grammes per cubic centimetre) at 4° C. is not 1 but 1·000013; multiplying the numbers given above by this factor we have as absolute density—

0° C. = 0·999884
4° C. = 1·000013

(Professor Everett on "C. G. S. System of Units.") The kilogramme was originally intended to be the weight of a cubic decimetre of pure water at its maximum density; it will be seen, however, from the above figures that it actually is somewhat greater.—BEX.

[32290.]—**Link Motion.**—I give below drawings of the straight-link motion, which, I think, is the easiest to make. I am preparing drawings for a model locomotive, and shall employ the straight link. Fig. 1 shows mid gear, crank-pin at end of stroke; Fig. 2, full gear forward, crank pin in middle of stroke.—SHORT STROKE.



[32294.]—**Copper Steam Boiler.**—I should advise you to work your boiler at a speed of not more than 60lb. to 70lb. per square inch. The bursting pressure would be about 180lb. per square inch (if the vertical seam is single-riveted) with cold water, and at 70lb. of steam per square inch the copper would lose its tenacity by about one-tenth, reducing the strength to about 160lb. per square inch. By all means have a double-riveted vertical seam (if the boiler is of the upright type). I am surprised your boiler shell is $\frac{3}{8}$in. and fire-box $\frac{3}{8}$in. thick. The shell ought to have been $\frac{1}{4}$in., and fire-box 3-16in. thick.—PRACTICAL BOILER-MAKER.

[32295.]—**Yacht Engine.**—These run from 250 to 300 revolutions per minute (the screw) for 3in. to 4in. cylinder engines.—PRACTICAL BOILER-MAKER.

[32298.]—**Great Eastern Engines.**—The 97 class of engines were broken up many years ago. The 274 class were built at Canada Works, Birkenhead, in 1856, from the design of Mr. Gooch. The cylinders were 15in. by 22in., and a single pair of 6ft. 6in. drivers. Until lately these were the Tilbury engines. Mr. Gooch's engines were all after this style. His first tanks, built at Stratford, were small engines, outside cylinders 12in. by 22in. The driving wheels were 6ft. 6in. Afterwards 10 tanks were built, with 15in. cylinders and 6ft. 6in. wheels. Several of these are still running. Eighteen 4-coupled goods engines were built—6 at Canada Works, 6 from Sharp's, and 6 from Kitson and Hewitson's. These were the well known "Butterflies." They had cylinders 15in. by 24in., and four 5ft. 6in. drivers. Two of these engines are now running. No. 218 was one of this class smashed up in the Thorpe accident. No. 87 is one of Mr. Sinclair's fine expresses, outside cylinders 16in. by 24in., and a single pair of 7ft. 1in. drivers. She was built in 1866 by M. Schneider, and exhibited in the Paris Exhibition of that year. No. 201 is a bogie engine, built by Mr. Johnson, with 17in. cylinders. They can be seen every day at Liverpool-street.—G. P., Stratford.

[32299.]—**S.E. Engines.**—The following are the only dimsensions I have of the 134 class of engines, as they used to be:—Cylinders, 15in. diameter, 22 in stroke; driving-wheels, 6ft. diameter; 4 leading-wheels, 3ft. 6in. diameter; wheel-base, 16ft.; extreme length of framing, 24ft.; boiler, 10ft. 8in. long, 4ft. 1in. diameter; 184 tubes, 2in. external diameter, and 11ft. long. I believe they have all, with the exception of one, been converted into coupled engines, by removing one of the leading axles, and placing driving-wheels on the intermediate shaft.

They were built by Stephenson, in 1850 and 1851, from a design of Mr. Crampton's. Since they have been altered they have done some very good runs between Dover and London.—W. L.

[32299.]—**S.E.R. Express Engines.**—In reply to "New Zealand," I am very pleased that I am able to inform him that he is quite right in thinking that the "Folkestone" class of engines are by Stephenson, and not Crampton. The chief dimensions are these:—

ENGINE.	ft.	in.
Diameter of cylinders (15)	1	3
Stroke of piston (22)	1	10
Centres of cylinders	2	6
Breadth of steam ports...	0	1¼
Length of steam ports	1	0½
Breadth of exhaust ports	0	2¼
Lap of valve	0	1⅛
Lead of valve	0	0 3/16
Travel of valve	0	4½
Diameter of piston-rod...	0	2½
Centres of connecting-rod	6	4
Centres of outside-rod	7	0
BOILER.	ft.	in.
Length of barrel (in plates ⅜in. full)... ...	10	8¼
Diameter outside smallest plate	4	2
Outside diameter of tubes (18½, 12 and 13 W.G.)	0	2
	sq.	ft.
Area of grate	14	0
WHEELS AND AXLES.	ft.	in.
Diameter of driving wheels	6	0
Diameter of driving axles	0	6¼
Diameter of leading wheels	3	6
Diameter of leading axles	0	5

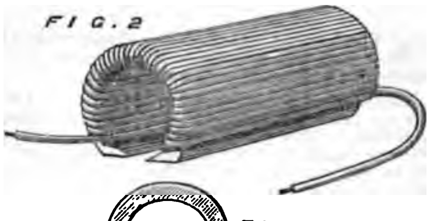
Single hindspring applied transversely over footplate and linked to it. Pumps at side of fire-box and worked from crank-axle. Compound frame with inside bearings to driving and crank-axles, and outside to carrying axles.

WEIGHT IN WORKING ORDER.	tons.
On four front wheels	16½
On driving wheels	10
Total	26½

I very much wish that some of our readers would give the dimensions of the "Lyons class," and also "Poplar class," L.B. and S.C.R.—STRAIGHT LINK.

[32303.]—**Jamin Magnet.**—I inclose sketch of what I believe to be the magnet in question. Take a piece of wrought-iron pipe about 3in. long by 1in. diameter, file away one side until through (see Fig. 1), and then (after softening it in fire) wind with cotton-covered wire in direction of its length, as in Fig. 2. It is superior to the ordinary form of magnet in its great power, arising from several causes. The poles are close to one another, and have large surfaces, and, from their proximity, the part of the wire in the interior of tube reacts on both poles, thus utilising battery power to the full.—GLATTON.

FIG. 2



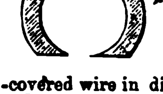


FIG. 1

[32312.]—**Spongy Music Paper.**—I have no doubt that the paper has been in some damp place or is old. The body of the paper has gone, and the only thing to be done is to put another into it. The book must be pulled to pieces and "sized," dipping or brushing each leaf with a very thin solution of best glue, and hanging the leaves up to dry; when dry "rolling" each leaf by itself or pressing them between polished boards.—ZAEHNSDORF.

[32312.]—**Spongy Music Paper.**—Yes. Sponge with thin parchment size or gelatine, or send it to any print colourer to be sized, or write with lithographic ink or chalk.—BOSH FAKER.

[32321.]—**Strength of Boiler Plate.**—If "Test Valley" will say what size he proposes making his boiler (he does not say what type he intends having), some of "ours," no doubt, can help him.—PRACTICAL BOILER-MAKER.

[32322.]—**Microscopic Field of View.**—Arrange the microscope (raising it on books, &c., if necessary) so that the eyepiece is 10in. from the tablecloth. Illuminate the field, and by placing a common rule on table and looking with one eye at the latter, and with the other through microscope, you will be able to compare the diameter of field with the divisions of rule, and read off the apparent diameter. The distance of 10in. is arbitrary, being the average distance at which most persons read with comfort. To find magnifying power of lens lay rule on stage, focus between two divisions, and laying a piece of paper on table (at 10in. distance from eyepiece as before), and again using both eyes, mark the apparent positions of the two divisions on the paper with a pencil; then by measuring the distance between pencil marks you arrive at once at the power. Thus, suppose you focus the sixteenth of an inch, and find that on the paper it appears to be 2½in. long, a simple division sum—thus: 2½ ÷ ¹ = 40—gives you 40 as the number of diameters magnified. —GLATTON.

[32327.]—**Wooden Legs.**—I fixed a ferrule on a crutch for a friend of mine that wears very well, and perhaps it would answer "Chester's" purpose. Drive a piece of stout copper or brass tube on the wood, leaving the end projecting about an inch. Turn an ordinary wood screw into the wood, leaving the head in line with the end of the tube, and fill up the space with solder, well sweating it in with a copper bit.—WM. WHELAN.

[32327.]—**Wooden Legs.**—If "Chester's" friend will only combine the suggestions given in the two answers to his query, he will have what is desired. With the brass or iron ferrrule, if used in the way given by "Os"—viz., pegged with wood—"Chester's" friend will find it very objectiouable walking, especially upon hard roads or pavement, as the jar produced at each step is very tiring and unpleasant; but if the portion of the ferrule extending beyond the wooden leg is plugged with a number of indiarubber discs) this being preferable to leather) he will find greater ease in walking. To keep the discs in their place, he would find a shoe could easily be made, and with little expense, by any shoemaker, consisting of a round sole rather larger than the ferrule, and the upper formed by two pieces of leather with holes, which can be drawn together by laces. If the ferrule is made larger at the end which touches the ground the shoe cannot slip off, and will give greater surface for tread.—CHARLES E. CLENCH.

[32328.]—**Telephone.**—Your ferrotype plate, according to your query, is touching the magnet. Take the plate off, screw the magnet back about ¼in., then screw the plate into position, and slowly screw up your magnet (at the same time singing a high note into the instrument) until you hear a discordant noise, which is caused by the plate vibrating against the pole of the magnet; then give the screw about half a turn in the opposite direction. You can remagnetise with a powerful magnet by simply rubbing the bar. The telephones may be kept in any position, and with the wires attached, for there is no action going on until you speak into the instrument. O. E. C. C.

[32328.]—**Telephone.**—Is "John" sure the connections are all right, as otherwise it would be impossible to obtain success? By far the best way to adjust the magnet to diaphragm is to allow the former to project about a quarter of an inch beyond the wooden case (the same fitting magnet quite tightly, so as to prevent its shifting). Then tack the diaphragm on to the mouthpiece part through a washer of sheet lead, which will keep it flat. Then place 4 blocks of cork about ⅜in. thick on the wooden case, and screw the mouthpiece, with its diaphragm down, on to the case, till a thin card can only just be inserted between magnet and diaphragm. The advantage of this method is, that one sees what one is doing, and is not working in the dark, as when the diaphragm is pinched between the case. The cork forms a delicate spring, by which the instrument can be adjusted either way with great nicety. The magnets are certainly weak, but that would hardly account for failure. It matters little how the telephones are kept—whether standing up or lying down, connected or disconnected. You seem to have taken great pains with your instruments. They should succeed. I could not get mine to work till I adopted the plan I have mentioned, but now they are as perfect as one could wish them to be. I'm almost sure your fault must be one of adjustment only.—HAZY.

[32330.]—**Aneroid.**—Most probably the pointer touches the glass. Mine did the same, so I took it out and bent it back very gently.—O. E. C. C.

[32331.]—**Bronzing Brass Work.**—Boil the articles to be bronzed in strong soda, to remove all grease and dirt. Be careful to keep them under water, or the air will leave a mark. Any rough places that remain can be scoured off with sand. Dissolve 3d. worth of corrosive sublimate in vinegar, place your brasswork in it, and rub in with a painter's tool, keeping it (the sublimate) worked up from the bottom. If too much sublimate is used it will turn the articles white. This will turn the work black when nearly dry. Black-lead the same as a stove would be done. If a steel is wanted heat on a stove, and lacquer with pale lacquer. If green bronze, mix half pale gold and half green. Try it on your thumb-nail, and if not to your fancy, add more of whichever is wanted. The heat required when you put on the lacquer is just sufficient to throw up a steam when the brush touches it. This should be done as quickly as possible, and then heat again. To heat long tubes a steam kettle is used. To relieve scrape off and burnish the prominent parts, re-heat and lacquer with pale gold.—WM. WHELAN.

[32332.]—**Submarine Forests.**—Trees growing so close together as you describe would shade each other, and could not all get the sun at the same hour, and consequently not the same power. This difference would be felt most on the east and west sides of the forest, and some little distance in on the south, and on the north edge of forest (if the trees were close) the rings would be thickest on the north side of tree. But all depends on position
proximity. Please (if you can) see if this is the
and you will much oblige—BOSH FAKER.

[32334.]—**Engine-room Artificers.**—In rep
"Fitter" I subjoin full particulars of pay and
tion accorded by the new Warrant of June, 18
1. *Engine-room artificers:* Pay under 3 years'
vice, 5s. 3d. a day; above 3, 5s. 9d.; above 6,
above 10, 6s. 3d., on re-engaging for a further
of 10 years; above 13, 6s. 6d. Age for entr
future to be from 21 to 30. Rank as at present
below chief carpenter's mate). 2. An acting en
room artificer must obtain, before being confi
in the rating, a certificate from the chief engi
or engineer in charge, approved by the comman
officer, that he is capable of taking charge of a w
in the stoke-hold, and has proved himself an effi
workman, and is deserving of confirmation. B
receiving the first increase of pay, after 3 years'
vice, he must obtain a certificate from a chief
neer or engineer in charge, approved by the
manding officer, stating that he is capable of ta
charge of a watch in the engine-room. 3.
Engine-room artificer (number to be limited to
Rank, to be next above the chief carpenter's
Pay under 3 years' service, 6s. 9d. a day; abo
7s. Extra pay of 3s. 6d. a day to be granted
when employed on ships other than those to w
they belong, executing repairs. 4. The new sc
pay to commence from 1st April last. In futu
man is to be advanced from one scale of pay t
higher unless he has maintained a "very g
character during the previous twelve month
Advancement: Engine-room artificers who
completed 10 years' service as such will be qua
for advancement to the new rating of chief en
room artificers, provided they have maintai
"very good" character during the previo
months, and have re-engaged for a second peri
10 years. Fifty engine-room artificers wil
advanced at once to chief engine-room artifi
notwithstanding they have not completed 10 y
service, on condition that previous to advance
they enter into a new new engagement to ser
years. 6. *Uniform:* Blue cloth tunic, or close-fi
pea jacket, with uniform buttons; blue cloth w
coat; blue or white trousers; cap as at pre
Chief engine-room artificers to wear three bu
on each sleeve of the tunic. 7. *Pensions:*
chief petty officers to be pensioned on the same
and under the same regulations as other chief
officers; and if they are required or allowed to
beyond 20 years they will be granted the usual
tions allowed to other chief petty officers under
lar circumstances. They will not be allowe
receive their pensions while serving. 8. *Mess,*
Engine-room artificers and chief engine-room
ficers will all mess together in a separate mess
which will be provided for them, and a stoker w
allowed to take care of the mess place, hamm
&c. The pay is for 7 days a week, and candi
must enlist for 10 years. Application should be
to the officer in command at any of the docky
There is no chance whatever of attaining the
of engineer; but the above scheme is pretty
taking into consideration free lodgings, sep
mess, and other advantages. Artificers are no
request in the navy.—C. E. K.

[32335.]—**Barlow Eyepiece.**—What "
macarret" means is, I suppose, the Barlow len
achromatic concave lens placed behind the eye
of a telescope to increase its power, by virtuall
creasing the focal length of the objective (le
mirror). The lens consists, I believe, of a do
convex flint lens placed between two double con
of crown glass. The power of an eyepiece in
junction with the Barlow is measured in the
nary manner with a dynamometer.—F. C. DEN

[32342.]—**Electric Bells.**—I inclose a sket
arrangement which I think will answer, but hav
tried. The circuit is complete for the telepho
at all times, as there is metallic contact betwe
and Y, D being a spring of copper and Y a c

FIG. 1

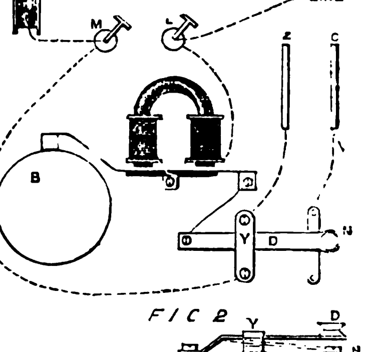
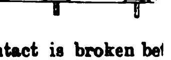
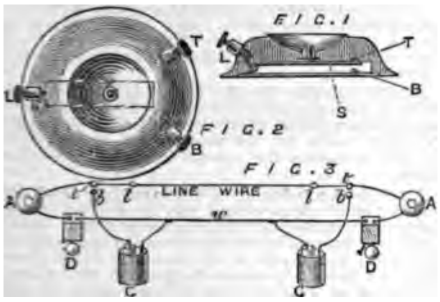


FIG. 2



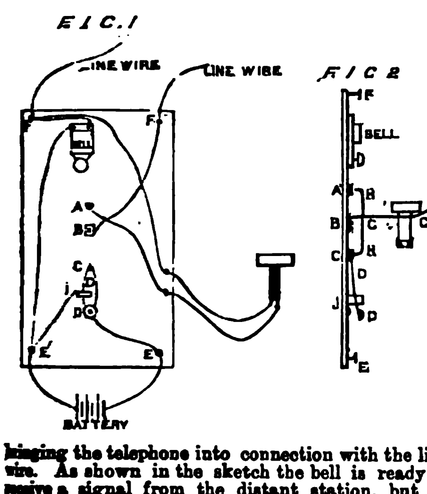
bridge. By pressing D contact is broken be
D and Y, and the carbon, C, is put into circu
contact between copper, N and D. The dia
will explain itself best. Fig. 2 shows secti
spring contact-maker, D.—W. F. KNOX.

• [32342.]—**Electric Bells.**—I see "X. X." wants to know how to connect bell, &c., with the wires used for telephone. Perhaps the inclosed sketch may help him. The "push" (Fig. 1 and 2) is of



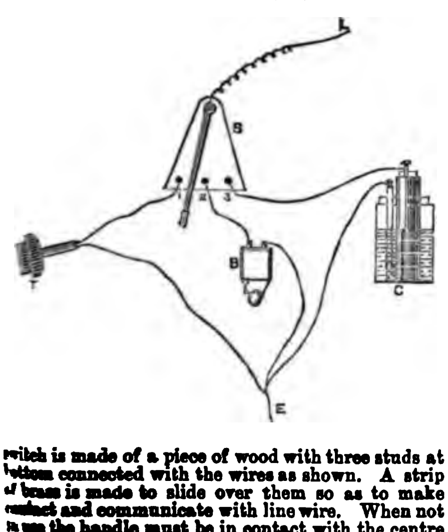
rather peculiar construction. A spring, S, is connected through a binding screw, L, with the line-wire, and is fixed so that the free end plays between two contact pieces, T and B, the former of which is connected with the telephone, the latter with one pole of the Léclanché cell. The other pole of battery is connected to the return wire, as shown in Fig. 3, or, in the case of there being no return wire, to earth. The normal position of spring is as shown in section, pressing against T. The telephone, A, is thus in circuit. By pressing the stud the spring is brought into contact with B, and the bell at further station rings.—Glatton.

[32342.]—**Electric Bells.**—I send a rough sketch which I think will suit "X. X." G G is a piece of brass shaped like the shafts of a cart (only the telephone takes the place of the horse), secured to the base board by a short piece of steel spring. The telephone, by its weight, brings H into contact with C, thereby breaking communication with the speaking instrument, and bringing the bell into readiness for receiving a signal. Directly the telephone is removed G springs up, making contact at H A, so



bringing the telephone into connection with the line wire. As shown in the sketch the bell is ready to receive a signal from the distant station, but by pressing down the spring, D (similar to the key used for the Morse telegraph), you cut off connection at I, and bring your own battery into action, thereby ringing the bells. The board should be suspended against a wall, as in Fig. 2.—O. E. C. C.

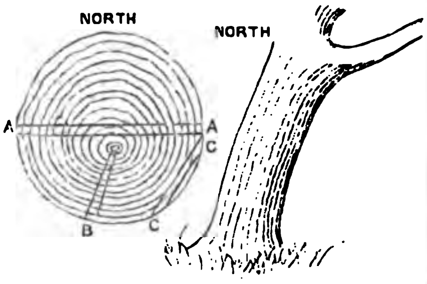
[32342.]—**Electric Bells.**—Make connections like sketch at both ends. Description of sketch: S, switch; T, telephone; B, bell; C, battery; E, earth, water or gas pipe will do; L, line wire. The



switch is made of a piece of wood with three studs at bottom connected with the wires as shown. A strip of brass is made to slide over them so as to make contact and communicate with line wire. When not in use the handle must be in contact with the centre stud at both ends to call attention at the other station. Put the switch to No. 3 stud, which will ring his bell for a few seconds, and put your switch back to stud 2. The other station now must just do the same to let you know that he is there, and as soon as the bell stops ringing move the switch to stud 1 to connect telephones. The other station must move his switch as soon as he has run reply to your call. You can now go on with your speaking, and as soon as finished move switch to stud 2 at both ends. One cell Léclanché will not ring so very far; better use two at each end.—G. B. C.

[32345.]—**Grain of Violin Wood.**—"Fiddler" asks, "Why should the grain of the hard back be placed at right angles to the grain of the soft belly?" The grain never is so placed, never was, and probably never will be. The grain runs from top to bottom in all instruments of the violin tribe. The figure of the wood runs the other way.—Gemini.

[32345.]—**Violin.**—How can "Fiddler" ask such a question? It is never done. He must mistake the flower of the wood for grain. But as his query amounts to a statement which may mislead others I will explain. The breasts and backs of violins are made with the grain to run the same way. From end to end the breast of Swiss pine, cut as marked



in Fig. 1 (cross section of tree), at A, and the back of sycamore cut as marked B. I have seen and made a few with flat backs, cut as marked at C. But as they seldom look handsome, and the propriety of this mode has been questioned, it is not done now by the makers. The cross pattern, or flower, of the wood seen on backs of violins, called chuckle wood by the cricket-bat makers, is found occasionally in all close-grained woods, and on the sunny side of the tree. It is caused by the sap rising earlier in the season, and remaining longer on that side. In fact, the tree grows more on the sunny side, and should be taller there. But the branches grow more, and larger also, on that side. Their weight and the drawing of the sun combine to send the trunk over that way, and so compress the larger quantity of wood into a curl, and stretch the smaller quantity on the other, as shown in Fig. 2; hence the superior quality of wood on one side of a tree grown on the south side of a forest or cluster of trees.—Bosh Faker.

[32349.]—**Surface Printing.**—As regards the difficulties of zincography in presenting under-biting, &c., may I draw the attention of those interested in such processes to a new one, which is free from many of the difficulties mentioned? The original writing is made on ordinary paper in a simple ink; ordinary gall ink will answer if to be copied as soon as written. A film of gelatine is prepared, supported on slate or other suitable material; this is moistened with an exciting fluid, and all surface moisture removed. The writing is brought in contact with the gelatine surface, passing it through a pair of rolls, the paper is removed, and the plate is found to be impressed with the writing. It is at once ready to be inked with a suitable ink, which will only adhere where the ink has touched. The results are very perfect, and with care much more perfect copies can be produced from stone or zinc, as the gelatine is capable of more gradations than either. I shall be glad to send Mr. Mortlake samples and further particulars.—A. Pumphrey.

[32351.]—**Dark Tent.**—After 20 years' experience in landscape photography I can unhesitatingly recommend the Archer's camera. In the space of 11 × 11 × 15in. whole plates can be well worked. I shall be glad to send drawings and description, if the Editor approves. The plan has an advantage over ordinary tents in the following points: It does not involve the breathing of a vitiated atmosphere charged with chemical vapour and the manipulator does not work in a cramped position. The apparatus is not affected by the wind like tents.—A. Pumphrey.

[32353.]—**Screw Cutting by Hand.**—Instead of "cleaning," read "chasing."—Dorset Member A.M.S. and Mem. Soc. Arts.

[32359.]—**French Clock.**—If you put a very much weaker mainspring you will find it greatly diminish the fault, but I do not think that you will be able to quite cure it.—W. G. H. A.

[32360.]—**Lawn Mower.**—You cannot grind them any better way than you are doing. I repair and grind them the same way with emery and oil. I have tried stones in a slide-rest, but you won't do them true that way. You must run the knives the other way about. I cross my strap in the lathe.—C. O.

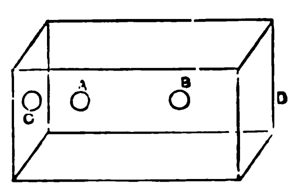
[32360.]—**Lawn Mowers.**—The easiest and best way to grind the blades is to fix a piece of stone (broken grindstone suits first-rate) in the rest, same as a tool, but fixed so as to present a long surface to the blades; then put on fast speed, and apply water, and let the tool-box and stone travel from end to end until the stone touches all over, and all the way along. I have seen them trued up in this way in a very short time. The way to set them in the lathe is to the bearings, and not the knives.—A. Reid.

[32368.]—**Chromatic Pitch Pipe.**—Unless "T. D. J." is particularly anxious to make the above I should recommend him to invest 5s. in Eardley's patent chromatic pitch-pipe, which for portability and usefulness is wonderfully good and cheap. It is made of metal, and contains a whole chromatic octave in the space of 2½in.—F. T. D. B.

[32380.]—**Cementing Ivory to Lathe Chuck.**—I think "J. L. H. S." will find the following a good recipe for his purpose:—Burgundy pitch, 2lb; resin, 2lb.; yellow wax, 2oz. Melt all these together, and then add plaster of Paris, 2lb. When wanted for use, chip out as much as will cover the chuck to 1-16in., spread it over the surface in small pieces, mixing it with an eighth of its bulk of guttapercha, in thin slices; then hold a heated iron over the chuck till the mixture and the guttapercha are liquid, cool the iron a little, and stir the mixture until it is homogeneous; then chuck the ivory.—H. Crawford, Liverpool.

[32381.]—**Gilt Corners.**—These are, I understand, a mixture of whiting, glue, and linseed oil, and can be cast in a flexible or gelatine mould, composed of glue and treacle, or glycerine, but as they can be bought at a picture-frame dealer's for 6d. a set, ready gilt, I should think it is hardly worth while to bother with making them.—W. H. Davies.

[32391.]—**Vortex Rings.**—The best way of showing these in air is to make a small box of cardboard, like annexed diagram, with a hole about ¾in. in



diameter at *c*, and two small ones at *a* and *b*. Now, fit two test-tubes with cork and tubing the latter, to be inserted in the holes, *a* and *b*. Put a small quantity of ammonia and hydrochloric acid in each. Apply heat, and in a short time the box will be filled with dense white vapours of chloride of ammonium. On gently tapping the end, D, the vortex rings will escape at C, being larger or smaller, according to the force with which the opposite end is tapped. To produce them in water, take a glass of clean liquid, and dip the end of a cedar pencil in milk, so as to leave a drop adhering to the end. By bringing this into contact with the surface of the water, the milk will, in descending, form a beautiful ring. The above is taken from Cassell's new publication "Science for All."—Mauritian.

UNANSWERED QUERIES.

The numbers and titles of queries which remain unanswered for five weeks are inserted in this list, and if still unanswered are repeated four weeks afterwards. We trust our readers will look over the list, and send what information they can for the benefit of their fellow-contributors.

31733. Isolation of Raphides, p. 437.
31734. Goniometer Stage for Microscope, 437.
31746. Water Pump, 437.
31747. Mixing Colours, 437.
31748. Finishing and Sizeing, 437.
31757. Boiler for Model Locomotive, 438.
31758. Lathe, 438.
31761. Horse Clipper, 438.
31766. Watch Query, 438.
31768. Conchological, 438.
31774. Dyeing Leather, 438.
31775. Punching Iron, 438.
31776. Strength of Gunpowder, 438.
31782. To Deodorise Turpentine, 438.
31783. Disintegrator, 438.
31787. Gas Generator, 438.
31788. Vertical Engine, 438.
31791. Gun without Recoil, 438.
31797. Scholarships, 438.
31799. Founder's Blacking, 438.

32001. Speed of Trains, p. 538.
32009. Cold Waterproof Cement, 538.
33021. Sculpture and Modelling, 538.
31022. Mining Questions, 538.
32023. Pendulum Experiments, 538.
32026. Steam-gauge Locomotive, 539.
32027. Commutator for Extra Currents, 539.
32032. Head Gear for Pit, 539.
32033. Egg Time Boilers, 539.
32037. Slide-valve, 532.
32039. Looper for Sewing Machine, 539.
32040. Scotch Expresses, 539.
32041. Cricket Balls, 539.
32042. Alum Analysis, 539.
32049. Soluble Prussian Blue, 539.
32051. Mushroom Growing, 539.
32054. Explosion in Preparing Hydrogen, 539.
32059. Silk Manufacture, 539.
32060. Brake Power, 540.

QUERIES.

◆

[32405.]—**B. Sc. Examination.**—Can any of your correspondents who have attended the above examination give me any information with regard to the kind of questions asked *vivâ voce* at the examination in practical chemistry?—G. J. B.

[32406.]—**Twist.**—Is there any twist taken out in the draft of a roving frame or mule?—Cotton Carder.

[32407.]—**L. and S.W. Bogie Express.**—Will "The New Clock" give the length of wheel-base of driving and bogie wheels, sizes of steam ports, diameter and length of boiler, tubes, and size of fire-box? Also a description of the brake, which looks rather complicated. —Short Stroke.

[32408.]—**The Phonograph.**—Doubtless some of your readers have had an opportunity of examining the phonographs which have been exhibited at meetings of the Society of Telegraph Engineers and of the Physical Society; if so, will some one kindly answer the following questions for the assistance of all readers, who, like myself, are desirous of making one of these wonderful yet simple instruments? About what dimensions are the following? 1. Diameter of rotating cylinder. 2. Diameter of diaphragm. 3. Pitch of screw or spiral groove. Also, (4) what length should the point in the centre of the diaphragm be, and should it be blunt or sharp? 5. How is the tinfoil fastened on to the cylinder?—J. H. H.

[32409.]—**Yacht Boiler.**—Would "Firefly, Melbourne," give our readers a sketch of his yacht boiler? I for one should like to see how the fire-box and tubes (if any) are arranged.—Practical Boiler Maker.

[32410.]—**Music.**—I have some four-part songs (S. A. T. B.) which I would like to arrange for one cornet and E♭ horn (or two cornets), baritone and E♭ bass. What part should each play?—Poor Musician.

[32411.]—**Telephone.**—Would "Cob" (1410) give particulars respecting his instrument, stating how the wire is wound on the two poles, if in the same or opposite directions? In joining the two instruments for work, should the transmitting wire join the two sets of magnets or the reverse? Also what is ferrotype?—Tux.

[32412.]—**Windmills.**—Having read your review of the "Miller's Textbook," allow me to suggest how greatly your mechanical readers will value his or any one else's experience as to the number of hours in each of the twelve months during one year that a windmill can be worked, and also if the millers take advantage of the wind at night time?—Arthur Bennet Richardson.

[32413.]—**Return Tickets.**—Can any of our readers tell me why railway companies limit the time during which return tickets are available? It seems to me an utterly unreasonable rule, for what possible difference can it make whether the second half of the ticket is used by the next train or not till next month or even next year? Moreover, if tickets were of longer or unlimited duration more would get lost, which would of course benefit the company.—Wm. John Grey.

[32414.]—**Heliopolis.**—In a discussion lately upon the site of this city I have been at a loss as to what has most right to be called by this name. The place which is generally styled Heliopolis is Baalbec, an inland town in Syria, at present in ruins. This could hardly have been the Heliopolis from which the Cleopatra's Needle originally was brought, the "On" of the Scriptures. I find several places which are termed Heliopolis, I suppose from there having been temples of the sun in those places. But it is hardly likely, if those places were contemporaneous, that they have a genuine right to be termed so. Of the Egyptian Heliopolis I have not been able to gather any information as to its site and history, or of its temple of the sun. While books are written about Thebes, Karnac, and Memphis, yet this On, which must have been quite as important city in its day, remains to the best of my belief unchronicled. I have a remembrance of reading that at this place at one of the gates of the ruined temple is still standing a sycamore tree which tradition states has been standing 2,000 years, and under whose boughs Christ was nursed. As some of the readers and correspondents of the Mechanic probably are versed in history, some light upon this subject will doubtless interest others as well as—Inquirer.

[32415.]—**Compressed Air Chamber and Pump.**—I want to have made a compressed air-chamber capable of holding three cubic feet, with sufficient strength to resist from 40 to 60 atmospheres. I wish it to be light as it is possible to make it. Which would be the best and strongest material combined with lightness and the shape? I want it to rest on an ordinary table, with pump and hose attached for experiments. Will some of your readers describe what sort of pump would be the best, also about the weight of the chamber when fully charged up to 60 atmospheres?—J. H. S.

[32416.]—**Electrical.**—To "Sigma."—If I introduce a condenser of tinfoil and paraffin paper between one pole of a Léclanché cell and a bell I find that a current passes through the condenser and rings the bell; does it induce a current or is my condenser at fault?—G. B. C.

[32417.]—**Gilding Frames.**—Should there be any preparation used on iron frames before gilding them? A few hints on gilding iron frames will greatly oblige—G. B. C.

[32418.]—**Royal Engineers.**—Will any of "ours" kindly inform me the duties of a recruit in the Royal Engineers, how the same recruit may be promoted, what he is required to know to get promoted, and also if it is possible to be examined to get a commission? Perhaps it is as well to state that I am aged 18, and am a pupil teacher in the fifth year.—G.

[32419.]—**Telephone.**—I should be glad if any one could give me advice on one or two points. I have made a pair of Bell's instruments. The service wire runs from the top to the bottom of the house, and is connected at each end to the gas pipes. I can generally catch what is said when things are quite quiet around, though the sound is exceedingly weak. 1. Does the strength of the current depend upon that of the magnets? Mine are not now strong enough to lift each other end to end; their size is 4in. by ¼. 2. Would it be better to have a double wire to complete the circuit? Any other hints as to strengthening the sound would be very acceptable.—T. P. A.

[32420.]—**Science Examination.**—1. Two forces of 30 and 40lb. respectively act upon a point or particle in directions at right angles to each other, find the magnitude of their resultant in pounds. 2. A heavy cylinder would roll straight down an inclined plane, but is prevented by a string attached to its circumference which pulls in a horizontal direction: the cylinder is at rest. Show by a figure what forces act on the cylinder and point out couples, if there are any. 3. A body under constant acceleration moves from rest over ten feet in the first second; how far has it moved at the end of the second second?—Iota.

[32421.]—**Salt or No Salt in Food.**—"G. R. T.," No. 539, p. 476, says that criminals fed entirely without salt (chloride of sodium) died of intestinal worms. Will any reader of the English Mechanic kindly give authority for this statement, also for the following?—"It was noticed that in people seized with cholera there was a remarkable absence of salt from the system which fact alone would go to prove that the no salt system is unhealthy." It has been said that the absence of salt in cholera patients is caused by the excessive purging and vomiting, that the absence of salt was the effect of the disease and not the cause of taking cholera. I should be glad to hear "G. R. T." reply. Also is there any proof that the blood, tears, and sweat require salt, and are there any facts which show that the animal fluids contain salt in those animals which never eat added salt? I think that the moderate addition of salt to food is beneficial to health, and to me it gives relish, but this is no proof. I should feel obliged to any correspondent who would furnish proofs that the salt naturally contained in food is sufficient for man, or that it is beneficial to health and that the system requires added salt.—F. C. S.

[32422.]—**Inlaying.**—I will be glad to know the sort of saw frame most used to cut the pieces of veneer into shape for inlaying, such as may be seen in a London made drawing table.—Lucius.

[32423.]—**Oxyhydrogen Light.**—I shall be glad to know if any correspondent of "ours" has tried the effect of heating the oxygen gas used in the oxyhydrogen light, by passing it through a heated coil of copper tube, in the manner of Mr. Fletcher's ingenious hot-air and gas blowpipe. Theoretically it should increase the light, but whether it will do so practically I leave to those having the necessary apparatus and time at their disposal.—Hy. C. Parlour.

[32424.]—**Carbon Block.**—Wanted a good recipe for making carbon blocks, suitable for jewellers' work, melting small quantities of gold, &c., by blowpipe. Have seen circular ones, but require oblong ones, as the circular are useless. Have tried ground charcoal and treacle baked, but it splits under heat.—A. E. Bannister.

[32425.]—**Balance-wheel.**—Am I right in assuming the time of oscillation to be as the square root of the effective radius? Is the time affected by the size of the spring? What sized wheel would beat seconds? What is the best means of regulation in a wheel of this size, the object being not to keep true time but to obtain varying rates of speed at pleasure?—Skerryvore.

[32426.]—**Sel de Verre.**—In the February number of the *Journal* of the Franklin Institute there is a very simple form of galvanic cell given—carbon, zinc, and sel de verre, or fiel de verre, or unvitrified salt in solution, said to be as powerful as a Daniell. Can any one kindly say what is meant by this salt?—B. F.

[32427.]—**Acoustics.**—To Mr. W. J. Lancaster.—I am desirous of repeating Chladni's experiments on the vibration of plates as described in Tyndall's work on sound, p. 139. What is the most suitable material for the plates, and the most convenient size? Also could I perform the experiment described on page 226 of the same work with hydrogen, and what should be the diameter of the tubes?—E. J. Marshall.

[32428.]—**Brickmaking.**—Will some kind reader of "ours" oblige an old subscriber with information about brickmaking machines? I want to know which are proved by practice to be best—*i.e.*, least liable to get out of repair, and do the largest work with a given steam power, and capable of using the clay in the natural state, supposing it to have no stones in it. Perhaps the locality where such as may be recommended is working may be stated.—Ishtar.

[32429.]—**Bicycle.**—I am anxious to get a bicycle suitable for travelling long distances in the Highlands. Last summer I spent two months in geological and botanical pursuits among our glorious hills and glens, and often walked thirty miles a day. I am anxious to do three or four times this distance, and should like to be advised as to the most suitable machine for such work. The Highland roads are generally models of excellence and good order, and well suited for bicycle work. The length of my leg is 35in., and I am strong enough for a good deal of hard work. I shall feel grateful for any advice or information on the subject.—Enthusiastic Scot.

[32430.]—**Dog Skins.**—Having several skins, of different kinds of dogs, I wish to be informed how they may be made into leather, and dyed and dressed the usual yellow colour suitable for gloves? Also what species of dog skins are best for gloves?—C. Cooper.

[32431.]—**Legal Query.**—A person, by will, left the whole interest arising from his property to his wife during her life, and after her death the estate to be divided equally amongst his children. A, a son, married B, and a child was born to them. In a short time the father, A, died, and in about six months after the child died. After a lapse of a few years B, A's widow, married again to C, and in about four years C died, B becoming a widow a second time. A's mother now dies, and the estate of A has to be divided. B obtains a share of the property on behalf of the child which survived its father, but died many years before the division of property. Is this share the sole property of the widow B, or should it form part of the estate of C the second husband?—Relieur.

[32432.]—**Buttons Made from Bone, &c.**—In a former query I asked what material umbrella and parasol handles were made from. Now I find some of the same sort of material in appearance is made into buttons, and as I fancy they cannot be turned from bone or ivory for the price they are sold at, I fancy they must be made of a material easily and quickly moulded. Being in want of a material of something of the same kind, can any subscriber assist me? The colour is of secondary importance. —L. W. D

[32433.]—**Klos Violin.**—To "Fiddler."—I want to know what the merits and peculiarities are of this maker's instruments? What great maker he copied, and the date he lived and made violins, and any other interesting information about the man himself or his fiddles?—Poor Fiddler.

[32434.]—**Large Telescopes.**—Would some of our astronomical correspondents kindly give us by way of a treat a description of some other large telescopes, after the style that was given of the Melbourne reflector?—Telescope Tele.

[32435.]—**Boiler Feed.**—In feeding a boiler with an injector, the steam used (for the injector) is only of the same pressure as the steam in the boiler, besides which it (the feed) has to lift the clack valve? How is it that the feed overcomes the pressure in the boiler?—Harry Beta.

[32436.]—**Angularity of Connecting Rod.**—Can any of "ours" please show a rule for finding the angularity of the connecting rod during any part of the stroke? Example: Suppose length of connecting rod equal 6ft., crank 2ft., find angularity of connecting rod, supposing the piston to be in the centre of cylinder? Also when the crank is at an angle of 90° to find position of the piston head in the cylinder? Suppose the angle at half-stroke is 78° 27′, the piston has travelled 4ft. to find the length of connecting rod. Please work out arithmetically, as I am only just beginning to learn algebra and trigonometry, so I should not clearly understand the above if worked out by trigonometry. I have got the above examples from Ever's work on the steam engine.—Enquirer.

[32437.]—**Cistern Leakage.**—We have a slate cistern which leaks, the joints being imperfect. Will some one kindly say how such can be stopped? If by cement, what kind? Its size is 4ft. × 2½ × 2½, and is placed in the roof.—J. A. A.

[32438.]—**Tramway.**—It is proposed to construct a tramway in the country, bedding the sleepers in gravel instead of concrete, and to pave on both sides of the rails, 9in. wide, with stone blocks, the remaining space between the rails to be paved with macadam. Will any of your readers kindly say if they know of any tramway having been laid with any other substance than concrete for a bed, and, if so, how it has answered? Also the objections, if any, to paving in the above manner?—A. B. R.

[32439.]—**Defective Harmonium.**—Can any correspondent explain to me why most of the treble notes of my harmonium have (if played loud) a nasty hissing sound? Is there any other cause for such a defect than the reed grating, as I cannot detect anything of the sort? —W. P. S.

[32440.]—**Blacking Cane.**—Will some friend give the best way to black small cane work a bright black?—J. A. W.

[32441.]—**Gas Engine.**—I have a horizontal engine, 3in. diameter, 7½in. stroke, which, as I am so situated that I cannot work a boiler, I wish to convert into a gas engine? Will any contributor say whether this can be accomplished, and how I should get a new cylinder if the present one could not be brought in?—An Anxious Enquirer.

[32442.]—**Heating Glue.**—When I put my glue-pot on a gas jet to get hot it stinks most unbearably, and fills the house most unpleasantly. How can I remedy this? —C. O.

[32443.]—**Blackleading Stove.**—How can this injurious (to everything but the stove) and troublesome operation be dispensed with without sacrificing appearances?—C. O.

[32444.]—**Fluid used for Tubes of Spirit Level.** —I believe that the fluid used for filling them is spirits of nitre. If I am wrong perhaps some of your correspondents would kindly inform me? Would they increase the obligation by informing me what I can use to dye the spirit a good indigo colour? I have tried Reckitt's Paris blue, and I might as well have saved myself the trouble. —J. L. H. S.

[32445.]—**Induction Coil.**—To "Sirius."—Thinking of reconstructing my coil (made according to "Dy[illegible]") on Fergusson's principle, I should be obliged if you would kindly say if paper soaked in solution of shellac (which I used for insulating) can be used in place of the guttapercha tissue you advise; and, if so, whether the same directions, as to number of turns wound round, would apply. The paper is about the thickness of English Mechanic paper. The present coil is 6in. long, wound with 1lb. No. 38 wire.—F. C. F.

[32446.]—**Rusty Machinery.**—Can any one kindly inform me if old machinery (lathes, sawing machines, &c.) that has been lying out of doors for some years would be of any value to machine-makers to do up again as second hand articles, or are they only worth the price of old iron? They are complete in every respect, only the rust has eaten in.—G. S. A.

[32447.]—**Electrical Indicator.**—Will some of our electricians or mechanics help me? I want to place an indicator in the River Commissioners' offices to show constantly the state of the tide in the river, the office being about a mile away from the river. I would like to do this in the following manner, if possible:—At the river I would rig up one of these new pneumatic sounders which have been, I believe, recently patented. They consist of three principal parts, a peculiar-shaped box open at bottom, a length of very small tube (any length), and a glass siphon mercurial pressure gauge. The box would be secured to a post and close down to low water mark, and the small pipe which is connected to the top of the box is led away above high water, and there connected to the pressure gauge; in this case the gauge would be hung up in a house close at hand. As the tide rises it would enter the box, and compress the air in it and pipe, and this compression would press the mercury up in the gauge, which has a scale, and shows exactly how many feet of water there is above the submerged box. Now if I could only get a mile of the small pipe laid to the offices, and the gauge hung up there, it would act perfectly, but laying this mile of pipe is out of the question, and in place of it I want to use an electrical wire, and I believe some of "ours" can show me how the rise and fall of the mercury will influence an electric current, and show this rise and fall at the office end of the wire.—An Old Reader.

Hens and Chickens.—Will some reader ANIC please say if it is possible to get hens to le kept in a house of good size and with good wish to know a safe and simple method of iokens without a hen? Could it be done in kitchen? Could it be done under glass in ' well secured by night? Please don't refer iumbers.—POULTRY.

Filling Teeth.—Will any of "ours" be to give me some instructions on teeth-filling? r three back teeth just beginning to decay in nd I believe if I fill them at once I shall How is the gold filling composition made; :t of instrument should I use to scrape out ·DENTIS ASINI.

The Organ.—Will some correspondent ith a description of registers, compass of pedals, &c., of St. Stephen's Church organ, The registers were chosen by a man of known id the result is a handy sweet-toned instru- . D.

Telephone.—I have a length of old iron underground from my house to place of at 30 yards, for the purpose of having a wire ugh it to ring a bell at either end. Will ondent tell me whether it would be advisable r of telephones instead; and, if so, whether apercha-covered wire would retain their ation in an iron-pipe? If so, whether it rell to have a length of common copper wire to a bell at either end, to call attention? ly to assist me in making this communication be esteemed. Would the cheap telephones, 5s. each, be of any use to me?—TOWE.

Electric Bell.—I have an electric bell an A B C instrument which I wish to con- ı Léolanché battery and push, to use of a of the front door knocker being made too ; find that after ringing it once the poles of ar to require changing or reversing. How ed?—W. B.

Air Pump.—I am about to make an air- e air into the bottom of a cast-iron pan d, holding 400 gallons of oil, the air to be e oil while it is boiling. Will any reader st kind of pump for the above?—C. M.

Taking Burrs out of Watch Wheels. e burrs taken out of the teeth of centre and after they have been turned down? A little brush curls up when using it. Is there no The teeth of good finished wheels are nicely How can the roller and nicely polished s be taken off, without making a burr or a liers? Some are very tight on. How are e wheels faced up? Are they done by ordi- ıkers or the finisher?—JOBBING JOHN.

Colour for Confectionery.—I should be eader could tell me of a bright red colour r above purpose?—W. M. S.

Finder.—What are the best dimensions of acting telescope 4½in. aperture, 5½ft. focus?

Steam Boiler.—Can any reader inform e proper sized pipe to use from steam boiler ad heating two cisterns of water? There is 0ft. of 1¼ and 20ft. of 1in. pipe, with 6½ they are all open, I can get no pressure of gauge.—G. S.

Lunar Photographs.—To "A. A. C."— . you mentioned taking some of these with Calver mirror. Could you say what were rs?—F. C. D.

Carbonate of Ammonia.—What is the on the nervous system, and on the stomach, aternally? Has it any influence in suppress- in? I am anxiously serious in asking this IDDLER.

Geological.—I shall be obliged if some tell me how, and during what period, the flints found in the Silurian conglomerates . as I have never come across an explanation tion of flints other than those found in the J. JOHNSON.

Tasmania.—Will some reader tell me if a good field for mining engineers, and if the supposed to be rich in useful and precious Also if it is a good field for general farming as of any kind? Is there much water power uroughout the country? Is it adapted for manufacture; and are there good markets in r Australia, where the produce of manufacture ily disposed of? Is coal cheap there? I know in the island.—R. J. JOHNSON.

Achromatic Objectives.—What is the quality between English 1½in., ¼in. ⅛in., and res, and English 1½in. with French triplet, into ½in., ¼in. and ⅛in.? That is, would an n. decomposed into ⅛in., do as good work as ⅛in.? I am going to get a microscope, but it anical stage, and as I cannot get it exchanged one, I was thinking of getting a spring stage suppose the mechanical stage could be taken deal has been said against mechanical stages— anything to be said for them?—W. A. PEARCE.

Telescope.—A friend of mine has a tele- h in its present condition is useless. The body having four draws opening to about 16in. in e object-glass is composed of two lenses, a ex and a plano-concave; they are placed both at are not cemented; their focus is about are two more lenses fixed in a short piece of both double-convex, distant about 11in. from glass. The one nearest the object-glass is focus, and one nearest eyepiece about ½in. one is cracked across the middle, and is rom the eyepiece, which is deficient. Can any what is required to make it complete?—

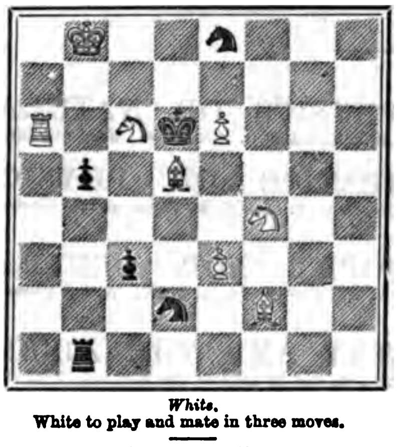
Kangaroo Skins.—Having had a few ins sent from Australia as a sample, any oblige by informing me how to convert them and dress and finish them for use, and what ally applied for?—C. J.

CHESS.

ALL Communications intended for this department must be addressed to J. PIERCE, Copthill House, Bedford.

PROBLEM CCCCXV.—BY JAMES PIERCE.

Black.



White.

White to play and mate in three moves.

SOLUTION TO 413.

White.	*Black.*
1. R to K Kt. 6.	1. Q R takes R, or B to R 7, or P takes Kt.
2. B to Kt. 5.	2. Anything.
3. Mates.	
	1. Q or Kt. to B 6.
2. Kt. to Kt. 3 (ch).	2. K moves.
3 Kt. to Kt. 2 mate.	

NOTICES TO CORRESPONDENTS.

PROFESSOR TOMLINSON has been elected President, and Mr. H. J. C. Andrews Vice-President of the British Problem Association.

CORRECT SOLUTION to 412 by T. A. Amery; that by B. Hooker is wrong.

ANSWERS TO CORRESPONDENTS.

*** *All communications should be addressed to the* EDITOR *of the* ENGLISH MECHANIC, 31, *Tavistock-street, Covent Garden, W.C.*

HINTS TO CORRESPONDENTS.

1. Write on one side of the paper only, and put drawings for illustrations on separate pieces of paper. 2. Put titles to queries, and when answering queries put the numbers as well as the titles of the queries to which the replies refer. 3. No charge is made for inserting letters, queries, or replies. 4. Commercial letters, or queries, or replies are not inserted. 5. No question asking for education or scientific information is answered through the post. 6. Letters sent to correspondents, under cover to the Editor, are not forwarded; and the names of correspondents are not given to inquirers.

The following are the initials, &c., of letters to hand up to Tuesday evening, March 19, and unacknowledged elsewhere:—

T. FLETCHER.—G. Read.—W. H. Davies.—G. Knott.—L. Michiels.—Major Lymberry.—J. Elliott.—R. Vion.—W. E. Metford.—Champion Bros.—R. W. Armstrong.—W. Hunt.—W. B. Osberne.—J. L.—J. Cooper.—J. H. Collins.—F. G. S.—Willesden.—W. J. B. R.—R.—Hugh Clements.—A. R. M.—Speravi.—Etna.—Mongibello.—W. E. Brown.—Biasfree.—W. Burns.—C. Lever.—Nemo.—Stromboli.—Chelt.—New Zealand.—M. S., A Beginner.—Omega.—W. J. B.—John.—Cotton Mill.—E. H. Jones.—W. S.—Amateur.—Arcanum.—E. M. R.—Tom Connor's Cat.—J. G.—Benj. Snooks.—E. B. C.—Psycho.—W. L. Pendered.—J. E. Nugent.—F.R.A.S.—J. F. Dickson.—Niobe.—Rupes Vadum.—R. H.—F. G. B.—J. C.—M. L. J.—F. R. Waite.—F. J. Jackson.—Inquirer.—Hammer.—No. 3.—Short Stroke.—W. T..le.—Malt and Hops.—Wm. Cross.—Æquo Animo.—C. P.—Anxious Enquirer.—An Old Member.—Buttershaw.—J. Wilson.—Filius Agricolæ.—T. K.—Young Land.—C. O. G.—Momentum.—R. D.—Wallasey.—G. P. Turner.—J. Brown, Belfast.—A. Wright.—R. N. W. J.—Blind Bat.

SEMI DETACHED. (You will find all you want in the back volumes of the *Building News.*)—J. TYLDESLEY. (It is impossible to answer such a question as you put. You had better get a maker's catalogue. See indices to Vols. IX., X., XI., and XII.)—PACIFIC. (We have inserted the query, and can do no more. Stamps forwarded as directed.)—BLACK NOSE. (You can do nothing else except abstain as much as possible from animal food and especially from fat meat.)—S. HOGG. (You were invited to *advertise* your address, and must do so if you wish privately to communicate with the correspondent who replied to your query.)—F. W C. (It is impossible.)—F. C. D. (A private letter to Mr. Lancaster would most easily procure you the information you want.)—J. TAYLOR. (We described Edison's phonograph on p. 275, No. 662.)—F. W. CARMICHAEL. (Such an invitation would in all probability be useless, but we should be glad to have a description of the oven.)—ROSCOEITE. (Do you mean Gallium, or Davyum?) N. F. DENNING, F.R.A.S. (Thanks.)—J. R. S. (Nothing.)—N. T. C. (See p. 47 of last vol. for particulars respecting Cape Mounted Police.)—T. R. DOBSON. (We do not forward letters.)—WAYGOOD. (Thoroughly impracticable as are all such attempts.)—H. CRAWFORD. (Many thanks. We think a condensed abstract would be acceptable.)—COUNT FOSCO. (Swift, or any other respectable maker, will best advise you.) T. PARKER. (No.)—J. HILDERSLEY. (Not received.)—D. E. G. (Your claim must be sent to the overseer of your parish between Aug. 1 and 25, and must be repeated every year. Put yourself in communication with the local registration committee of whichever party you belong to.)—MORRIS COHEN. (Please send.)—THEODORE EVANS. (It kills by immediately paralysing the action of the heart; the smell has nothing to do with the cause of death. The acid is moderately volatile.)

FORTI NIHIL DIFFICILE, Rob Roy, O. E. C. C.—See indices to back vols.

J. PAISLEY, Target, Charity, J. H. S., Dorset Member A. M. S., Ironside, Argus.—Your queries are advts.

H. Y. J., R. J. Johnson, J. H. Collins, E. E. P., and others have replied to queries already similarly answered.

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The English Mechanic
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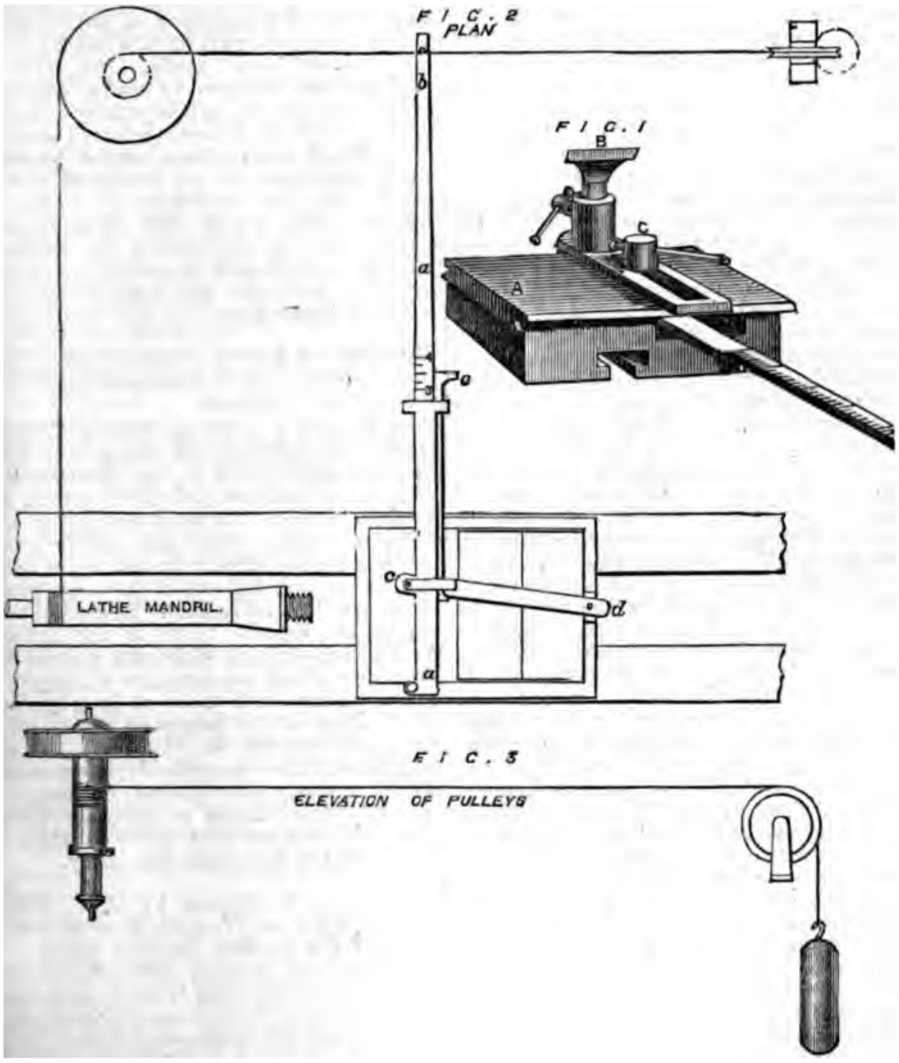
FRIDAY, MARCH 29, 1878.

ARTICLES.

SCREWMANIA.—III.

IN a previous paper upon screw-chasing contrivances, I had occasion to mention that of the Messrs. Cooke and Sons, of York, whose high-class work is too well known to need special mention. I have now received their kind permission to describe the apparatus invented by them more accurately, and its ingenious arrangement will be at once apparent. The perspective drawing of the rest and the details are copied from tracings kindly sent me by the inventor a few years ago. I believe I had, at the same time, sent me a few more particulars, of which, however, I only seem to have some very brief notes in my scrap-book. They will, however, afford sufficient explanation r our present purpose. Referring first to he perspective drawing, A is the sliding ver of the hollow base. The latter being formed at D as to allow of its being mped to the lathe-bed by a T-headed t. Inside it are the working levers, by ich the top is slid to and fro. Upon the A, is clamped a small hand-rest, made the usual manner. The long lever is, as ll be seen, graduated with a vernier at the de to still further reduce the several main graduations. Fig. 2 is a plan view of the levers and their attachments. The main lever, *a*, on the end of which the cord is attached, is pivotted, as seen, upon a screw attached to the case, but the short lever is pivotted to the under-side of the sliding cover. Thus, if the long lever is moved sideways by the cord, the cover will slide in the same direction. The rate of traverse depends on the distance of *c*, the end of the short lever from the pivot, *a*. The angles made with each other by the levers are wholly disregarded as not affecting the *practical* use of the apparatus, and none knows better than the inventors—who are makers of astronomical instruments — the precise nature and amount of theoretical error introduced by the plan here adopted. Finding that, for the required purpose of the apparatus, this is of no importance, the arrangement has not been complicated by additions by which this error might, no doubt, have been corrected. It is, therefore, more than probable that, if I had myself adhered to my original idea, instead of going in "for correction of error," the apparatus would have proved quite as efficient in a practical point of view. Still, I am inclined to adopt the rack, and endeavour thus to introduce the corrective at the sacrifice of simplicity. The cross lever is attached to the main one by a slide or link at *c*, and the two are wedged by the long cotter, *e*, at the required division. In regard to the latter, Messrs. Cooke say, "A sliding index traverses a divided portion of the lever, and when it is desired to use the apparatus, the required number of threads per inch, divided into 40, will give the corresponding number opposite to which the sliding index should be fixed. Thus, if 10 threads per inch are required (40 ÷ 10 = 4), the index should therefore be fixed opposite the figure 4, and the corresponding screw-tool held on the rest. The drawing shows the rest of the arrangement so clearly that no further description need be given, except in calling attention to the elevation of the pulleys in Fig. 3. Comparing the latter with the plan, it will be seen that the cord to the mandrel passes to the largest part of the pulley, while the cord to the weight is attached to the lower part. The cords are simply looped over a pin at the end of the lever, as seen in both drawings. The pulley is so sized that the end of the lever traverses half an inch for every revolution of the mandrel.



Of the apparatus thus described, Messrs. Cooke speak thus:—"It was invented by Mr. Cooke in 1838, and has been used daily in our works since that time. By the use of it an inexperienced hand is enabled to cut screws—the machine giving him a true lead—after which he may finish them in the usual way, the only attention necessary being the steady holding of the screw-tool on the small rest, and giving the necessary reciprocating motion to the lathe. In use the machine is clamped to the lathe-bed in the same way as the ordinary hand-rest, and as parallel to it as the eye is capable of judging. Before looping the cords on to the small pin, there should be several turns of the first cord made around the mandrel to insure its working without slip, and to secure the required traverse, for the least slip would be fatal to its correct action. The weight must also be heavy enough to keep the cord tight, so that the coils on the mandrel shall be undone instantly as the treadle rises. With these precautions there is every reason to suppose that the apparatus will always prove as efficient in other hands as in the maker's, when once the knack has been acquired of causing the fly-wheel and crank to swing only half a turn and back again, and also of gripping the tool and rest firmly together. But the necessity of acquiring this knack is not confined to such apparatus as the above, for without it nothing can be done with the *traversing mandrel* unless the slide-rest is used, and even then the treadle action has to be learned by practice. Of course, one object of Messrs. Cooke's machine is to do away with the traversing mandrel for mere screw-chasing purposes, and to substitute a plan applicable to lathes in which the mandrel runs in a collar and back centre, and my own opinion is that they have achieved this in a perfectly practical and satisfactory manner, so much so that my only regret is that I cannot afford to purchase the apparatus—the price I see is £6, and not £5 as stated.

With regard to the arrangement of rack and toothed segment, sketched in a recent number, the only alteration that some might find easier to make would be to substitute a round bar of iron for the squared slide, under which the rack is fixed. This, as it would of course be turned in the lathe, may possibly be easier to get up than the square bar, which, simple as it is on paper, requires very good filing to make it work smoothly, yet without shake as it ought to do. The bar would require to have a flat filed below on which to attach the rack, and by this it could be kept from rotating on its axis. At the same time, it is not as good a plan as to have a nicely squared bar. I am not sure, but I believe I am right in thinking that square or triangular, or other shaped bars of steel, can be had accurately rolled, which would require very little touching up on either side. Just a rub, perhaps, on a flat bit of oilstone. We country folk are at a sad disadvantage in not being able to go out and hunt up such articles, and, indeed, city folk certainly ought to do all things of this kind far better owing, to the facility of

VOL. XXVII.—NO. 679.

obtaining, at an hour's notice, not only tools of all kinds, but also various odds and ends so valuable in a workshop, but absolutely beyond the reach of those who live at a distance from London, or any large manufacturing town. It is true that one can send for such things, but every workman knows the vast advantage of being able to go personally to the toolshop, and there to pick out for himself exactly the article suited to his requirements. Well, I am not envious. Give me country air, and let me see spring dawning on every shrub and tree, and I will put up with a few of these inconveniences of the workshop. In London it will soon be all up with J. L.

REVIEWS.

A Star Atlas for Students and Observers. By R. A. Proctor. London: Longmans.

This star atlas, which shows 6,000 stars and 1,500 double stars, nebulæ, &c., is so well known to our readers and the astronomical world generally that we need scarcely do more than announce the publication of a fourth edition—an event sufficiently remarkable to form the best testimonial to the value of Mr. Proctor's labours. Three editions have been sold in about the time that it was expected the first would be distributed, and such evidence of the growing popularity of star observation induced Mr. Proctor to issue a new and cheaper edition. The date for which the atlas is constructed is 1880, so that it is more nearly correct as to the places of the stars than when first issued, and it will continue to be so until 1890. It will, moreover, not be so far from exactness (on account of precession) as the S. D. U. K. maps and Harding's Atlas are now, until 1927. In the present edition the gnomonic maps, which in former editions were employed as index-plates, have been replaced by a single sheet, showing the arrangement of the northern and southern maps at one view. They can be obtained in a separate form of the publishers, but as only a comparatively few of those to whom this atlas is most useful would have occasion to use the gnomonic maps, their omission seemed to be a suitable means of reducing the cost of the present edition. Numerous corrections, many of them supplied by the remarkable double and triple star discoveries of Mr. Burnham, have been made in the maps, the alterations having been made in the original drawings by the mappist, and fresh photo-lithographs taken. To those who are about to become the owners of telescopes we would say that Mr. Webb's "Celestial Objects" and Mr. Proctor's "Star Atlas" are the necessary complements to the instrument.

Transits of Venus. By R. A. Proctor. London: Longmans.

This is the third edition of a work of so purely technical a character that many were surprised to learn that 1,500 copies were sold within six months. The subject, however, though not a popular one, had attracted considerable attention owing to the prominence given in the daily papers to the accounts of the preparations for observing the transit of Venus by various Governments, and also in consequence of a controversy between some of the leading men in the astronomical world. The object to be obtained by observations of the passage of Venus over the face of the sun, and the results actually secured, are now presented in the author's clear and interesting style, and though the subject can never have an absorbing interest to those of the public who read scientific books, even when they are acquainted with the important nature of the observations described, the approaching transit of 1882 is now so close upon us that this, the third, edition of the only popular account of the transits of Venus and the prominent part they play in the science of astronomy, will be welcomed by an ever-widening circle of readers, and the facts recorded will probably have no little influence in determining the details of the British Expedition of 1882.

The Construction of Roads and Streets. By H. Law and D. Kinnear Clark. London: Crosby Lockwood.

This book is almost a new work by Mr. Kinnear Clark, for the fact is that he has revised and corrected the "art of constructing common roads," originally written by Mr. Law, and has supplemented it with a treatise on the "recent practice," including pavements of stone, wood, and asphalte. As a digest of all the available facts in connection with road-making Local Boards would do well to have a copy of this work in their board-rooms, and if they could compel their surveyors to study it we might see much better roads in suburban localities than we find at present. As a rule, suburban roads are, to use a little excusable hyperbole, either deserts of dust or oceans of mud—that is, when they are not covered with those nubbly stones or fragments of granite laid loosely on the surface, to be ground to powder by the wheels of passing vehicles. Few parishes will go to the expense of even hiring a steam-roller to consolidate and surface the roads, although it would be true economy; and it is doubtful whether the Society for the Prevention of Cruelty to animals would undertake to prosecute a Local Board or two with the view of trying the question whether horses are not cruelly treated by being compelled to draw loads over highways surfaced with a layer of loose stones. London itself offers an admirable trial ground for the different kinds of pavement, and the Corporation deserves the thanks of the municipalities for the manner in which they have endeavoured to obtain the useful information published in the reports of their engineer. The most interesting portions of the book, to the general reader, are those which describe the modern methods of paving streets in towns, in order to secure a suitable surface for the passage of heavy traffic with durability and cleanliness. Asphalte, granite, and wood are the three materials now used throughout London, if we except those few instances where, as on the Embankment, the authorities prefer to try Macadam. Of these there seems to be little doubt that wood is steadily gaining ground, though, probably, where the abolition of noise is not the first consideration, granite cubes will still hold their own. It is known, from data obtained by observation, that a horse travels many more miles without falling on a wooden road than on either granite or asphalte; but besides that advantage there are others which tend to bring wood into favour. It is not so cleanly as asphalte, but it is, probably, cheaper, and can be more readily repaired, while it affords the best foothold for horses and is less noisy. Wood is, however, liable to absorb moisture, and may become so impregnated with noxious matters as to be positively offensive and dangerous to health at certain seasons; but wood pavements have in recent years much improved, and there is still probability of further improvement. It appears, too, that there is a saving of labour in cleansing wood as compared with granite, though of course asphalte stands first. Thus, for four loads of mud removed from a macadam road, it is found that one load is removed from a granite surface, and one-third of a load from a wood pavement. The tables of cost of construction and maintenance supplied by Mr. Clark are useful for purposes of comparison, while the technical information given will be found of considerable value by surveyors and others engaged in road-making.

Mineralogy. By J. H. Collins, F.G.S. London: W. Collins, Sons, and Co.

In this, the first volume of Mineralogy in Collins's Advanced Series, the author treats of the general principles of mineralogy, leaving the detailed descriptions of the minerals to a separate work now in the press. Mr. Collins's "First Book of Mineralogy" is well known to the students in the elementary stages and to working miners, and in writing the present work he has kept in view their special requirements. He has used plain language, and in dealing with Crystallography has remembered that the majority of his readers would labour under the disadvantage of a defective mathematical training—consequently, the definitions and descriptions are not always so precise and perspicuous as, with greater knowledge on the part of the reader, they might have been made. Mr. Collins recommends teachers to make constant reference to models, and especially to actual specimens of the minerals referred to; and although, of course, there cannot be anything very novel in his treatment of the subject, he has produced a condensed treatise (with nearly 600 illustrations), which will be appreciated by working miners, students, and others who are unable to obtain the larger and more pretentious works on mineralogy.

Miscellaneous Papers Connected with Physical Science. By H. Lloyd, D.D., D.C.L. London: Longmans.

The learned Provost of Trinity College, Dublin, has followed the example set him by other contributors to the Transactions of scientific societies, and has reprinted in a volume some of his most interesting and valuable papers. They are mainly upon subjects connected with the science of light and magnetism, but two of them are upon the climatology of Ireland. Several of the papers are reports made to the British Association—one, an elaborate account of the progress and present state of physical optics, having been made so long ago as 1834. Many of the papers on optical subjects are treated in the mathematical manner, and are consequently less popular than they might otherwise be; but they are valuable contributions to science, and the fact that they are now gathered into one volume will be appreciated by many.

Destructive Distillation, by E. J. Mills, D.Sc., F.R.S. (Van Voorst), is a "manualette" of the paraffin, coal-tar, rosin, oil, petroleum, and kindred industries, which will be found useful by both students and manufacturers. The former will appreciate the value of the bibliography which Dr. Mills appends, and the latter should find, in the explanation of the principles underlying the processes with which they are familiar, knowledge that may be of importance in assisting them to make new departures, and to open out fresh fields of industry.—*The Picture Amateur's Handbook and Dictionary of Painters*, by P. Daryl, B.A. (Crosby Lockwood), is intended as a guide to the amateur in ascertaining the authorship, quality, and value of a picture. The various methods of painting are briefly described, and the practical details of the various processes from the commencement of a picture to its restoration are explained, accompanied by descriptions of the different "schools," and a dictionary of painters, with the copyists and imitators of the masters. Mr. Daryl makes a slip when he attempts to compare the pigmentary colours with the colours of the spectrum, for he tells us that "blue is the complementary of orange, because orange is composed of yellow and red. and with blue would make white *light.*" "Blues," says Mr. Daryl, "are either ferrocyanides of *potassium*, as Prussian blue, or vegetable *dyes*, as indigo. Nearly all greens are *extracts* of copper."—*Morality*, by James Platt (Simpkin, Marshall, and Co.), is a thoughtful little book, which cannot but do good to all who read it. Mr. Platt is a well-read man.—*Trades Unionism and its Results*, by Sir Edmund Beckett, Bart. (Crosby Lockwood), is a reprint of Sir Edmund's letters to the *Times*, with some additions. We believe that the majority of working men heartily like Sir Edmund's denunciations, powerless as they are to effect any change in their belief in unionism. They are too one-sided. Sir Edmund, for instance, asks the unions to "justify their prohibition of piece-work wherever they can," apparently unaware that the unions do not prohibit piece-work per se, but object to having piece-work and time-work mixed up in such a manner that the work which yields least money is done by the piece, while that which yields the most is done on time. The unions say, "Let the work be done on one system all round," and where it is almost impossible to do it by the piece, they insist, as far as they can, on time-work. Can Sir Edmund point to a trade without a union to which an artisan in a good position would care to apprentice his son? Trades without unions have the dregs of the labour market as their slaves.—*Principles of Elementary Mechanics*, by De Volson Wood (Trübner) is a textbook by the professor of mathematics and mechanics in the Stevens Institute of Technology, which, so far as we can see, is no improvement upon half a dozen others which have become recognised class-books. —*A Lecture on the Winds, Ocean Currents, and Tides*, by W. L. Jordan (Hardwicke and Bogue), is a second edition of one of Mr. Jordan's "Challenge" lectures. The author appears to think that scientific men will discuss a difficult subject in public instead of in camera. His hypothesis is probably as sound as others bearing on the tides and ocean currents, and those who wish to know what it is will find it in these lectures; but a scientific society is the proper place for its discussion. We do not understand that the Royal Society has refused to receive Mr. Jordan's papers.—*Bell's Telephone*, edited by Kate Field (Bradbury, Agnew, and Co.) reads more like an advertisement than a description of the telephone. At least, we can find no explanation of the principle of the electrical transmission of sound, but simply a brief history of Prof. Bell's experiments and a hotch-potch of "extracts from the press," of no value whatever.—*The Future of Sanitary Science*, by B. W. Richardson, M.D. (Macmillan), is a reprint of an address delivered before the Sanitary Institute.—*The Woolwich System of Rifled Ordnance*, by its Inventor (C. F. Hodgson and Son), is an account of the treatment received by Mr. W. F. Padwick at the hands of the authorities. The War Office offered Mr. Padwick £100 for his invention of what is known as the "Woolwich" system of rifled guns—that is, studded projectiles—on the ground that he was the first to introduce it to the notice of the department.—*Builders' and Contractors' Price-book*, by F. T. W. Miller (Crosby Lockwood), is the well-known annual the publication of which is looked for by those to whom it is useful.—*Treatise on Modern Horology*, by Claudius Saunier, translated by J. Tripplin and Ed. Rigg, M.A. (J. Tripplin), is the first part of an English edition of the valuable work of Saunier, containing the original coloured plates and woodcuts. It is the standard work on watchmaking, and will doubtless find a large circle of readers amongst the representatives of the trade in this country,—*The Student's Algebra*, by the Right Rev. J. W. Colenso, D.D., edited by Rev. J. Hunter, M.A. (Longmans), is practically a new book, comprising Part I. and portions of Part II. of the well-known Algebra of the Bishop of Natal, with additions by the editor, the whole revised and approved by Dr. Colenso. It is well adapted for the use of pupils in schools and colleges, specimens of university examination papers having been furnished by the editor.—*Elementary Botany*, by W. Bland (Bemrose), is the second part of a useful little manual on the science, the first part of which we noticed favourably some time back.—*Industrial Art* (Hardwicke and Bogue) is the first volume of a monthly review of technical and scientific education. The illustrations of art work will be useful, but the descriptions of some of the articles described partake too much of the nature of advertisements to be received with confidence by the public. Such sentences as the following:—"The workmanship of the ——— is most perfect, and beautifully finished in every detail. The prices are moderate," &c., are out of place in a review of "technical and scientific education."

We have also received *Slate and Slate Quarrying*, by D. C. Davies (Crosby Lockwood); *The Human Eye*, by Dr. Dudgeon (Hardwicke and Bogue); *History of Bible Plants*, by John Smith, A.L.S. (Hardwicke and Bogue); *The Scientific Basis of Music*, by Dr. Stone, one of Messrs. Novello's music primers; *Remunerative Railways for New Countries*, by R. C. Rapier (E. and F. N. Spon); *Studies in Physical Science*, by W. J. Millar (Marlborough and Co.; and *The Lake Dwellings of Switzerland and Other Parts of Europe*, by Dr F. Keller (Longmans).

THE ORGAN: A COMPREHENSIVE TREATISE ON ITS MANUFACTURE, PROCURAL, AND LODGMENT.*

By John Watson Warman,

Associate of the College of Organists, London.

PART I.—GENERAL TREATMENT IN MANUFACTURE.

f. With regard to *Form* of Feeder there are, broadly speaking, three—the *hinged*, or cuneiform; the *cuckoo* (a mere variety of the hinged); and the *whole drop*, which is simply an inverted Horizontal Receiver, generally of one fold. Either variety may be of either Double or Single action. The Hinged is the most general and useful form (as the Blowing action is so simplified), it must be considered the *normal* type. The Cuckoo should only be used in *small* Organs which have no *Foot*-blowing action, and it will be manifest that these are rare, comparatively; its advantages are that the side pieces, or linings (which should with Cuckoo always be attached to middle-board) will increase rigidity of Bellows without adding to vertical space required, and that Blowing-action is limited to simple Lever and single rigid Rod. The Feeder-board must also be rendered rigid, but this can be done by girder-shaped Bracepiece or pieces firmly affixed edgewise beneath Feeder. Of course, when Bellows are large, this ceases to be practicable without a wider Brace or Spine than is desirable. The Cuckoo, however, is strictly to be guarded against when Foot-blower is used (*see* 16, s.), for not only can one Feeder not be used without other, but there is no way of blowing by foot *at all*, without either loading one Feeder (and this, even if permissible, would render any but the very smallest Bellows too heavy for foot to drive at all), or having two Pedals, and working them reciprocally; this latter is generally impracticable, and always inconvenient.

g. The Whole-drop will only be used either when room is short or machine blower employed; it obviously supplies a great deal of wind, but risks the steadiness, as the Feeder is thrown up with some velocity; the risk is, of course, not so great with machinery that *never* exceeds a certain rapidity, but it is always best to have two Feeders if of whole-drop, for while a single one of the size of Receiver will be very undesirable, two will do very well. Remember, however, that all whole-drop Feeders cause more work in Blowing-action. The foregoing relates to Single-action Feeders. With regard to Double-action the Cuckoo should never be made so; the Whole-drop Feeder is never recommended to be made double-action when of the full size of the Receiver, for the amount thrown is so great in such cases as to peril steadiness, and making two Feeders of it here does not, as already seen (6, *d.*), mend matters; if the designer intends to use only *part* of the space under the Receiver, and economise the remainder, well and good.

h. The best method to follow when space is very limited will be to have double-action *hinged* Feeder, the under one to drive with up-stroke; this is always a good arrangement with scanty winding, for not only will Blowing-action not be elaborated, it will be *simplified*, as but one Lug is wanted and no increase of height involved; note, however, the presence of a Foot-blower renders it impracticable. And it must be understood that double-action Feeders, except as directly to be stated, are not advisable as a rule, for the simple reason (which must always be borne in mind) that they save *space* and *time*, but not *power*.

i. This exception relates to Feeders that are distinct from Receivers. Here we may freely use double-action Feeders with parallel ribs same shape as whole-drop, only that in this case it is generally more convenient to place them upright—thus arises the "Vertical Feeder"; it must, however, be remembered that the same fundamental rule holds good—the Feeder must be smaller than the Receiver it supplies. Double-action Feeders are more fully described further on.

j. It may be here observed that the Feeder ribs have occasionally been made to fold outwards. An examples was furnished in the Organ by Willis in Exhibition of 1862, afterwards at Muswell-hill first palace; also a small instrument made by Mr. W. Pugh, of Canterbury, from drawings of present writer. The objects are the avoidance of *compression* of the Feeding air, and chance of *blowing outwards* of ribs when narrow in proportion to amount of drop. Nothing is gained in economy of material unless Ribs allowed to project beyond Board edge.

k. With respect to *Size*, the ratio of area total to area of Receiver has already been given (5, 3.). It only remains to say that where there are more than one Feeder they should be *alike* in size if *machine blower* used, or handle *reversible* (unless one a mere occasional handle, or "Teacher's blower"), or it be *double-handled* —that is, a blowist at both ends at *once*. In all *other* cases one should be *larger in area* than other (the drop always the same in all), and the larger be driven with the downstroke of the Handle, or with the right foot of the Pedal action; if both actions present this consideration of posit of the larger Feeder must be thought of in deciding which side to posit Handle. Where there are three Feeders blown without a Revolving-shaft, two will be alike and the third rather larger—the latter driven by the up-stroke, the two smaller by the down; but, as already said (6, d.), three Feeders with a Beam-blower should always be, if possible, avoided. Whenever the Interior form of Waste-valve is used the vent must, of course, be equalised; therefore, with such Waste-valve (which, however, is not a desirable form, see 6, c.), three Feeders are forbidden altogether, unless driven by revolving shaft, and whether two or three Feeders be used they ought, with this Waste-valve, to be all or both of one size.

l. The *posit of hinge*—that is, at what part of Organ and Bellows the hinge-side of latter should be placed—demands a little more consideration; the posit of Blowing Handle or other actuator is fully gone into in Blowing-action (18, i.), and this to a certain extent obviously involves the posit of Lug, and therefore of Feeder-hinge; but it does not *inevitably* do so, and latter will now be considered with respect to itself; of course its agreement with best posit for Handle is studied as far as possible.

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m. There can be little question that the best side for the hinge in a small Organ will be that nearest the keys; this is supposing two Feeders, and they small enough to be driven by simple Socket-pedal (*see* Blowing action, 16, u.), in each; if there be Swell Shutters opening to outer space the room under them is economised, and whether they be at back or at side (as when Keys also at side) this will be convenient. It is true the arrangement will not provide a Teacher's Blower, but Case will here be narrow enough for this to be affixed on as an extra to outside of Case side; or, if preferred, it can be a regular Lever, with reversible socket handle, this, generally, only when intended to act through wall or partition at back of Organ.

n. When Bellows too large to allow of Socket Blowing-pedals (in such case there ought always to be two Feeders present), the best arrangement will unquestionably be to have hinges at side, Bellows at same time being kept, if possible, so that Handle comes convenient for Teacher—that is, not too far to the side. The reversal will, of course, bring Handle at back; if room can be allowed behind Organ this is all that is required; or, to pass through back wall or partition, is good in chamber arrangement; if room cannot be allowed at back of Organ, a Back-blower can be very easily provided to act on the existing Beam. The Foot-blower will be Pedal and T-spindle acting on the Feeder nearest performer.

o. The two foregoing will be, as a rule, the best arrangements, but they cannot obviously always be carried out. *First*, a small Organ may have but one Feeder: in such case it is best to hinge it at side, having Foot-blower as last said; Blowing-handle will *ship* on a square protruding through and from side of Case, and so Handle be adjustable to project either towards *front* (thus giving Teacher's Blower), or towards back of room (or even through back wall or partition), for regular blowist; if no room thus, ship on upright, blowist is still back out of the way. *Second*, if no Foot-blower required, and there be no room at back of Organ, and it also be not practicable to carry Handle through back wall or partition, hinges may be at side nearest Player, then Blower-handle at back part of side of Case. *Third*, the economy of room must not be forgotten—that is, that the placing of Lug at narrower side of Feeder will involve less loss of room. *Fourth*, the keeping of Lugs a certain distance apart must be borne in mind (*see* s. *next* for this.)

p. Hinge placed at back has not been mentioned, and simply because the author most strongly deprecates this position if it can be avoided. If the Bellows be small the use of Socket Blowing-pedal becomes prevented, and, in fact, the application of any Foot-pedal rendered difficult; while the Blowing-beam, although at front, will generally be wrong for Teacher's Blower (and also in way of Touch-action), while Blowist proper cannot be got out of the way without a second lever. Of course there will be cases where blowing-handle can only be at front, as when Organ fits into Recess almost as deep as itself; but in such event it will be better to have hinges at side and Blower projecting from front, for Blowist will be little more inconvenience than if just round the corner, and the advantages of Teachers' blower and non-interference with front action become secured.

In some cases, where a confined Organ is placed in an apse, it will be best to hinge Feeders at back, and have a plain Blowing-beam projecting from Side very near to Front; by this means the Handle will be at some shallower point of the apse, and can be as long as desired without "grubbing" against wall.

q. No special directions necessary for Cuckoo Feeder.

r. With respect to the *particular* side chosen for hinge when at side, go if circumstances will permit of it by convenience of Foot-blower; this, of course, will generally bring hinge to right of player, so T-spindle to left of him, and pedal thus under his right foot.

s. There now remains the consideration of the *drop of the Feeder*, and the relation of this to the distance apart of the Lugs. It will be obvious that a certain such distance must be maintained, otherwise the deflection of Tug-top becomes too great; a safe rule will be the same as for Draw-action (*see* that *Department*)—viz., one-third as *minimum*; thus, supposing the drop of the Feeder 6in., the two Lugs may be as little as 18in. apart, but no closer; this point must be kept in view in the entire designing of the Bellows. With regard to actual amount of drop, it is difficult to give any precise directions; care must be taken that it be not too great in proportion to width of Feeder across Lug, for then space is lost. Of course a narrow rib and slight drop are more economical (if not *too* limited) than more drop, for the fold reduces the capacity of the Feeder; and although the drop is greater, more power is required, or, as an alternative, more motion at Blowing-bandle. It may be, I think, laid down that, for a Bellows containing 40 square feet, 6in. will be a very good drop; and that 4in. on one hand and 9in. on other may be set as boundaries.

(*To be continued.*)

CANOES AND CANOEING.—II.

By a Member of the Royal Canoe Club.

(*Continued from page 4.*)

CEDAR is a nice-looking wood, but is apt to split when exposed to the sun, and also any bumping on rocks will be certain to split the planks. For decks nothing equals a piece of well-seasoned cedar. Red pine is a hard heavy wood, not often used in canoe-building, but ships' boats are often built of it. Yellow pine is often used for the planks of canoes. All spars should be made of this material, being light and straight-grained. A mast made of pine will break on coming in contact with anything without tearing up the deck or breaking beams. Mahogany is a good wood for canoes, large numbers of ships' boats being now constructed of it. Spanish chestnut is a good wood for the timbers, and it is very tough and strong. Birch is a very good wood for the beams, carlines, timbers, &c. For all-round cruising nothing equals English oak for the planking. The three floor streaks on each side should be strong, the fourth lighter, and the top streak of mahogany or cedar, and the deck of cedar, well supported by pine carlines let into the top of the beams; this gives great strength to the deck, and adds very little to the weight.

Before proceeding to describe the best type of canoe for cruising, it will be as well to give a few particulars of the Rob Roy and Ringleader class of canoes; the former are about 14ft. long and 26in. beam, generally of oak, with cedar deck, and rigged with one mast and a low ugly lugsail. The well is small, nearly square, and covered with a macintosh apron. No rudder is used with these boats; they are practically useless in a sea, owing to their want of sheer, the top of the stem and stern-posts being lower than the deck-line amidships, which makes running dangerous when the water is at all lumpy. They are apt to bury their bows under water and lose way, when a following sea is liable to swamp them. To remedy this, Mr. Baden Powell designed the Nautilus canoe, which was built on entirely different lines to the Rob Roy. The Ringleader was longer than the former, and had less beam, but she cannot be considered an improvement on a Rob Roy. Either of these canoes will sail well with the wind anywhere abaft the beam. For full description of the Rob Roy, with illustrations, I must refer my readers to Mr. MacGregor's excellent work, "Rob Roy on the Baltic." I cannot advise any one to have anything to do with either of the last-mentioned canoes. I will now proceed to describe in full the modified Nautilus canoe, which I consider to be the best yet constructed. The original Nautilus was 14ft. long and 28in. beam, height of stem 21in., stern 18in. The following particulars and dimensions will, if followed, form the best type of canoe for all-round cruising and general travelling purposes: Extreme length, 14½ft.; beam, 28in. to 30in.; height of stem, 21in.; stern, 18in. or 19in. If the canoe is intended for much open water cruising the beam should not be less than 30in., or even 32in., the greatest beam being about 12in. abaft, the mid length depth of keel 1½in., but if a centre-board is used the keel may be reduced to ¾in. Two watertight bulkheads should be built in—one at the back of the seat upon which the back rest hangs, the other 2ft. farther aft, the space between forming a lo[illegible] access to it being by means of a lid behind [illegible] back rest. The main-mast is stepped about 20[illegible] from the stem, the mizen about 3ft. from [illegible] stern, no foresail is used, but the boom of [illegible] lug projects 9in. or 10in. before the mast. B[illegible] masts should be stepped in tubes from [illegible] deck to the keelson, which may be of copper [illegible] wood. These, of course, must be stro[illegible] fitted, as a great strain is put on them w[illegible] under sail. The depth at midships should [illegible] about 11in. from top of top streak to the bott[illegible] of keel, and the keel should have about 1[illegible] of camber—this will give a large amount [illegible] sheer, and prevent diving when running bef[illegible] short seas, and also create a tendency to ri herself after being upset. In the drawing t half deck plan, Fig. 1, gives the half wid of the deck line, also the form of well lockers (*a*, *a*, *a*, bulkheads). The body pl Fig. 2, shows the shape of stem and ste posts, also the position of bulkheads, ma &c.; *a*, *a*, *a*, bulkheads; *b*, locker; *c*, back- The rudder should hang about 4in. below level of keel, and be fastened to the stern- by a long rod and eyes on each, as it may necessary to raise it when coming to shal —lines run from the *yoke* (which looks b if brass), to an arrangement for steering

FIG. 1

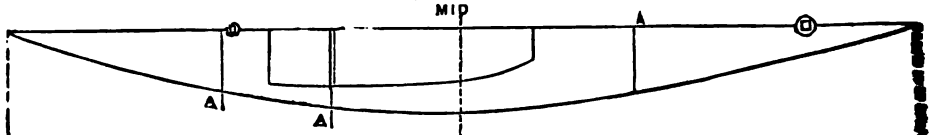


FIG. 2

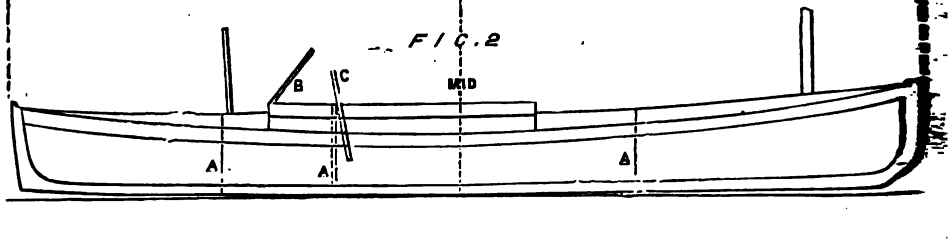


FIG. 3

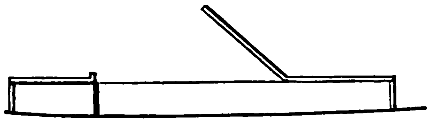
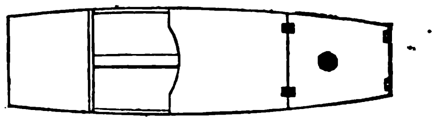


FIG. 4



the feet, by which the hands are at full liberty to attend the sails. The well is covered by a folding wooden cover, hinged on to the front combing, and again in the middle of its length, the part near the body being cut out as in the drawing, Figs. 3 and 4. With care this can be fitted watertight round the combing; the portion which is fastened to the combing will serve as a rest for a compass, which should be fastened down by a thumb-screw from the inside.

In very heavy seas a waterproof sheet is useful to throw over the whole of the hatch, and tucked close in round the body; this also forms a useful cover to the well when the canoe is not in use. If a centreboard is used in a canoe it will occupy the space, A B, in the body plan, Fig. 2, and should be made of ⅛in. galvanised iron. Paddles.—For general cruising work an 8ft. paddle is best, jointed at the middle by means of ferrules. This enables the paddle to be easily stowed under the deck. It should be made of yellow pine, free from knots, and bound with copper round the ends. For travelling, a straight blade with rounded ends is better than a spoon-bladed one; the latter hold the water better, but are not of any use for steering when sailing. An indiarubber ring just outside the hand on each side will prevent the drippings from running inboard. A good plan for carrying the paddle when under sail is to have a brass crutch fastened to the top streak near the elbow. The paddle rests in this, with the blado trailing in the water. By this means the boat may be kept under control when running before a heavy sea, as the rudder is often out of the water. Care should be taken to secure the paddle by a short line, as it is very liable to get washed away. This once happened to the writer when on a cruise six miles from the shore.

(*To be continued.*)

ASTRONOMICAL NOTES FOR APRIL.

The Sun.

Day of Month.	Souths.	At Greenwich Mean Noon. Right Ascension.	Declination North.	Sidereal Time.
	h. m. s.	h. m. s.	° ′ ″	h. m. s.
1	0 3 55·85p.m	0 42 47	4 36 13	0 38 50·73
6	0 2 27·26 „	1 1 1	6 30 46	0 58 33·50
11	0 1 8·55 „	1 19 20	8 22 30	1 18 16·27
16	11 59 46·62a.m	1 37 46	10 10 40	1 37 59·04
21	11 58 38·83 „	1 56 21	11 54 40	1 57 41·81
26	11 57 42·33 „	2 15 7	13 33 49	2 17 24·59

The same extraordinary inactivity continues on the Solar disc. The present protracted period of minimum sunspots, accords but indifferently indeed with the 11·11 year period.

The Moon

Is New at 9h. 14·2m. at night on the 2nd; and enters her First Quarter at 2h. 54·8m. p.m. on the 10th. She will be Full at 5h. 57·3m. in the early morning of the 17th, and enter her Last Quarter at 8h. 33·1 a.m. on the 4th.

Day of Month.	Moon's Age at Noon.	Souths.
	Days.	h. m.
1	28·4	11 2·2 a.m.
6	3·6	2 41·2 p.m.
11	8·6	7 19 0 „
16	13·6	11 38·9 „
21	18·6	3 32 3 a.m.
26	23·6	7 41·3 „

Moon will be in conjunction with Saturn a.m. on the 2nd; with Mercury at 7 a.m. the 4th; with Mars at 5 p.m. on the 7th; Jupiter at 11 a.m. on the 24th; with Venus noon on the 28th; and, lastly, once more with Saturn at 3 o'clock the next morning.

Occultations of (and Near Approaches to) Fixed Stars by the Moon.

Day of Month.	Name of Star.	Mag.	Disappearance.	Moon's Limb.	Angle from N. Point.	Angle from Vertex.	Reappearance.	Moon's Limb.	Angle from N. Point.	Angle from Vertex.
			h. m.		°	°	h. m.		°	°
9	37 Geminorum	6	9 51 p.m.	Dark	59	103	10 50 p.m.	Bright	287	310
10	84 Geminorum	6½	9 45 „	Dark	25	65	10 33 „	Bright	288	330
13	48 Leonis	6	6 40 „	Dark	61	34	7 48 „	Bright	233	217
17	75 Virginis	6	† 3 38 a.m.	N.N.E.	156	188				
27	67 Aquarii	6	† 4 26 „	N.N.W.	208	176				

† Near approaches.

Mercury

Is an Evening Star during the entire month of April; and is most favourably situated for the observer about the middle of it. At this time he sets more than two hours after the Sun, and may be well seen in the west with the naked eye on clear evenings. He attains his greatest elongation E (19° 40′) at 7 p.m. on the 15th.

Day of month.	Right Ascension.	Declination North.	Souths.
	h. m.	° ′	h. m.
1	1 25·6	9 34·7	0 46·6 p.m.
6	1 59·6	13 47·9	1 0·9 „
11	2 28·8	17 7·7	1 10·3 „
16	2 50·9	19 20 3	1 12·7 „
21	3 4·3	20 21·1	1 6·4 „
26	3 8·4	20 10·6	0 50·9 „

The planet will thus travel from Pisces into Aries, without, however, approaching any star more conspicuous than the 4½ mag. one, δ Arietis, North of which he will be found on the evening of the 21st.

Venus

Is a Morning Star from the beginning of April to the end of it, and is an interesting telescopic object, presenting a crescent like that of the Moon when the latter is nearly six days old.

Day of Month.	Right Ascension.	Declination South.	Souths.
	h. m.	° ′	h. m.
1	22 5·4	8 3 2	9 27·0 a.m.
6	22 18·4	7 42·5	9 20·3 „
11	22 33·0	7 6·3	9 15·2 „
16	22 48·8	6 16 0	9 11·3 „
21	23 5·7	5 12·8	9 8·4 „
26	23 23·2	3 58 0	9 6·3 „

The path thus indicated will carry Venus from Aquarius into Pisces, through a tolerably barren region of the sky. She will be situated a degree or two to the North of the 4th mag. star, λ Aquarii, on the afternoon and evening of the 15th.

Mars.

As we stated last month, we shall discontinue our Ephemeris of this planet until he approaches the Earth again sufficiently near to render his superficial detail visible in the telescope.

Jupiter

Is a Morning Star during the whole of April; but is about as badly placed for the observer as he well can be. He will be in (so-called) quadrature with the Sun at 5 a.m. on the 26th.

Day of Month.	Right Ascension.	Declination South.	Souths.
	h. m.	° ′	h. m.
1	20 20·8	19 49 1	7 42·6 a.m.
6	20 23·7	19 39 9	7 25·9 „
11	20 26·5	19 31·4	7 9 0 „
16	20 29·0	19 23 5	6 51 8 „
21	20 31·2	19 16 5	6 34 4 „
26	20 33 2	19 10 3	6 16·7 „

Jupiter, starting thus from a point to the South of π Capricorni, will travel towards the star υ in the same Constellation.

We give a short list of the (possibly observable) phenomena of

Jupiter's Satellites.

Day of Month	Satellite.	Phenomenon.	—
			h. m. s.
3	*III*	*Tr E*	3 58 0 a.m.
4	*IV*	*Ec D*	4 24 14 „
5	*II*	*Sh I*	3 41 0 „
7	*II*	*Oc R*	4 11 0 „
7	*I*	*Sh I*	5 15 0 „
9	*I*	*Tr E*	3 20 0 „
10	*III*	*Tr I*	4 36 0 „
15	*I*	*Ec D*	4 19 51 „
16	*I*	*Tr I*	2 55 0 „
16	I	Sh E	3 56 0 „
17	*III*	*Sh I*	3 26 0 „
21	*IV*	*Ec R*	2 18 15 „
21	II	Ec D	3 55 12 „
23	I	Sh I	3 30 0 „
28	II	Tr E	3 45 0 „
23	*I*	*Tr I*	4 49 0 „
24	*I*	*Oc R*	4 19 0 „
28	*III*	*Oc D*	2 40 0 „
30	II	Tr I	3 25 0 „
30	*II*	*Sh E*	3 43 0 „

Ec. Eclipse; Oc. Occultation; Tr. Transit of Satellite; Sh. Transit of Shadow; D. Disappearance; R. Reappearance; I. Ingress; E Egress. The printing of a phenomenon in *italics* indicates that its visibility is rendered doubtful, either by the brightness of the twilight, or by Jupiter's proximity to the horizon.

Saturn

Is much too close to the Sun to be visible.

Uranus

Is still very well placed, indeed, for telescopic observation, as he is visible during the whole of the working hours of the night.

Day of Month.	Right Ascension.	Declination North.	Souths.
	h. m.	° ′	h. m.
1	9 53·1	13 40·6	9 12·8 p.m.
6	9 52·6	13 42·9	8 52·6 „
11	9 52·2	13 44·8	8 32·6 „
16	9 51·9	13 46·3	8 12·6 „
21	9 51·7	13 47·4	7 52·6 „
26	9 51·5	13 48·0	7 32·8 „

Uranus will thus never depart very far from the immediate neighbourhood of the 5th magnitude Star ν Leonis.

Neptune

Is in conjunction with the Sun at 4 p.m. on the 27th; and, consequently, is now wholly invisible.

Shooting Stars

Should be looked for on the nights from the 19th to the 21st of April (and notably on that of the 20th). Also from the 26 to the 30th.

Greenwich Mean Time of Southing of Ten of the Principal Fixed Stars on Night of April 1st, 1878.

Star.	Souths. h.	m.	s.	
6 Cancri	7	16	1·20	„
ι Ursæ Majoris	8	10	42·74	„
α Hydræ	8	41	21·17	„
Regulus	9	21	31·93	„
α Ursa Majoris	10	15	44·31	„
δ Crateris	10	32	42·26	„
β Leonis	11	2	13 40	„
β Corvi	11	47	14 36	„
α Canum Venaticorum ...	12	9	31 83	„
Spica Virginis	12	37	53 36	„

The method of determining the Local Mean Time of Southing of either of the Stars in the above list, will be found on p. 60 of Vol. XXIII.; and that of finding the instant of its Meridian Passage at Greenwich for any other night in April on p. 393 of Vol. XXII.

ACTION OF COLOURED LIGHT ON THE GALVANIC CONDUCTIVITY OF SELENIUM.

AMONG other physicists who have been studying the variations produced by light in the conducting power of selenium is M. Forssmann, who, in a recent number of the *Annalen der Physik und Chemie*, deals with the influence of coloured light. He employed for his experiments bars of cast selenium of about 2mm. diameter, which were made conductive by heating for some time in an air-bath. The influence of coloured light was first examined by sending the light through glasses of various colours to the bar of selenium, and measuring the resistance of the latter by the deflections of a galvanometer. In one such series of experiments the following mean values were obtained: In daylight, a deflection of 205 scale divisions; under red glass, 194 divisions; under blue glass, 188; under green glass, 169. Using lamplight, direct illumination gave a deflection of 175 divisions, while with red glass the deflection was 176, with blue 169, with yellow 178, and with green 148.

From these and from all the other measurements it appeared that the increase of the conductivity is much less when the light passes through green glass than when it passes through light of another colour: thus the action of the green part of the spectrum seems to be a minimum on either side of which there is a rise.

Further experiments were made by M. Forssmann with light which was passed through some green solutions—viz., those of cupric chloride, chromic chloride, selenium in sulphuric acid, nickel salt, and others. We may here also give the numbers of our series. While in darkness the deflection was 108 scale divisions, lamplight gave 150 divisions, with cupric chloride 116, selenium solution 154, chameleon solution 153, and nickel solution 143. The entire series of experiments yielded the following results:—

The ether vibrations passing through various liquids modify, in very different degree, the conductivity of selenium. A cupric-salt solution, although it admits the greater part of the visible spectrum, produces nearly as much diminution of the current strength, as complete exclusion of light. The sulphuric acid coloured with selenium, which was much less penetrable by light than the cupric chloride, made the current strength even greater than in directly incident light. The chromic chloride, though quite intransparent, gave about the same values as those in direct light, and it was the same with the chameleon solution. The nickel salt and the indigo solution diminished the intensity of the current, and the latter, when sufficiently concentrated, even gave the same current strength as was obtained in darkness.

"From this I conclude," says the author, "that in general it is not the light vibrations, or certain kinds of them, that produce the variations of conductive resistance, but vibrations of another order. The perceptible spectrum produced by light, heat, and chemical force, embraces only two octaves. It is not at all impossible, however, that, besides this spectrum, there are vibrations which have neither lighting, heating, nor chemical action. Might we not attribute to these hitherto reactionless rays the variations of the resistance? This question, then, as to the nature of the active rays is still an open one, the decision of which remains for future researches. It has also yet to be determined whether the change in conducting power is to be ascribed to a superficial transformation of the conductor, or whether it is accompanied by molecular changes of the entire mass."

In conclusion, M. Forssmann calls attention to the following phenomenon. After the selenium bar had for some time received ether vibrations, which had passed through copper salt, the current strength, on removal of the copper solution, rose very quickly to over its normal value in direct light. With selenium solution the opposite occurred.

IMPROVED YEAST.

AN improved method of manufacturing yeast, which is claimed to yield a strong, white, and sweet product, has been recently patented by Mr. J. A. Liebert, of Portsmouth. The improved yeast is produced at a nominal cost, and without the use of chemicals or costly plant. It is stated to be of good quality, remarkably durable, and equal, if not superior, to any yeast of foreign manufacture. The patentee takes brewers', distillers', or other yeast fresh from the tun, and strains it through a fine hair sieve, pressing the liquor out by means of an ordinary screw or filter press. The yeast is then put under a large volume of pure cold water in a large yeast-back or other similar vessel, stirred well, and allowed to settle. About every eight hours, when the yeast has fallen to the bottom, the dirty bitter water is run off through a tap or bung hole, placed underneath at the end of the yeast-back. This process is repeated as often as necessary, until it is found that the bitterness and colour are removed; which is generally effected in two or three washings. The yeast is next refermented in unheaded casks, or other open vessels, under a low temperature of about from 42 to 45 degrees Fahr., produced by placing the fermenting-cask in an outer vessel, or refrigerator, filled partly with cold water, which can be cooled in any approved manner, either by the addition of ice or by the use of an ordinary cooling apparatus; 2½ to 5 per cent. of pure alcohol is then mixed with about 10 per cent. of cereals, such as the flour of wheat, rye, buck-wheat, malt, and similar cereals. (The patentee prefers a mixture of equal parts of finely ground rye-flour, buckwheat flour, and Hungarian or Californian wheat flour.) To these ingredients about two gallons of hot water is added for every 100 pounds in weight of the compressed yeast (that being sufficient to break up the yeast), the temperature being from 170 to 180 degrees Fahr. The whole is then stirred into a thin mash, and allowed to stand in a covered vessel for half an hour, so as to effect the formation of grape sugar, which, after cooling, is added to the yeast. The latter is then permitted to ferment slowly over night, but before pressing about 20 per cent. of thick butter-milk or other similar albuminous or gelatinous substance is added, and also 2½ to 5 per cent. of gluten to give the yeast a proper consistency, and about 10 per cent. of farinaceous substance, by preference potato starch; the proportions necessarily varying according to the seasons of the year. The yeast is again pressed to obtain the proper consistency, and is then rolled with a common wooden roller-pin, or other suitable implement, to procure a sameness of colour throughout; it should then be spread out in a dry cool place as long as necessary to allow the gas to evaporate; and finally be pressed hard into strong bags made of canvas or other suitable material, which are sewn up, and kept in a cool dry place ready for use.

Mr. H. W. Hammersmith, of South Bend, Ohio, has invented an improved rail joint, or vice, for connecting broken rails. It consists of a jaw, bearing upon the fish plate at one side of the joint of the rails, and extending in the shape of a bolt below the base to a second jaw, which is secured by a screw nut on the end of the bolt, so as to bear tightly on the opposite fish plate.

THE TECHNOLOGY OF PAPER-MAKING.—XI.*

The Various Classes of Paper; Characteristic Differences. The Determination of the Ash or Loading. Water Supply. General Arrangement and Construction of the Mill.

THE almost endless variety of purposes to which the material is now applied involves the production of papers differing very widely in colour, texture, and strength. For bank notes and deeds of various kinds we must have paper that will stand much tear and wear, while for newspapers, which are now considered sold twenty-four hours after publication, a paper indifferent both as to strength and colour will be quite suitable. We must have strong, heavy manilla papers for wrappers and bags, and light, airy tissues to be applied to such varied purposes as making letter books, wrapping up silver plate and jewellery, and for decorations of various kinds. We must also have satin cream-laid note for writing our missives upon, and bibulous papers for blotting and filtering.

The papers in every-day use may be classified in various ways. For our present purpose it will be sufficient to look at them as divided into four groups—(1) printing papers, (2) writing papers, (3) wrapping papers, and (4) miscellaneous papers. The first group comprises about one-half of the entire paper manufactured, and of course includes products widely differing in their nature. Beginning with newspapers, we have a variety of fabrics, into the composition of which may enter esparto, straw, and wood. Made from all esparto, carefully beaten out, and not too heavily loaded, the product may be considered quite equal to all the requirements of a first-class newspaper. Mixed with, say, 7 to 10 per cent. of wood fibre, or 10 to 15 per cent. of straw, esparto will give a fairly good paper for the ordinary run of newspapers, while with larger proportions of wood or straw the strength of the sheet will diminish. Straw and wood by themselves do not give strong papers, but still they are produced and consumed in considerable quantities. The amount of clay introduced will also materially influence the character of the product. A paper made from a short, hard fibre, and heavily loaded, may be considered at the bottom of the scale, both as regards strength and flexibility; the mere look of the paper may be good enough. Next to newspaper papers come common and medium printings—they are intermediate in character between newspapers and fine printings, and are of almost endless composition and tone, to suit the views of the printer and his clients—the element of cost always being prominent. They rarely contain anything of a nature stronger than esparto, and perhaps a little jute. Fine printings are more carefully prepared than the other varieties we have spoken of, the bleaching, pulping, toning, and straining being all very carefully attended to, and the strength of the fabric increased by the addition of from 5 to 10, or even 20 per cent. of strong rags. The beauty of the texture of some of these papers is admirable, and, perhaps more than any other class of machine-made papers, illustrates the perfection to which the art has been brought. It is comparatively easy making beautiful papers when a long price can be got for them, such as will enable the manufacturer to use the finest materials obtainable, but it requires skill and experience to produce the admirable specimens I speak of with comparatively worthless materials, and at small cost. The cotton or linen rags to be blended with the esparto are put into the beating engine as bleached half-stuff, and the two materials are beaten up together. The effect of even 5 per cent. of linen upon the character of esparto paper is very noticeable, especially as conferring a considerable degree of strength to the sheet.

In the second group we have writings of all kinds, divisible at once into engine-sized and tub-sized, machine-made, and hand-made. The first-named variety differs but little from fine printings, and is produced to meet the popular demand for cheap goods. Engine-sized writings may contain a larger per-centage of rag stuffs than printings, and are more heavily sized, as well as more highly calendered. They are generally coloured, too, to meet the taste of the consumer. Tub-sized writings embrace a very large variety of papers, differing in texture, weight, colour, and marking. Among them we have some of the most beautiful products of the paper-maker's art, made from the finest, whitest, and strongest of materials, beaten so as to retain all their good qualities—strength, flexibility, and elasticity—uncontaminated with mineral matters beautifully and appropriately water-marked, and surfaced to perfection. In recent times I have been struck with the close resemblance which many of our better qualities of machine-made writings bear to hand-made papers, and it seems to me that, with skill and care, and the same quality of raw materials, machine-made papers need not be far behind the undoubtedly fine product of the hand mould. The better classes of tub-sized writings are produced from various admixtures of cotton and linen fibre. Some of them contain a small percentage of clay or pearl hardening, others starch, either introduced dry or swelled with boiling water, or both agents may be present along with whatever colouring matter may be required to give the paper the requisite shade or tone. Hand-made writings are always of a high quality, made as they are for those who can appreciate and pay for an unexceptional article. The fibres are drawn out so as to retain as much of the original length as possible, and the peculiar shake which the experienced vatman communicates to the mould causes these to interlace into a strongly felted sheet. Messrs. Hodgkinson and Messrs. Spicer have sent me some specimens of hand-made papers which are simply faultless, while Messrs. Cowan Allan and Annandale have handed me an extensive collection of their machine-made writings, which very well illustrate the remarks I have just made. Account-book papers belong to this group, and differ but little, unless in thickness and shade, from the writings we have been speaking of. Much of the paper used for this purpose is yet made by hand. Artists' papers may also be considered under this head. Complaint has been made that papers cannot now be got that are absolutely trustworthy for high-class work. It is, of course, a serious matter for the artist to find, after he has spent much time and labour in developing his ideal, that the sheet upon which he has been working has lost its flatness and its surface, and is no longer the thing of beauty which it appeared to be. I am inclined to think, however, that if paper ever was produced with all the qualities desired, it can still be produced, and that probably the prevailing cry for cheap goods has not been inoperative in even this department of the trade.

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* Being the substance of the Cantor Lectures delivered before the Society of Arts by Mr. W. Arnott, F.C.S.

The third group embraces papers of the most widely different characters, from the thinnest of caps to the heaviest manillas. The variety here is indeed endless, such as to defy even a passing reference to the various classes in the short time at our disposal. Ropes, manilla, jute, and flax waste enter largely into the composition of the stronger and heavier classes, such as cartridges, manillas, hosiery, &c., while sedges, palmetto leaves, rough grass, straw, and esparto figure in the lighter and weaker classes. Clay plays an important part, too, in the composition of some of the cheap heavy papers; and various colouring matters added to all the classes multipy the varieties very greatly.

In the fourth group is embraced all the varieties of coloured and fancy papers, and to these certainly one entire lecture might be profitably devoted; I must for the present, however, leave them untouched.

Boards, which can scarcely be included in any of the groups, are used for a variety of purposes, probably most largely for binding books. The raw materials used in their manufacture are of the coarsest kind—indeed what all other mills reject can be readily used up in the board mill. The machinery involved is much less elaborate than that used in producing paper. The finest boards are still made on moulds by hand, but the great bulk of them are produced on machines resembling the wet end of the Fourdrinier or the "cylinder." The raw material is not usually boiled at all, but is at once put into the engine. The stuff, after being beaten—and of course that is an operation that is not carried very far—is run direct into stuff chests, and from these on to the wire of the machine, the refinement of sand-traps and strainers being dispensed with. The board is not made at once by the simple draining of the stuff upon the wire, as paper is, but is made in layers. Stuff of the thickness necessary to produce boards of medium thickness would never drain upon a wire or cylinder, and could not well be made uniform with the rough materials used; the sheet is, therefore, run out very thin, so as to form a sheet something like good strong brown paper, and this, after passing between the press rolls, winds upon the upper one—which is usually of wood—until a sufficient thickness has been attained, when it is slit up and removed from the roll. The various layers, being pressed into each other while quite wet, adhere and form one solid sheet or board. The roll round which the boards are formed is grooved in several places longitudinally; the grooves serve to guide the knife used to slit up the cylinders as they attain the desired thickness. As the sheets are removed from the roll they are, of course, curved, but are easily pressed out flat upon a table. They are then made up in piles, alternated with felts, and squeezed in the hydraulic press until the bulk of the moisture has been removed. The drying which follows may be accomplished in three ways, either by the air, or on steam-heated plates, or in kilns; or the air process and either of the others may be combined. When they are to be dried by the air they are either laid out upon grass plots or put up in racks. Of course this is a very slow process, and, unless in very small establishments, quite inapplicable. Steam drying is more rapid, but it is also more expensive. Kilns or stoves are just hot-air chambers, in which the boards are arranged in racks. The drying is done rapidly in these, and if care be taken to prevent the temperature rising too high, the results are satisfactory. The boards have finally to be calendered, the rolls by which this is done being heated by steam, which enables them to impart a much higher surface to the goods than they would if cold. Before subjecting the boards to the pressure of the calenders, however, they have to be steamed for a few seconds to soften them a little; in fact, the steaming and hot calendering are exactly analogous to the damping and ironing of linen.

SOME RECENT IMPROVEMENTS IN THE METALLURGY OF NICKEL.*—II.

By ALFRED H. ALLEN, F.C.S.

(*Vice-President of the Society of Public Analysts.*)

WHEN New Caledonian ore is treated by magnesia for the separation of the iron and the nickel, the liquid separated from the precipitate containing the latter metal is a concentrated solution of nearly pure magnesium sulphate. An essential part of the invention for which I claimed protection was the production of magnesium sulphate from these liquors by the process of evaporation and crystallisation. Average samples of ore would yield nearly 150 per cent. of crystallised "Epsoms," and I found that by far the greater part of this amount was fairly obtainable. If undue dilution of the liquors be avoided, the fluid separated from the nickel precipitate is nearly saturated with magnesium sulphate when cold. Nor has this been obtained wholly from the magnesite used, for, if the ore contain 15 per cent. of magnesia, the yield from that source alone is theoretically equal to 92¼ per cent. of crystallised sulphate. But it is just this abundant production of "Epsom salts" that prevents the process being a complete success. Any magnesia in the ore necessitates the employment of sulphuric acid for its saturation. It would require very exceptional circumstances to enable the above enormous yield of "Epsoms" to be useful as a purgative, but really the chief application of magnesium sulphate is for weighting cotton-cloth.

A few years ago the manufacture of "Epsoms" in the above manner would probably have been a perfect success; but the discovery of the native deposit of magnesium sulphate, known as kieserite, prevents any likelihood of its profitable manufacture from nickel ore, while the present price of nickel is insufficient to admit of the process being successfully worked without regard to secondary products. As mentioned before, however, the process is sound in principle and may become available under altered circumstances.

A process somewhat akin to my own has been patented by M. Kamienski, of Paris. In point of date his patent has somewhat the priority of mine; my specification having been filed before the lapse of the six months which ended with the publication of his patent.

M. Kamienski dissolves in hydrochloric acid, separates silica, precipitates the iron with chlorine water and carbonate of magnesium, and then separates the nickel from the magnesium, by fractional precipitations with carbonate of sodium. He obtains common salt as a secondary product. It is evident that the same objections which render my process imperfect apply with much greater force to that of M. Kamienski.

As the New Caledonian ore contains only some 15 per cent. of heavy metals, it is evident that very great and desirable concentration would be effected by a furnace operation which would get rid of the silica and magnesia. Various processes have been suggested, in which this principle is applied, the following being those most worthy of notice.

M. Jules Garnier has patented a process by which he proposes to obtain an impure cast nickel by melting the new Caledonian ore in crucibles with carbon and appropriate fluxes. He also proposes to smelt the ore in a blast furnace similar to that used for the production of pig-iron, tapping off the molten metal at intervals, &c., and subsequently refining the crude nickel by puddling or treatment in a Bessemer converter. Whenever M. Garnier succeeds in working these processes to a profit, German silver will drive brass quite out of market, and, doubtless, many of our common iron implements will be superseded by those manufactured of nickel. Following the precedent M. Garnier has already set, in calling the Caledonian ore "Garnierite," he might christen the metal resulting from the above patented processes the name "Garnierium" or "Garnier-nickel."

The next dry process for treating New Caledonian ore is that of Mr. Alexander Parkes, of Birmingham. As described in his patent, the process consists in fusing oxidised compounds of nickel with oxide of copper, fluxes, and carbonaceous matter, so as to obtain an alloy of copper, nickel, and iron, which is to be subsequently refined. A suitable mixture consists of one ton of ten per cent. ore, four hundredweights of fluor-spar, half a hundredweight of rock salt, four hundredweights of copper scales, and two and a half hundredweights of anthracite; these are well mixed and subjected to a good heat in a reverberatory furnace for four or five hours, when an addition of from two to four hundredweight of granulated metallic copper is made, and after another hour the charge is tapped into moulds, or skimmed and run into water. To refine the crude metal thus obtained, one ton is remelted with two or three hundredweight of copper scales, one hundredweight of sand, and a half hundredweight of lime, an oxidising atmosphere being maintained.

This process has been very perseveringly tried, on a manufacturing scale, under the immediate superintendence of the inventor. As in most of the applications of nickel the metal is used in alloy with copper, the above method seems admirably adapted for the purpose. The first product contains more or less iron, and in practice it has been found very difficult to refine this even by repeated treatments with copper oxide. The alloy thus contains an excessive proportion of copper, and German silver prepared with it, requires a further addition of unalloyed nickel obtained by some other process. This is a great disadvantage, but the product would, nevertheless, have made its way had the German silver produced by it been of good quality. The cause of its failure in this respect is not very apparent. I have examined various samples of the copper-nickel alloy resulting from the treatment of New Caledonian ore by Parkes' process, and their analyses have by no means indicated the origin of the difficulty. The following analyses represent the general composition of the alloy, a specimen of which is on the table:—

	A.	B.	C.
	Per cent.	Per cent.	Per cent.
Arsenic ...	... none	... trace	... none
Copper ...	... 74·80	... 68·31	... 65·80
Lead ...	... trace	... ——	... trace
Iron ...	... ·87	... 1·47	... trace
Nickel ...	... 23·60	... 29·08	... 33·50
Sulphur ...	... ·45	... ·25	... ·34
	99·72	99·11	99·64

I am far from believing it impossible to overcome the difficulty connected with the use of Parkes' alloy, but I am unable, without committing a breach of confidence, to indicate the direction in which I am disposed to look for success.

An alternative process, described under Parkes' patent, consists in fusing New Caledonian ore with fluor spar and carbon, with addition either of sulphur, sulphate of barium, or sulphate of calcium. By this means the patentee claims to obtain a sulphide of iron and nickel which he can treat for the preparation of nickel by well-known processes. I have had some experience with the product of this mode of treatment, and find the results very different from what the patentee supposes. By fusing New Caledonian nickel ore with fluor spar, salt, sulphur, and carbon, there is obtained not a sulphide, but a silicide of nickel and iron. A regulus obtained in this way contained 17 per cent. of silicon, of which ·2 per cent. was graphitoidal, and the rest combined. It might be supposed that the failure to obtain a sulphine was due to the volatilisation of the free sulphur at a comparatively low temperature, but a similar product (though poorer in silicon) resulted when I substituted a mixture of plaster of Paris and coke for the free sulphur of the previous experiment. By somewhat varying the conditions I found it quite possible to obtain a sulphide free from silicon. I am engaged in experimenting on the whole subject, and propose to employ the process for obtaining pure silicide of nickel, and to see how far the method is generally available for the preparation of metallic silicides. It is evidently more convenient than those involving the use of potassium silico-fluoride, and it will probably much facilitate the preparation of graphitoid silicon.

Before leaving the subject of Parkes' patent I may say that recent experiments made at Birmingham, on a manufacturing scale, have given exceedingly hopeful results, but success is not yet completely attained.

By whatever method the ore is treated the ultimate product (except in the case of Parkes' copper nickel) is a more or less pure oxide of nickel. This is reduced by heating in pots with charcoal. The curious masses of metallic nickel known as cube nickel are made by mixing the oxide with wheat flour and water, so as to form a thick paste, which is cut into cubes with a knife and dried. In some cases the flour is omitted, the precipitated oxide being itself cut into cubes. The cubical masses are heated in a plumbago crucible, with charcoal powder.

Commercial nickel varies much in quality. Some samples are mere alloys of copper and nickel. All the so-called "nicked coins" are really copper-nickel alloys, containing a large proportion of copper, generally two-thirds of the whole weight. Copper is in no way objectionable in nickel to be used for the manufacture of German silver, but the presence of more than traces of iron, sulphur, lead, and antimony must be carefully avoided.

In analysing samples of commercial nickel and nickel alloys it is well to remember that the deservedly favourite method of precipitating copper with the thio-sulphate (hyposulphite) of sodium cannot be employed, as very considerable quantities of nickel are liable to be simultaneously precipitated. Results obtained by this process are sometimes erroneous to the extent of 5 per cent., or even more. As nickel alloys are valued by the units of nickel contained, and nickel is worth 4s. to 5s. per lb., this difference is quite intolerable. A process I have largely employed with exceedingly satisfactory results is the precipitatien of copper as cuprous sulphocyanide, by adding an alkaline sulphite and sulphacyanide to the faintly acid solution of the alloy. Another good method is electrolysis in an acid solution of the sulphates. After removing the copper the nickel may be thrown down in the same manner in the solution rendered strongly ammoniacal.

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* A paper read before the Chemical Section of the Society of Arts.

NOTES ON THE TELEPHONE.—II.*

By R. M. Ferguson, Ph. D., F.R.S.E.

FIRST, to show the utmost extent of a disc vibration, I connect a telephone with the galvanometer, and then tap on the disc; the deflection of the spot of light so made must be indefinitely greater than any one made by sound. I put my finger down and keep it there, for if I let it up suddenly again, the motion and counter-motion, producing opposite currents, would eliminate each other. I now lift the finger, and you see that in each case the displacement of the spot of light is hardly ¼in. I now take this two-pole magnet (Fig. 3), and bring quite close to it a heavy piece of iron, one vibration of which sends the light off the scale, and when I cause it to vibrate quickly with my hand, you see the sort of fixed quiver of the light. The currents here generated are indefinitely stronger than those of a telephone can be, and yet if they are despatched through a telephone their presence is utterly ignored. To make the case still stronger, I take a 28lb. iron weight, which is a disc of tolerable dimensions, and as I cannot well shake such a disc, in presence of the magnet, I shall shake the magnet in presence of it. Here again the agitation of the spot of light is as before, and the telephone is deaf to the whole proceeding. I shall now vary the experiment. I shall press the magnet close to the weight, and tap very faintly with the handle of a screwdriver on the other side of the weight, and the telephone does not miss a single tap. There is something remarkable in the extreme sensitiveness of the telephone to sounds in the disc and core as compared with its indifference to strong undulatory currents. Even when the magnet is placed on an armature of polished iron much heavier than itself and pulled away without noise, the telephone is still silent. The tug felt in drawing away the two from each other might make one think that if any ordinary magneto-electric undulation would effect the telephone, it should be one thus generated. How different is the action of the infinitesimal galvanic pair already referred to? Each individual break makes a distinct tick, though the strength of the current it transmits is immeasurably weaker than that induced by drawing away the armature, and the series of breaks or partial breaks is distinctly heard when the connecting wires run loosely on each other. This surely must arise from the fact that the telephone records an electric break or momentary current, but not an undulation. One could scarcely fancy anything nearer a break than the fall of current strength after the first parting of the armature from its magnet. Still, the shading away of the current corresponding to the after withdrawal of the iron from the poles prevents anything like a decided break. But it may be said that in vibrating bodies no individual vibration is heard. It is only the vibrations in series in a note or noise that are audible. But how does it happen that the single break in the circuit of almost the weakest pair that can be made is telephoned to perfection, if the principle advanced be not true? It may seem extreme to distinguish thus between a break and an undulation, but I shall cite two other examples. I have a magneto-electric machine that is electrically equivalent to a battery of six or seven Bunsen elements. The armature revolves about forty times in a second, and gives off in the same time eighty currents, each of which is an electric undulation of considerable depth from a high maximum to a low minimum. When I put the telephone in circuit and work the machine, those undulations are rendered by a dull whirr mingled with the sound produced in the iron by its rapid rotation. When the motion of the armature is slow, nothing but the latter noise is heard, and the electric undulations do not crop up at all. But if I substitute for this powerful instrument a medical magnetic machine, the wave of which is, even in highly resisting circuits, of much less strength, but whose undulations are cut short near their maximum, each electric throb thus imparted sounds like the tap of a hammer, and when the machine is driven fast, the series of such becomes almost insupportable. It is manifest, therefore, that in the telephone an undulation spoiled is an undulation gained, and that if any undulation can have an effect on it, it is not because it is an undulation, but because it approximates to a momentary current. The second illustration is this:—I take the finest platinum or German silver wire, and attach one end to the terminal wire of a galvanic pair. I take the other terminal and run it up and down rapidly on the fine wire without breaking contact, so as to lessen or increase the circuit resistance by, in an unbroken way, shutting out or including the resistance of these highly non-conducting wires—the action is not marked by the telephone. If I attach the ends of the fine wire, one to each terminal, and place one terminal on any portion of the fine wire, or take it off, thus shunting off or on the resistance of the intermediate wire at once, the telephone now answers to the electric pulses thus made. It would thus seem that the telephone answers to an electric pulse or break, but is incapable of rendering the fine outline of an undulation, and that each electric pulse is recorded in the instrument as well as the series of them. In continuation of this argument, I would mention an investigation I made with reference to the form of the telephone. It struck me that as in all magnetic actions where the two poles play together, any effect in moving armatures is much enhanced as compared with the action only of one pole, the same would be found in the telephone. All telephones hitherto only bring one pole into play. To test if such would be the case, I constructed a magnet of the shape shown in Fig. 4. I took an ordinary shilling magnet, and screwed an iron pin, ⅜in. long and ½in. in diameter, to one pole, and put a 1in. bobbin of ·007 copper wire on it. On the other pole and iron stage P was erected, to which was screwed an iron ring 3½in. outside, 2¾in. inside diameter, and ⅛in. thick. On the under side of the ring a disc was soldered, with as little tin between as possible. The object of the heavy ring was to give body to the disc, and to continue the magnetism of the other pole all round it. I began to construct on the vibrating theory, and found, when I got all to act, that the disc of ferrotype plate conveyed the sound well enough, but was accompanied with a metallic jingle. It was too thin for its size. As I did not wish to make a very loud instrument, but only to try an experiment, I did not change the ring, but used a thicker plate. I found No. 28 or No. 26 untempered steel plate to answer well. For one of the magnets I provided a stage of brass instead of iron, so that I could demonstrate the difference between a two-pole and a one-pole telephone. On sending a message, and keeping one of these in each hand, I found that the iron-staged instrument was louder than the other. To the bobbin sole I fixed a brass arm, S, with an adjusting screw to regulate the distance of the disc from the pin. The effect of distance here is very marked, a thick disc being only raised, and nothing more, from the pin to insure the best effect. Taking off the disc, and laying bare the pin and platform, I now took a box of tinned iron plate, 2in. in diameter and 1in. deep, and putting my ear to the open end, I gradually brought it close to the pin to hear the musical scale sung by a person in a distant room. When the middle of the box was held just over the pin, so as to act clear of it, the sound was as in the usual telephone. I then laid the box down on the pole, and expected the sound to die away. But no; it was still there, but like the faintest echo miles away. I then gradually shifted the box towards the other pole stage, and it grew loud till, when it was fairly on both poles, the sound broke forth again, but not so loud as in the vibrating position. I could, however, not only hear a message, but faintly send one. I then carefully listened to hear any sound that the pin might emit, for I was sure it was there, but I heard none. I next put the magnet in the circuit of a Bunsen cell, charged with water, and produced, so to speak, a galvanic message, by rubbing the connecting wire against its binding screw, and repeated the same experiment with much the same result, only the difference between the vibrating position and the two pole positions was not so marked. The sounds were now loud enough to be heard in a room, and the pin made itself heard at 1ft. off. I now repeat this experiment. The scratching sounds you thus hear are familiar to any one who has dealt with the Reis's telephone, and prove unmistakeably the identity in action of the two instruments.

FIG. 3

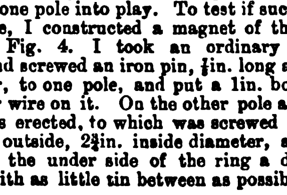
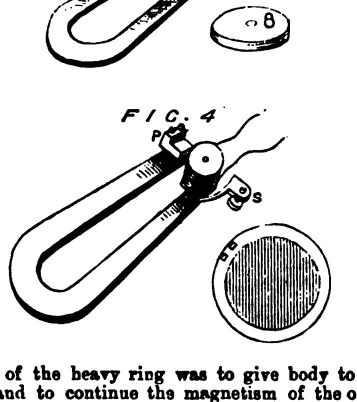


FIG. 4



I proceed to develop what I consider to be the theory of the telephone. The first great contribution to telephony comes from America, where in 1837 Page discovered the sounds that accompany the magnetisation of iron. His observations have been very much extended by the Germans. I shall endeavour to demonstrate these sounds to you by means of the two bobbin magnet I have once or twice referred to; and as it plays a considerable part in my communication, I may here describe it. It is a horse-shoe magnet (Fig. 3), about 5in. in length. A pin is screwed at right angles to one pole; and in order to allow the pin on the other pole to be 1¼in. distant, so as to admit of large bobbins on the pins, an iron plate is attached, into which the pin is screwed. The pins are ⅜in. thick and 1in. high, the bobbins are nearly 1¼in. in diameter, and are filled with ·007 copper wire. The resistance of the two is 200 ohms. This may not be the best for the purposes for which I use it, but it does well, and I have not sought to change it. The pole pins are flat on the top, and keep fixed any article of iron placed on them, partly by their flatness and partly by the strength of the magnet. When the flat round box (Fig. 3), made of thin sheet 3in. in diameter and ⅛in. deep, is put on the pole, the magnetic sounds can be well shown. I work now with Bunsen cells, and I close circuit by dipping this wire in a cup of mercury. A sound is heard, but so faint as to be only heard by those quite near it; but when I break circuit by taking the wire out of the cup, a loud tick is heard audibly for a considerable distance. You hear it almost reaches to the end of the hall. These ticks indicate a new molecular disposition in the iron, its particles in the line of magnetisation taking a new set with the magnetism, and then relapsing into their former state on the demagnetisation caused by the ceasing current. Refined observers, such as Joule, find that the iron lengthens in magnetisation, and of course shortens to its old size when left to itself. The sound thus produced is at basis a molecular vibration, though it may involve in it the ordinary transverse and longitudinal vibrations. In the single tick these last sound loudest. In rapid series, however, it is alleged by several observers that it is the molecular vibrations chiefly that sound, though these may be accompanied sympathetically by ordinary vibrations. When you make and break contact suddenly the initial and final tick sound together. If we understood the conditions in which these magnetic sounds are best produced, we should be in a position, I humbly think, to construct the best telephone. We can learn something of these by putting one or two pieces of iron on the poles. To a certain extent size increases the sound, as you will hear, when I put a 2in., a 4in., and a 6in. plate on these poles. Generally, however, a certain size answers best for a certain position of poles. Thin plates are loudest, and thick plates seem to keep the sound within them. I have here an ordinary glue-pot of cast iron, with two holes in it for screwing it tightly to the poles. The ticks from it, though scarcely audible in a room, are given as thin tinkling sounds to those near it. Anything made up in the form of a closed box, however, sounds loudest, as you perceive, when I put a 3in. disc and a 3in. box on the poles. Shallow boxes can be used instead of plates for telephones. Deep or large boxes, though they may increase a musical sound, sound hollow in speaking. These magnetic sounds are always louder when there is facility of vibration. The magnetic force plays best on the best instrument. Hence, perhaps Bell's vibrating disc is the best form of development or resonance for these magnetic sounds. He has discovered a method of making magnetic sounds loud and audible, just as a musical-instrument maker succeeds best who makes the best sounding box for his strings. The tick, too, that a plate gives out is almost exactly what it emits when it is gently tapped, and when you tick and tap alternately with about the same loudness you can scarcely discern the difference. We have, however, at basis a molecular action, of of which the vibrations of the armature plate are but a manifestation. We may have in its vibrations a momentary redistribution of magnetic matter in a magnetic field; but it is not the simple play between magnet and keeper that is the essence of Professor Bell's theory. The action occurs when the keeper lies fixed on the poles, and without a keeper at all, for with electric messages powerful enough the core of the magnet itself sounds without any aid. The magnetic conditions of this action are as yet comparatively unexplored territory.

The next stage in the history of telephony was Reis's application of these ticks to the telegraphing of musical sounds. The magnetic ticks of the plates and vessels just examined are, for the most part, the fundamental notes produced by transverse vibrations. When the current is frequently interrupted, the individual ticks are no longer observed, and a note is produced, dependent in pitch solely on the frequency of the interruptions. This note is, however, accompanied by the metallic clang of the fundamental note, and the sharpness of the former is thereby much impaired. It is, therefore, of the utmost importance to suppress this confusing accompaniment, and this is done in every good telephone by damping or muffling the fundamental note. This is affected by jamming the diaphragm between two pieces of wood, so that it sounds dull and dead quite without clang. When a weak galvanic pair is extemporised by putting the blade of a knife in a tumbler of ordinary water, and the other element is supplied by the end of the copper wire coming from the binding screw of a Bell telephone, and when the wire from the other screw is made to touch the part of the knife above the water, the first magnetic tick is heard, and when it is lifted the second sounds. In either case it is a dull tap. The loudness and unmusical character of these ticks is a rough test of the loudness and definition of the instrument. It conforms to acoustic principles that any single vibration repeated with any degree of intensity, in any order, and with any rapidity, will be able to render all the complexities of articulate speech. The magnetic tick or tremor is capable of all this. We have but to send electric currents, which are the electric interpretation of these sounds, to such a magnetic arrangement, and the tick will reproduce them to perfection. Everything depends on the perfection of the sending instrument, and therein chiefly lay the imperfection of the Reis telephone.

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* A paper read at a meeting of the Royal Scottish iety of Arts, and published in the *Engineer*.

We now come to the crowning stage in the history of telephony. Professor Graham Bell, in addition to developing the receiving instrument of Reis, has shown that the receiving instrument makes a perfect sending instrument. That it does so, as he represents, is open, as we have shown, to grave question. It is much more likely that the sending action is the converse of the receiving action—viz., instead of electricity producing sound through molecular action, that sound produces electricity through molecular action. Vibrations play their part in this as in the magnetic tick, in some way heightening the action. Each element of sound may be something like the tick which is converted into a momentary current, and recorded at the other end. If there be such molecularly generated currents, their presence has not hitherto been suspected. Nothing but a magnetic substance produces them; nothing but such can reveal their existence.

I would sum up what I humbly submit as the theory of this perplexing instrument. At the receiving station it can be proved well-nigh to demonstration that it is a molecular tremor or vibration, and not a vibration mechanically produced, that emits the sound, and this molecular vibration becomes louder the easier the sounding body vibrates. Seeing that there is the most perfect correspondence between the sending and receiving instruments, there is every reason to to believe that the sending instrument exhibits the converse action to the receiving instrument, and that there again sound acts on iron so as to produce molecular changes, the electric power of which is much enhanced by the vibration of the sounding body.

That this theory is not all speculation, I introduce to your notice a new form of the telephone, half Reis, half Bell. It is nothing else than the two-bobbin magnet (Fig. 3) with the shallow tin box, B, placed on its poles. Here there is no vibrating disc. We might call it a fixed plate telephone, for the box is held firmly by the poles. With two such instruments I have occasionally worked quite satisfactorily; but as it is only here in pieces, and not put up for use, its action is not yet quite to be depended on. However, it has reached the stage that, with a disc telephone at the one end and it at the other, messages can be clearly given and received by it. I have had no labour in the construction, as the parts of it were made to develope magnetic sounds. It might be called a free and easy telephone, for any scrap of iron laid on the poles will send or receive a message in a sort of way, very much proportional to the powers, as you have heard, of showing magnetic ticks. I can easily send a musical message through this cast-iron glue pot—sometimes even a verbal message. I can also with ease deliver a message through a biscuit tin. The shallow tin box is selected because it is the most resonant of magnetic sounds. Still, even here vibration follows hard on the heels of molecular action, for I cannot screw these boxes firmly to the poles without very much weakening the sound. They can be pressed, however, by a wooden frame on the poles without compromising their action. On the other hand, if they rock on their poles, the message is not well sent. The bearing of the fixed plate telephone on the drift of these notes must be evident to any one. Reis's telephone was an iron wire in a coil. In the present apparatus the wire and coil is only bent up into a horseshoe form, and a box put on the top. The wire or core of the magnet emits sound when the currents transmitted are strong enough. The box only serves to bring them into relief. With weak currents I must use the box, for my ear is not sensitive enough to hear them in the core. So much for galvanic currents. With telephonic currents the box is again necessary. Is it not almost a certainty that I should also hear by the core if my ear were sharper? The Bell receiver is thus not essentially different from the Reis receiver—it is only an improved modification. When I speak through one of these telephones I use an instrument, in my opinion, identical with Bell's; and when I receive at the other end, I have only the developed knitting-pin and coil of Reis.

Before concluding, I would only guard myself against the possible imputation of not fully appreciating the genius of the man who has presented the world with this wonderful gift. I have endeavoured to prove that in future books of science Bell's discoveries will be given as twofold; first, having devised, perhaps, the best way of developing magnetic sounds in iron; and, second, of showing that the condition produced in iron by external sounds results in electricity. But I cannot close my eyes to the fact that it is easy to register or examine a thing when it is got. The getting of it is the important matter. Every problem is easy when it is solved, but that does not detract from the merit of him who solved it. Professor Bell has furnished new material for thought and advancement, which others may work up as they may, but his is the merit of creative power.

PRACTICAL MECHANISM.—IV.*

BY MR. JOSHUA ROSE, M.E.

Teeth of Gear Wheels.

IN selecting which of the curves previously described shall be applied in the formation of a wheel or wheels the constructor is governed by the purpose for which the wheel or wheels are to be used, because the conditions will not always admit of the employment of the theoretically most desirable form of tooth. It is perhaps the better plan to first explain the mode of construction of the various forms of teeth, and to subsequently explain the conditions which determine the selection of either form. First, then, for a pair of wheels intended to work together, and not designed to work in gear with any other wheels of a different diameter, teeth having epicycloidal faces and radial flanks are usually conceded to be the most desirable. If, however, wheels require to operate with others having a different number of teeth they are termed interchangeable wheels, and require to have hypocycloidal instead of radial flanks, the faces remaining epicycloidal as before. Both of these forms of teeth are termed epicycloidal, as contradistinguished from involute teeth. Epicycloidal teeth are employed when the distance between the centres of the wheels in gear is permanently fixed, but when this distance is required to vary, involute teeth are preferred for reasons which will appear in due time.

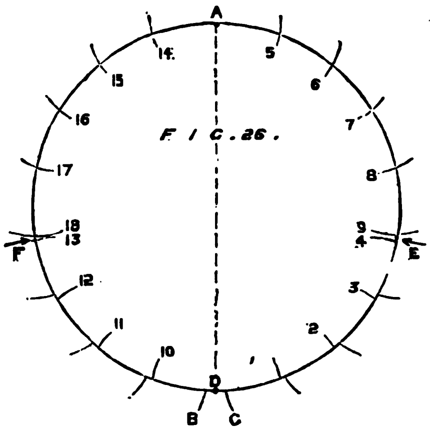

FIG. 26.

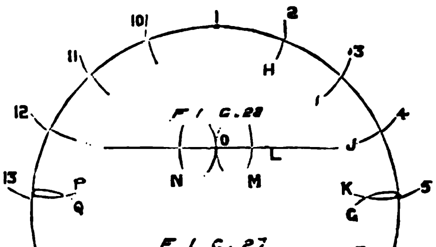

FIG. 28

FIG. 27

On account, however, of the difficulty of constructing epicycloidal teeth for pitches less than about ¾in., it is the usual practice to apply the involute curve to all pitches of that and less pitch. Small cut gears, both involute and epicycloidal, have indeed been made of late a special manufacture, and from the refinement of construction attending their production under these circumstances, they are obtainable in far more perfect form than it would be practicable to make them in the ordinary course of workshop manipulation. Fine pitch gear construction, both as regards the involute and epicycloidal forms of teeth, is indeed so entirely a branch by itself that it must receive separate treatment.

Let us now proceed with the construction of a pair of wheels to work together and not to gear with any other wheels. The distance between the wheel centres being permanent, we select, according to custom, epicycloidal teeth with radial flanks. If then we are given the diameter of the wheel at the pitch circle, and the pitch and number of teeth, we may proceed at once with the practical construction; but it is obvious that the circumference of the pitch circle must be such as will be divisible, without leaving a remainder, by the given pitch, otherwise there would be at one part of the wheel a fraction of a tooth—a construction which is impracticable; so that if the circumstances of the case require a definite circumference of pitch circle, the pitch of the teeth must be made such as will divide into that circumference without leaving a remainder; but if the circumstances compel a definite pitch we must make the pitch circle of a circumference divisible by the pitch without leaving a remainder. If one of two wheels is to be twice as large as the other, one will contain twice as many teeth as the other; hence it is much more simple to gauge the size of the wheel by the number of teeth it contains, and to avoid calculations in the workshop. Most workmen have a printed table containing columns of figures under the following headings, "Number of teeth," "Pitch 1″," "Pitch 2″," &c., "Diameter of wheel," &c., so that a ready selection of pitches or diameters suitable to any given circumstances may be made; or, finding none to exactly suit the requirements, we may select the nearest, varying either the pitch or diameter as may be most suitable. It will generally be found that the pitch diameters of wheels for certain pitches and numbers of teeth run to two or three places of decimals, and that these decimals are not convertible into such fractions of an inch as are marked on ordinary measuring rules. This, where accuracy is required (and accuracy is invaluable in gear work), has been a serious drawback in the practical operations of the workshop. The special steel gear rules of Brown & Sharpe are therefore a boon to careful workmen. These rules are marked in fine clean lines to various fractions of an inch, as 6, 7, 8, 9, 10, &c., up to 38ths, enabling the setting of the compasses to correct radius as well as their ready adjustment to chord pitch.

The diameter at the pitch circle and the pitch and number of teeth being determined, we have to find the proper addition to make to the radius of the pitch circle for the points of the teeth, and this addition is termed the addendum or "depth beyond the pitch line," as marked in the wheel scale. The proportions in that scale are those given by Professor Willis, which proportions are now almost universally acepted, except it be in so far as regards the question of clearance, which we will leave for future consideration. Referring to that scale, then, we add to the diameter of our pitch circle an amount equal to twice the "depth beyond pitch line" given, for the selected pitch, on the scale, and we have the total or extreme diameter to which the wheel must be turned, and while the wheel is in the lathe we must strike a fine circle, of correct diameter, to serve as the pitch circle. Our next duty is to divide off the wheel at the pitch circle into as many divisions as there are to be teeth in the wheel, and in the case of the larger wheels this is no easy task, because the pitch given so far is the arc pitch, and we have to convert it into chord pitch. This we may do by the construction given in Fig. 24, p. 494, Vol. XXIV.; but even by that construction it is impracticable to set the compasses to the exact proper distance, because an error of half the thickness of a line will be multiplied on going around the wheel by as many times as the pitch is contained in the circumference of the pitch circle, so that in a hundred teeth the error would amount to the thickness of fifty lines, and as all this error would fall upon the last tooth it would be too great to be admissible. By the construction shown in that figure we may set the compasses so near as to save spacing over the wheel two or three times, and this is a great assistance [illegible] it is impracticable to set the [illegible] as to space off the wheel [illegible] accuracy, we can only adopt a method that will be practically correct and that will divide whatever error there may be between a number of teeth; and this may be done as follows:—Commencing (for a wheel having an even number of teeth) at any point, A, upon the circle, Fig. 26, we mark off on the left and outside of the circle as many divisions as equal in number one-half of the required number of teeth, the last division so made being denoted in the figure by B. Commencing again at A, we mark off the same number of divisions on the other outside of the circle, arriving at C, and midway between B and C on the circle we mark a point, D; and no matter whether the compasses were set correctly or not, D will be exactly diametrically opposite to A. It may occur to the reader that D may be more readily obtained by a straight edge intersecting A and B, and carried across to D; but the process as here carried out shows us that the compasses are set too close together to an amount equal to the one-eighteenth part of the distance between C and D at the pitch circle; hence we may oilstone the compasses with a slip a slip of stone applied to both points on the inside so as to correct them.

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* From the *Scientific American*. Continued from p. 494, Vol. XXVI.

Meantime the wheel having an even number of teeth, A and D are two correctly marked divisions. With our compasses corrected to the best of our judgment we proceed to obtain two more correct divisions as follows:—Starting at D, we mark within the circle the lines 1, 2, 3, 4, and then starting from A we mark the lines 5, 6, 7, 8, and 9, and the centre between the lines 4 and 9 is another correct division, and if the lines exactly meet at the circle the compasses are correctly set; but, if not, we may oilstone the points again. Here it is to be noted that in the divisions marked to obtain our first point, D, the marks were all made outside the circle, and all short and of about equal length, while the divisions to obtain our second point, E, were marked within the circle; the object of this is to keep the lines distinct and thus insure greater accuracy. On small wheels it is sometimes advisable to step the points of the compasses around to set them approximately correct without drawing any lines, the object being to avoid having a confusion of lines. Starting again from D, we mark the lines from 10 to 13 inclusive, and starting from A, we mark those from 14 to 18 inclusive, obtaining the point, F, correctly. Continuing this process between A and E, E and D, D and F, and F and A, we may step or divide off the wheel more accurately than is possible by any other means with compasses, and the error, whatever it may be, will be too fine in itself and too widely distributed to be found by any ordinary workshop measurement. If, however, the number of teeth in the wheel is an odd instead of an even one the process requires to be slightly varied, as follows: Setting the compasses as near as possible by the method shown in Fig. 24, we start from any point, 1, Fig. 27, and step off the divisions from 2 to 9, and then commencing again at 1 the divisions from 10 to 17, and the error of the set of the compasses will be shown in the difference between the distance between 17 and 9 and the set of the compasses, and since there are 17 divisions in the circle the compasses require altering to the 1-17th part of the difference. This being done as nearly as the judgment can determine, we find the centre between 9 and 17, which must be done with another pair of compasses, because it is impracticable to reset the pair first used as true as the construction has enabled us to do. We then draw a straight line, L, Fig. 28, and with the first pair of compasses, with one point resting on the line and used as a centre, we mark a section of circle, M. Then resting the other compass point upon the intersection of M and L, we draw the section of circle, N, and from M to N will be the length of each division. Taking the second pair of compasses, we find on the line, L, the centre between M and N, producing the point, O. Adjusting these compasses so that one point resting upon O, the other exactly coincides with M and N respectively, we, with these compasses, rest one point in the centre, A, and mark on the inside of the circle the lines, B and C, and the distance between C and B will be that of the first and adjusted pair of compasses. Then, starting from B, we mark on the inside of the circle the divisions, the lines, D E F and G, and then commencing at the point 1 we mark also inside the circle the divisions, H I J K, and equidistant between K and G on the circle we obtain another of our permanent and correct points of divisions. This process we carry out on the other side of the circle, beginning first at C and then at 1, producing another permanent division equidistant between P and Q at the circle. We have thus obtained five accurate points of division, represented by the points, 1, C, B, K G, and P Q, on the pitch circle, and continuing the process from those points we may obtain all the others, and thus obtain an accuracy that would be unobtainable by stepping entirely around the circle.

F. Rosetti finds the temperatures of the flame of the Bunsen burner to be in the external envelope, 1,350°; in the violet portion, 1,250°; in the blue, 1,200°.

SCIENTIFIC NEWS.

THE Committee of Public Accounts, in one of their reports refer to the expenditure in the Science and Art Department in the year ended March 31, 1877. They say that the total cost of the Loan Exhibition will probably exceed £15,000, an expenditure incurred without the knowledge of Parliament or the sanction of the Treasury. Apart from all considerations as to whether or not the Exhibition was worth the money, a very serious—the committee call it "grave"—irregularity has been committed by some persons in authority. If the House votes a sum of money, or the Treasury sanctions its expenditure, John Bull may grumble, but he knows that the vote has been regular, or that his servants are prepared to justify their sanction, but in this case a sum of £15,000 has been expended without the sanction of the Treasury, and without a vote from Parliament. If the money was spent in the bonâ-fide expenses of that Exhibition there is nothing more to say except—Don't do it again; but from the manner in which a request for the items has been treated a very unpleasant suspicion has got abroad that something more than a "grave irregularity" has been perpetrated. Hence the mild recommendation of the Committee of Public Accounts—that, whenever it is proposed to hold an exhibition which will in any material degree increase the expenditure under the various sub-heads, a note to that effect should be appended to the estimates for the information of Parliament, will not satisfy the present critics, and will not inspire them with any confidence in the ability of the Department to advance the best interests of science and art.

The death is announced of Dr. J. R. Mayer, at Heilbronn. The deceased was famous as the propounder of the mechanical theory of heat.

At the Royal Institution recently Lord Rayleigh "discoursed" on the explanation of certain acoustical phenomena—mainly with reference to the maintenance of vibrations producing sound, especially by means of heat. A modification of a Trevelyan rocker was shown to be capable of producing a continuous sound, the maintenance of the vibrations depending in all cases upon the maintaining force being applied at the right moment. The hydrogen singing flame was shown in various forms, Lord Rayleigh saying he had worked out the explanation mathematically, but hesitated to put it into a colloquial form. A simple glass tube, with a ball at one end, when heated, gave out a continuous musical note, as also did a tube with a wire grating in it, the grating continuing the note after the tube was removed from the source of heat. Lord Rayleigh said he believed the explanations usually given of many of these phenomena were incorrect, but from the nature of the conclusions at which he had arrived, and the short time at his disposal, it was impossible to describe them to the audience. Presumably they will appear in the second volume of his "Theory of Sound."

At the meeting of the Edinburgh Royal Society last week, Prof. Tait gave an account of his investigations into thermal conductivity. He finds that there is generally an increase of thermal conductivity on a rise in temperature, and not a decrease, as in the case of iron; that the thermal conductivity of electrically bad is greatly inferior to that of electrically good copper; that German silver is about the same as electrically good copper in conducting power for heat, but he was not able to give the proportions between the thermal and electrical conductivities of the bodies named.

A modification of the bichromate cell has been introduced to this country under the name of the pneumatic battery. Instead of a carbon plate, the negative consists of a copper plate coated with lead, one side of which is faced with platinum. The most peculiar feature of the cell, however, is a method of aërating the solution by means of a perforated tube fixed into the bottom of each cell, and through which air can be blown by a fan or forced by pressure. The result is said to be an extraordinary development of power. The exciting solution is composed of 5 pints of water to one of sulphuric acid, to which is added 12oz. of bichromate of potash. A battery of ten cells is sufficient to bring a platinum wire of 14 B. W. G., 30in. long, to a red heat in a very short time when air is injected. Opinions are divided as to the cause of the remarkable results, the inventor claiming that they are due to his composite metallic plates, while others regard the injected air as the acting cause, the circulation thus promoted assisting to bring fresh solution continually into contact with the plates. When air is being forced in, the battery develops an enormous amount of heat, and after a time the cells become so hot that they cannot be touched with the naked hand.

Duboisia is a new drug introduced from Australia, containing a principle resembling atropine in its action. It is an extract from the leaves of Duboisia myoporides, and will probably form a substitute for belladonna, as it acts more promptly and certainly in dilating the pupil of the eye.

The Pharmaceutical Society have issued a catalogue of the collections of materia medica and chemical products in their museum, which has been prepared by Mr. E. M. Holmes, F.L.S., the curator.

The life of the steam boilers in the Navy is so unsatisfactory that it is proposed to appoint a committee of naval officers and scientific experts to prosecute further inquiries into the cause of the deterioration. The committee which has been sitting under the presidency of Capt. Aynsley, C.B., will be dissolved.

The Yorkshire College at Leeds has, thanks to the Drapers' Company, been able to add lectures on coal-mining to its curriculum. The course commenced last week, when Mr. Lupton delivered the first of the series of lectures on the theory and practice of coal-mining, mining engineering, and colliery management to the twenty-two students.

A signalling apparatus for the telephone has recently been devised by Dr. Pulieg, of Vienna, and has the following arrangement:—Two telephones, without sounding pieces, are connected together, and placed with their bobbins opposite two tuning forks of exactly the same pitch. On the opposite side of each of the tuning forks is placed a metallic bell. Between this and the fork, and resting against the latter, hangs by a thread a small brass ball. The tuning fork at the sending station is struck with a leather-covered iron hammer, whereupon the fork at the receiving station is also put in vibration, and causes the ball to strike on the bell. The signal having been answered in the same way from the receiving station, the sounding pieces (which include the iron membranes), are adjusted, and the correspondence begins. The bell signal is so strong that with closed doors one may hear it in an adjoining room.

Our readers may be aware that, in a work published in 1854, M. Du Moncel referred to an inventor, who, with the signature of Charles B***, suggested the possibility of corresponding by means of an apparatus formed of a wire, and two vibrating plates. M. Du Moncel has now ascertained that this was M. Charles Bourseulle, sub-inspector of telegraphic wires at Auch. It is unfortunate that he was diverted from working out his ingenious idea.

The event of the French Academy séance of the 11th March was the exhibition of Edison's phonograph. The representative of the inventor, approaching the mouth of the instrument, first said, with a loud voice and a very strong English accent, "Le phonographe présente ses compliments à l'Académie des Sciences." A minute after, amid profound silence, the little apparatus was heard, with amazement, to repeat the words, giving all the inflections of the voice, including the English accent, but with a peculiar falsetto tone. The success was so marked that the grave assembly burst into applause, and eagerly demanded a fresh experiment. The American demonstrator again spoke into the instrument, which then reproduced his question and answer in the most comic manner:—"Môssieu, phonographe parles vô Français? Oui Môssieu." To convince the most incredulous that there was no trickery M. Du Moncel himself made a third experiment, and the voice as of a second Du Moncel was heard in the hall, "L'Académie remercie M. Edison de son intéressante communication." It was with difficulty, we are told, that the meeting settled down after this to its normal course.

Some curious experiments have recently been made by Messrs. Dietl and Vintschgau, with regard to the effect of morphium, coffee, and wine, on the "reaction time"—that is, the time between action of a stimulus and reply to it with a signal. The quantities taken were only such as to leave consciousness perfectly intact. Morphium was injected under the skin, and it caused a lengthening of the reaction time, which, however, disappeared in about 45 to 50 minutes if a new dose were not injected or sleep did not ensue. On taking a cup of coffee the reaction time was considerably shortened, and this effect was perceptible even two hours afterwards. Next, champagne was taken in various quantities, and with these results:—If the quantity of wine is not very great, there occurs for a certain time a shortening of the reaction time. If the wine is slowly and gradually drunk the shortening continues longer, even if the quantity taken is greater. If, lastly, a large quantity—*e.g.*, a bottle of champagne—is drunk quickly, the reaction time is very soon considerably lengthened.

The experiment of Harvey is well known, in which a hen's egg is uncovered on the third day of incubation. The beatings of the heart are perceived, but suddenly stop. The egg is then put in tepid water, and the heart begins to beat again. M. Dareste has lately gone a little further. He takes from the sitting hen an egg which has been three days under incubation, and keeps it at ordinary temperature for two or three days (of 24 hours). Then he replaces it in conditions favourable to incubation. The fowl is developed as usual. It appears from this experiment that the life of warm-blooded animals may be suspended for a very long time without death intervening, just as is the case with very inferior animals—*e.g.*, rotifers.

In connection with the recent rapid progress in electric lighting it is interesting to recall the fact that Otto Von Guericke (1602-1688), burgomaster of Magdeburg, and inventor of the air-pump, was the first who produced light by electricity. He did so by simply pressing his hands against a globe of sulphur, which was set in rapid rotation about one of its diameters. The effect he describes as being similar to the glow of sugar when bruised in the dark. The spark was obtained more distinctly a short time afterwards by Dr. Wall, by rubbing a piece of amber with a woollen cloth. He, with others, believed that in such cases the light was the cause of the electric state. The advance from these germinal observations to the electric light as now used—*e.g.*, in our lighthouses—is remarkable.

At a recent meeting of the French Physical Society M. Bertin exhibited some new applications which M. Duboscq has made with his projection apparatus, whereby opaque objects in a horizontal plane are sufficiently illuminated, and their image thrown on a screen. Among the experiments made was that of Arago, in which a horizontal magnet is carried round by the rotation of a copper disc under it. If the disc is cut there is no movement of the bar. Fragments of camphor deposited in water were shown in rapid rotation, which is instantaneously stopped by the presence of a fatty substance. The system of waves produced in a surface of mercury in vessels of various forms was also exhibited.

The important researches by M. Pasteur on germs contained in the air, have led to some quite new methods in surgery, especially that of Lister (producing a spray of carbolic acid about the part operated upon), and that of Guerin (the use of wadding in dressing wounds). It is a curious fact, however, mentioned by the celebrated traveller D'Abbadie, that on the shores of the Red Sea the conviction is universal that a wound to be healed must be exposed to the air. His own experience confirmed this. Every bandaged wound gets inevitably inflamed. He suggests the possible absence of germs in the air in those regions.

USEFUL AND SCIENTIFIC NOTES.

Great Western Railway.—Owing to want of sufficient accommodation, some extensive alterations are about to be carried out in the Paddington Station. A contract has been let for some portion of the work, which will be pushed on as rapidly as possible, in order that it may be ready for the summer traffic. The new lines and subway between Westbourne-park and Bishop's-road stations are approaching completion. The Netherton and Halesowen Railway will be ready for opening in a few days. This line will afford a new route between Birmingham and Dudley. The works of the Blendley and Kidderminster Railway have been completed, and this line is now ready for inspection by the Board of Trade. Good progress is being made in the construction of a branch line into Stourbridge. A slip over the Merthyr tunnel is to be repaired as early as possible. In the meantime, by arrangement with the Taff Vale Company, the traffic between Merthyr and Neath is carried by way of Aberdare. A vote of the proprietors has been taken for the expenditure of £251,000 on capital account, for additional carriages, extension of workshops, improvements at Paddington, Bristol, Bath, and Swansea stations, and for other purposes.

Death by Drowning.—MM. Bergeron and Montano have performed a series of experiments at the College of France, for the purpose of throwing light on some questions connected with death from submersion. From these experiments, and from the post-mortem examinations made by M. Bergeron at the Morgue, the authors draw the following conclusions:—1. The only constant and certain sign of death by drowning is the presence of foam, not only in the mouth, but in the larynx and bronchial tubes. 2. There is always some degree of congestion and occasionally of echymosis under the pleura, but the latter never presents the dotted appearance seen after death from suffocation. 3. The intensity of the congestion and the extent of the echymoses are always in proportion to the efforts made by the animal during the struggle. This has been confirmed, for the human subject, by the post-mortem examinations made at the Morgue during the last ten years. The results obtained by the College experiments are undoubtedly valuable, so far as they go, but we may be permitted to doubt whether they can be applied to cases where the individual has been submerged for any great length of time before examination of the body. The distinction under such circumstances would seem to be extremely difficult, if not impossible.

How to Keep a Piano.—Otto Brunning, writing to the *Journal de Musique*, of Paris, says:—"The piano is constructed almost exclusively of various kinds of woods and metals; cloth, skin, and felt being used also in the mechanical portion. For this reason atmospheric changes have a great effect on the quality and durability of the instrument, and it is necessary to protect it from all external influences which might affect the materials of which it is composed. It must be shaded from the sun, kept out of a draught, and, above all, guarded against sudden changes of temperature. This latter is a most frequent cause of the piano getting out of tune, and the instrument should be kept in a temperature not lower than 54deg., and not higher than 86deg. F. When too cold the wood, cloth, and skin swell, and the mechanism works badly; when too warm these materials shrink and produce clicking, squeaking, and other diagreeable sounds. Moisture is the greatest enemy of the piano, and it cannot be too carefully guarded against. In a very short time damp will destroy every good point about the instrument. The tone becomes dull and flat, the wires rusty and easily broken, the joints of the mechanism stiff, and the hammers do not strike with precision, and if these symptoms are not attended to at once, the piano is irretrievably spoilt. Therefore, do not put your piano in a damp ground-floor room, or between two windows, or between the door and the window where there is a thorough draught. Never leave the piano open when not in use, and, above all, when the room is being cleaned. Do not put it near a stove, chimney, or hot-air pipes. Always wipe the keys after playing. Never pile books, music, or other heavy things on the top. Be careful when using the soft pedal not to thump the notes. Do not allow five-note or other exercises of a small compass on a piano you have any regard for. A leather cover should be kept on the instrument when not in use, and removed every day for the purpose of dusting. A cushion of wadding or a strip of flannel laid on the keys will help to keep them white and preserve the polish. Never leave the piano open after a musical evening or dance. If you are obliged to have it in a damp room, do not place it against the wall, and raise it from the floor by means of insulators, and always cover it after playing. Employ the best tuner you can get, and if a new instrument, let it be tuned every two months during the first year, and at least three times a year afterwards. Always have it tuned after a soirée if the room has been very hot."

LETTERS TO THE EDITOR.

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[We do not hold ourselves responsible for the opinions of our correspondents. The Editor respectfully requests that all communications should be drawn up as briefly as possible.]

All communications should be addressed to the Editor of the ENGLISH MECHANIC, 31, *Tavistock-street, Covent-garden* W.C.

All Cheques and Post-office Orders to be made Payable to J. PASMORE EDWARDS.

*** *In order to facilitate reference, Correspondents, when speaking of any Letter previously inserted, will oblige by mentioning the number of the Letter, as well as the page on which it appears.*

"I would have everyone write what he knows, and as much as he knows, but no more; and that not in this only, but in all other subjects: For such a person may have some particular knowledge and experience of the nature of such a person or such a fountain, that as to other things, knows no more than what everybody does, and yet, to keep a clutter with this little pittance of his, will undertake to write the whole body of physicks: a vice from whence great inconveniences derive their original."
—*Montaigne's Essays.*

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ERRATUM – SPIRIT PHOTOGRAPHS—DARK SIDE OF VENUS—TELESCOPIC APERTURES—TIME OF FALL OF THE EARTH TO THE SUN—VORTEX RINGS—"GRAVE IRREGULARITIES" AT SOUTH KENSINGTON—SIR EDMUND BECKETT ON TRADES-UNIONISM—COLOURS OF STARS—HELIOPOLIS—FLUIDS USED FOR SPIRIT-LEVELS—FINDER—MICROSCOPE OBJECTIVES: AND STAGES

[14134.]—IN my reply to query 32289 (letter 14087, p. 13), "1 kilo must be = to 2·2046192lb." should be "1 kilo must be = 2·2046213lb."

If Mr. Brown (letter 14094, p. 16) will turn to p. 140 of Vol. XVII. of the ENGLISH MECHANIC he will find a description of a much more simple method of effecting the fraud which he describes, than his own; and a very much more striking one to boot: inasmuch as the confiding disciple may see the plate cleaned, coated with collodion, sensitised, and placed in the dark slide. He may then pose himself before the camera with the absolute certainty that no "ghost" has previously been impressed upon the collodion film, and yet, upon again accompanying the operator into his dark room and watching the development of the plate, he will find his own counterfeit presentment accompanied by that of "Katie," or of "John King" in all his glory. I was in hope that this most contemptible imposture had been finally exploded, and that the application of section 4, of 5 Geo. IV., ch. 83, to those respectable gentlemen, Monck and Slade, had driven spirit photographers to earn an honest living.

I cannot, at this moment, lay my hands upon the original record of Mr. Webb's observation of the dark side of Venus; but, in connection with letter 14097, p. 16, should like to ask him whether the unilluminated limb of the planet appeared lighter or darker than the surrounding sky? I heartily endorse the concluding sentence in letter 14099.

It may be a "mistake" (as asserted by "8¼in. O.G." in letter 14101, p. 17) "to speak of the power of a telescope as being so much to the *inch* of aperture, unless a *square* inch be used for the purpose;" and I am not concerned to defend the practice. It is, however, universal; and when it is said that a fine object-glass under favourable circumstances will bear a power of 100 to each inch of aperture, every observer and optician will at once understand it to signify that a 4¼in. object-glass of sufficient excellence would define well with a power of 425; a 7½in. with one of 750, and so on.

I must crave the forgiveness of Mr. Pinnington (reply 31945, p. 19), for saying that what is true in it is not new, and what is new is not true. He is entirely correct in his assertion "that the squares of the times of fall from different distances in space are as the cubes of the distances" of the falling body from the Sun's centre, but is wrong in his inference from it. I suspect that his mistake has arisen from his confusion of the law which he has deduced with Kepler's third law—viz., that the squares of the times of revolution are as the cubes of the mean distances from the Sun, or as the cubes of the major axes of the orbits. This law and the one he enunciates he appears to regard as identical; albeit it by no means follows that the time of fall must be equal to that of one fourth of a revolution. Reverting, for instance, to my own example on p. 600, of Vol. XXVI. (letter 14027), while it is quite true that the Earth would take 82d. 5h. 4m. 38 4sec. to fall to the Sun's centre, it is news to me that the length of our sidereal year is 328d. 20h. 18m. 33·6sec. Or taking the case of Jupiter, whose mean distance from the Sun is 5·2028 times that of the Earth, we may say correctly that as $1^3 : 5\ 2028^3 :: 83\ 211{\cdot}5^2$ days $: 975{\cdot}64^2$; but, if my memory serves me, Jupiter's sidereal revolution takes considerably longer than 3902·56 days to accomplish.

If "Amara" (query 32391, p. 24) will make a box of card 2½in. to 3in. square, and about an inch deep, and will then cut a circular hole of ¾in. diameter in the top part, he will have a very "cheap and easily constructed apparatus" indeed, for showing vortex rings. I have seen it constructed of ordinary playing cards. It is used by filling it with the smoke from a cigar, and then sharply tapping the bottom of the box with the finger. Upon each tap a vortex ring will issue into the air, until the supply of smoke is exhausted.

At last, that barefaced and most impudent job, the Loan Collection of Scientific Instruments, has attracted the attention of the Committee of Public Accounts, and in their report just issued very forcible reference is made to the scandal involved in the manner in which the public pocket was picked for the private benefit of a needy and utterly unscrupulous confederacy. "The object which the committee had in view," we learn, "has been secured by the statement which the Treasury directed should be appended to the appropriation account, and which shows the expenditure upon the Exhibition in question during the year 1876-77. In addition to the sum of £13,677 10s. 7d. so shown, it is stated that there was a previous payment of about £500 in 1875-76 on account of the Exhibition, and that there are still outstanding claims which will amount to about £1,000. The total cost of the Exhibition will then probably exceed £15,000—an expenditure which was incurred without the knowledge of Parliament or Treasury sanction. Explanations were made to your committee showing the gradual manner in which the proportions, and consequently the expenses, of this Exhibition had grown, but they trust that the minute issued by the Committee of Council on Education, dated the 18th of December, 1876, will prevent the recurrence of these grave irregularities." It is, indeed, to be trusted that some strong and stern measures will be adopted to render it impossible for the future that so wicked a waste of public funds shall ever again take place, merely to provide for a mendicant clique who want situations, but who prefer battening on the tax-payer to earning an honest living as clerks and such like. It is to be hoped that a stop will be put, at once and for all, upon such people travelling *en prince* at the public cost, and drawing public money for rendering "assistance" "without the knowledge of Parliament or Treasury sanction." No wonder that "private and confidential" circulars were hawked about by this set for signatures to petitions to perpetuate a condition of things on which they throve so merrily at the public cost. Forewarned, however, is forearmed, and it is earnestly to be hoped that the House of Commons will profit by the report from which I have been quoting, and insist upon itself deciding to a single farthing the amount to be annually spent by the Brompton Ring and their aiders and abettors. "It is," says the proverb, "of no use crying over spilt milk," and we may confidently assume that not the smallest fraction of this £15,000 will ever be refunded to the nation by any of those who obtained it in so discreditable a fashion. Should this recent report, however, have the result of effectually stopping the machinations of a powerful cabal, perhaps the money will not be wholly lost to the country. We all buy our experience, and the nation has paid pretty well through the nose for it in this particular instance. But the inquiry must not stop here. Months ago I was accused of "malice" for pointing out what has now been openly proclaimed by the Committee of Public Accounts; and either that Committee or some member or members of Parliament should now insist upon the very fullest details of every single item of expenditure in connection with the "Loan Collection"—even to the cost of the "private and confidential" petition. I have, over and over again, called attention to the existence of a Ring of jobbers who trade upon the Endowment of Research, Loan Collections, Solar Physical Observatories, and the like, to fill their own pockets at the public cost; and an exhaustive inquiry into the items of expenditure of this last device of theirs could not fail to bring the leading wire-pullers prominently to the front, and to show the public by whom they have been robbed. If it be necessary their names can easily be furnished to any committee of inquiry or individual member of either House who may require them. A most dangerous combination exists, and, in the public interest, must be broken up and rendered impotent. The sooner this is effectually accomplished the better for scientific honour and morality, and for the national interests at large.

I have just been reading, with very great interest, Sir Edmund Beckett's little pamphlet on "Trades Unionism and its Results." It contains a heavy indictment against the British Workman; but one, alas! the leading details of which can be but too easily corroborated from the experience of any one and every one who, from needing his services, has been brought into contact with him. I am not myself an "employer of labour," in the ordinary acceptation of the term; by which I mean, that I do not carry on any trade or business which involves the employment of workmen. Perhaps, then, I may claim to regard them with a tolerably impartial and unprejudiced eye; and the narration of some facts in connection with them, which have fallen within my personal cognizance, may not be wholly uninstructive. Some time ago, then, one of the lead gutters on the top of my house leaked, and the wet came through into the bedroom below. I sent to my builder, and asked him to let me have a man up to see to it. *Four* men (or rather three men and a lad) arrived; and this was their course of proceeding:—They first came round to the front of the house in a kind of procession, and stood regarding it—apparently admiring its architectural elevation. Then two of them went round to the stable-yard at the rear of the house, obtained a ladder, and brought it back, the other two remaining in the carriage-drive. One of these gentlemen, who returned with the ladder, subsequently mounted it, and inspected the part of the roof where the leak was; upon which he descended, and the whole four went round to a pump-house in a field adjoining the stables, and sat down to smoke. (By the bye, wishing to be accurate, I think that only the men smoked—the lad merely gaping into space). Ultimately two of them returned to the front of the house, finally mounted the ladder, and in about an hour and a quarter did the exceedingly little there was to do to make the gutter perfect. And this is the Dignity of Labour! (with a capital D). Here was a job which any really honest workman, whose sole object was to perform his task quickly and efficiently, might have finished single-handed in an hour, for which I was charged for four men for three-quarters of a day. As a matter of course I complained to their master, but merely with the result of obtaining a promise that if I could give him the men's names he would take care that they should not be sent to my house again! So much for an illustration of the way in which work is performed. A word now as to the work itself when it is done. A friend and neighbour of my own built a mansion. It was completed and inhabited, when my friend found to his dismay that upon every shower one of the cellars was flooded. Efforts were for a long time made in vain to trace the source of this; but ultimately, after an infinity of trouble, it was discovered that one of the large water-pipes, instead of being carried down into the ground, *actually terminated in the substance of the wall itself;* the rascal of a workman, to save himself trouble, and get paid for what he had never done, having so finished his job. After this illustration of the workman's honesty I may pass on to his independence and high principle. The relieving officer of a Union, of which I happen to know something, was applied to to bury a child, and on asking the woman, who made the application, what her husband's earnings were, was informed that they were 14 shillings a week. The officer was new to his work and, accepting the statement as true, did defray the cost of the child's funeral. Upon his bringing, however, this expenditure before the Board of Guardians for approval, inquiry was at once made as to the real earnings of the applicant's husband, and it was then ascertained that they were not 14, but 30 shillings a week. A subsequent threat from the relieving officer produced an immediate repayment of the sum disbursed; and upon his asking the people how they could so impose upon him, he received the reply from the wife (who was again spokeswoman), "*if I had told you the truth I should never have got the money!*" Another and very recent instance indeed came under my notice in the shape of a man, who actually went into the workhouse rather than take a situation at 18 shillings a week; as he demanded 22 shillings, and had determined to live upon the ratepayers until he got it. Upon being informed that he would be straightway taken before a magistrate as "an idle and disorderly person," however, this pattern artificer speedily took his departure. It would seem from Sir E. Beckett's pamphlet that cognate facts advanced by him have been vehemently denied by Messrs. Potter, Jones, Simcox, and Co. I therefore give a simple narration of what has occurred within my own personal experience, leaving to others the task of drawing their own inferences from it.

In connection with letter 14110 (p. 38), I may tell "Brickwall" that the late Admiral Smyth did institute a series of experiments, with reference to the varying perception of colour in stars by different observers. He embodied the result of his researches in a small book called "Sidereal Chromatics," which was printed for private circulation by J. B. Nichols & Sons, in 1864. "Brickwall" might probably obtain a copy of this work by advertising for it, and it is really well worth having.

In reply to query 32414 (p. 48) the Heliopolis, whence the (so-called) "Cleopatra's Needle" was brought is close to Mataréëh, some two hours' ride to the N.E. of Cairo. It is the "On" of the Bible. It was partly destroyed by Cambyses when he invaded Egypt, 2,403 years ago, as narrated by Herodotus.

Spirits of nitre is certainly not the only fluid employed for filling the levels of Astronomical instruments as assumed by "J. L. H. S." in query 32444 (p. 48). Ordinary alcohol is used, and I remember to have heard and read that some of the superb and most sensitive levels made by Ertel, of Munich, are filled with sulphuric ether.

"X. Y." (query 32456, p. 49) will find that an inch object-glass of about 12in. focus, with a thick cross wire fitted in the focus of a low-power Ramsden Eyepiece, will form the very finder he requires for a 4½in. telescope.

Mr. W. A. Pearce (query 32462, p. 49) may rest assured that "an English 1½in. decomposed into ¼in." will *not* "do as good work as an English ¼in." Of how many pairs of lenses does your correspondent conceive that a properly constructed ¼in. Microscope Objective is made up? Moreover, what in the world does he want to exchange a mechanical stage for a "Spring" one (whatever the latter may be)? No one who has experienced the comfort and convenience of a thoroughly well-made mechanical stage would ever part with it.

A Fellow of the Royal Astronomical Society.

RED STARS AND COLOURS OF STARS—VORTEX RINGS—HEATING GLUE—FINDER FOR 4½in. REFRACTOR—TO "F. R. A. S."—PROCTOR'S ATLAS.

[14135.]—As Mr. Gore (let. 14058) suspects, in number 18 of my list of red and orange stars (English Mechanic, Feb. 22, let. 13998), ζ is a misprint for ξ. Two other small mistakes occur in the same letter, and I had better rectify them. For "between his pair and ι Geminorum in right angles," read "between his pair and 1 Geminorum in right ascension."

No. 12 is apparently variable, and might be watched. I estimated its magnitude on two nights, and measured it on three nights. The estimations gave 7·2 as a mean, and the measurements gave the same. The star is No. 16, appendix I in Birmingham's catalogue, and the magnitude assigned is 7 8. Though I observed the region several times, Mr. Gore's 6m. orange star has escaped me. Presumably this is the star that "Brickwall" (let. 14110, p. 38) calls white. Once or twice when a party of ladies and gentlemen have come to look at some celestial objects, I have repeated Admiral Smyth's experiment, turning the telescope on some double star and requesting each to write down the colours. The result is always curious, and even in single stars, where the colour to me is most pronounced, the difference of opinion is very great. I have not by me any of these results or would send them, but any one with a telescope has generally plenty of opportunities for repeating the experiment. I will annex to this letter a few stars for experiment, and if the colours are sent to me I will, after a time, send up the results, which, being thus placed side by side, will facilitate the comparison in greater manner, and at the same time take up less space than a number of independent communications to the English Mechanic.

Coloured Double Stars.

No.	Name.	Right Ascension. h. m.	Declination. ° '
19	η Cassiopeiæ	0 41	+ 57 9
20	σ Orionis	5 32	− 2 40
21†	Castor	7 26	+ 32 9
22	35 Sextantis	10 37	+ 5 22
23ƒ	12 Canum Venat	12 50	+ 39 0
24	39 Bootis	14 45	+ 49 14
25*	Σ 1999 Libræ	15 57	− 11 6
26	95 Herculis	17 56	+ 21 36

† A blue companion, 9·5, 72″.
ƒ Cor. Caroli.
* In field ξ Libræ. There is a blue star N.F.

The following preparation for obtaining vortex smoke rings I have read of somewhere. Place liquid ammonia in the box described by "Mauritian" (reply 32391, p. 47), take a saucer with salt in it, pour some diluted sulphuric acid on the salt, and place the saucer in the box also, and proceed as "Mauritian" describes. The tapping should be very gentle indeed. To the latter part of his answer, I may add that a magnifying glass will greatly help observation of milk rings in water.

Surely "C. O." (query 32442, p. 48), might place the obnoxious glue-pot on the fire.

"X. Y." had better have a finder with object-glass of 1in. aperture. Mine is a little larger, and has a focal length of about 13in. My telescope is a 5in. refractor.

My thanks are due to "F. R. A. S." for kindly giving me the magnitudes of some objects in my list according to Argelander. It is unfortunate as, he says, that Mr. Proctor has based his magnitudes on those of the B. A. C. To this fact is also due, perhaps, the omission of certain stars visible to the naked eye, and which has caused others, I dare say, like myself, to make blunders in stellar observation, since we have not equatorials with circles, &c., and therefore depend upon atlases to help us to find the objects we may desire to observe.

If "Choir Boys" (query 32375, p. 24) will communicate with me, I can, perhaps, be of some service to him.

T. E. Espin.

Wallasey Rectory, Birkenhead.

THE GAS-ENGINE.

(*Continued from p. 554, Vol. XXVI.*)

[14136.]—No. $\frac{2081}{1876}$—C. D. Abel, a communication from Nicolaus A. Otto, of Deutz, near Cologne, Germany. N. A. Otto occupies a position in relation to the gas-engine similar to that held by James Watt in connection with the steam-engine. Other inventors before him had designed, and pratically applied devices, which still hold their own as essential parts of the gas-engine. Hazard, in 1826, first introduced the water-jacketed cylinder and its attendant reservoir. F. H. Wenham in 1864, brought out in an almost perfect form the double piston atmospheric gas engine, which, though deserted in its infancy by its unnatural parent, still survives in healthy vitality, with every prospect of longevity and usefulness. Hugon in 1865 invented and introduced the light-bearing slide valve, dispensing thereby with the uncertainty and unpleasantness of lighting by electricity. Mr. Wenham has undoubtedly the honour of inventing and carrying into effect the first engine that could be regarded as a practical and commercial success—an economical working gas.engine; but it has been the good fortune of Mr. Otto to produce two gas-engines working on entirely opposite principles, with an equal display of mechanical ability and attendant commercial success. At the time Mr. Otto introduced the now well-known Otto and Langen atmospheric gas-engine he entered a totally unoccupied field, and produced for users of small power what had been so long desired—a small motor combining, in a hitherto unknown extent, economy and usefulness. It is no part of my object to describe the successive improvements subsequently introduced into the engine by Mr. Otto and his able collaborateurs, Messrs F. W. and W. J. Crossley, of Manchester, as I have already indicated previously where the detailed information may be found, but I would simply observe that, in the whole limits of mechanical invention no more beautiful application of means to an end can be found than Otto's application of a free piston to Barsanli and Malleucci's engine, $\frac{1655}{1857}$, the mere change of a ratchet wheel, and a total change of action and principle resulted. The invention comprised in the present patent may be considered as the solution of the problem, how to convert a rapid explosion into a continued direct acting pressure. In its essential principle it is a combination of the ordinary gas-engine as left by Lenoir, Hugon, and others, with the hot-air-engine as left by Stirling and Eusdon—it has combined two failures to form a complete success. Any one taking the trouble to examine Imray's patents, No. $\frac{1628}{1873}$ and No. $\frac{1946}{1873}$, communicated by Mr. Otto, will easily trace the development of this engine from an attempt to introduce a horizontal atmospheric gas-engine with a differential stroke—a quick out-stroke and a slow in-stroke. It would be a great mistake to consider this engine as a happy inspiration springing complete from the head of the inventor. It is the result of a long gestation, which can be readily traced for upwards of three years of laborious experiment and unflinching perseverance. The fact that an explosive mixture, fired in the presence of a body of air in a closed vessel, would produce an effect due to the combined action of the explosion and subsequent expansion of the inert gas, was well known, and had been made the subject of a provisional protection, in no way detracts from the merit and originality of Mr. Otto's invention, but rather heightens it. The honour due to a successful invention is not to him who clearly states the problem, but to him who solves it. The following extracts from Mr. Otto's specification will sufficiently explain the principle and method of working the invention:—"In gas motor engines, as at present constructed, an explosive mixture of combustible gas and air is introduced into the engine cylinder, where it is ignited, resulting in a sudden expansion of the gases and development of heat, a great part of which is lost by absorption, unless special provisions are made for allowing the gases to expand very rapidly. According to the present invention a combustible mixture of gas or vapour with air is introduced into the cylinder, together with air or other gas, which may or may not support combustion in such a manner that the particles of the combustible mixture are more or less dispersed in an isolated condition in the air or other gases, so that an ignition instead of an explosion ensuing, the flame will be communicated gradually from one combustible particle to another, thereby affecting a gradual development of heat and a corresponding gradual expansion of the gases, which will enable the motive power so produced to be utilised in the most effective manner. The mode of using the gases and other arrangements of the engine may be variously modified in carrying out this invention. Thus, according to one arrangement, the gases are introduced into the cylinder at atmospheric pressure. The cylinder is, for this purpose, provided with a slide having suitable ports for the admission of air, and an intimate mixture of combustible gas and vapour and air, and the movement of the slide is so regulated by means of a cam or eccentric on the engine shaft, that during the first part of the stroke of the piston air alone enters the cylinder, while during a succeeding portion of the stroke the mixture of gas or petroleum vapour and air is introduced behind the air. This mixture on entering the cylinder will become more or less dispersed in the air previously introduced, the particles of the mixture being situated nearest together at the points where they enter the cylinder, and becoming gradually more dispersed as they mix with the air in front. A communication being now established by the slide between a small flame and the contents of the cylinder at the point where the combustible mixture is most dense, this ignites, and the combustion of the whole charge takes place gradually, the mixture burning with gradually decreasing rapidity as the flame extends to those particles that are more dissipated among the air. The gradual expansion of the gas thus produced causes the piston to complete its stroke, and on the return stroke, which may be effected either by the momentum of the fly-wheel or by the introduction of a similar charge at the other end of the cylinder, the products of combustion are expelled through a valve, after which the above-described operation is repeated for the next stroke. According to another arrangement (the one actually carried out in the Otto silent engine), the combustible gas and air or other gas are employed in a compressed state in the engine. For this purpose the engine may operate as above described, the gas and air being simply compressed to the requisite degree before being introduced into the cylinder, or by preference the compression in the cylinder itself, in the following manner:—"The cylinder is constructed of greater length than the stroke of the piston, so that there is a space beyond the latter when it is at end stroke. Assuming the space to be filled with a portion of the gaseous products of combustion resulting from the last stroke at atmospheric pressure, the piston in performing one part of its stroke draws in atmospheric air, after which it will draw in the combustible mixture during the remainder of the stroke. The cylinder will then be filled with three strata of different gases more or less intermingled at their junction—namely, a stratum of products of combustion, then a stratum of air, and lastly, of the combustible mixture. The piston then performs the return stroke, whereby the gaseous charge is compressed into the before-mentioned space at the end of the cylinder. The gases will in this condition still retain their stratified character, the particles of combustible mixture being diffused to a certant extent through the other strata. The charge is now ignited, and burns gradually, and, with the same effect as described with reference to the first arrangement, on the return stroke the products of combustion are expelled, with the exception of the quantity contained in the space at the end of the cylinder. The regulation of the power of the engines operating according to the above described invention is effected by admitting more or less of the combustible gas for each charge. This is done by regulating the time of opening and closing of an admission valve on the gas-supply pipe. The motion of this valve is regulated by a rotating cam, capable of being adjusted longitudinally on its shaft by any suitable known arrangement of governor." The inventor claims as his invention—First, admitting to the cylinder a mixture of combustible gas or vapour with air separate from a charge of air, or incombustible, so that the development of heat and the expansion or increase of pressure may be gradual, substantially as and for the purposes set forth. Second. Compressing by one in-stroke of the piston a charge of combustible and incombustible fluid drawn into the cylinder by its previous out-stroke, so that the compressed charge when ignited propels the piston during the next out-stroke, and the products of combustion are expelled by the next in-stroke of the piston substantially as described. Third. Regulating the admission of the combustible gas or vapour to the cylinder by means of a separate slide controlled by a governor, so that when the speed of the engine increases the combustible charge is reduced as described. Fourth. The construction herein described of a gas-motor engine, wherein by one out-stroke of the piston separate charges of combustible fluid and air are drawn into the cylinder, which charges are compressed by the in-stroke, and then ignited, so as to propel the piston, which by its return stroke expels the products of combustion. Descriptive criticisms of this engine appeared in *Engineering* and the *Engineer* for July 13th, 1877. Any one interested in the details of this invention can best study it in the Otto Silent Gas-Engine.

No. $\frac{2824}{1876}$—C. Linford, Abbey Iron Works, Leicester. The patentee describes his "Improvements in Gas-Engines and Appliances connected therewith" to "consist in their main feature and object to render possible the construction of gas engines of large size and power—a result which has hitherto been deemed unattainable, or at least impossible to effect economically." He goes on to say—"In carrying out this purpose I employ, as main features of my invention, the combination of a piston fitted with a balance weight, in such manner that the dead weight of the piston, which has to be lifted by the explosion of gas and air on the up or out stroke of the piston in air and gas engines as hitherto constructed, may be reduced to a minimum, or only to as much as will overcome the friction of the piston-packing in its descent, thereby reducing by a considerable amount the charge of gas and air necessary for lifting said piston. In connection with and auxiliary to the above I employ a receiver and air-pump to empty the cylinder, or nearly, of the exploded gases during the descent of the piston, thus rendering unnecessary the continued descent of the piston to the bottom of the cylinder, as has been usual hitherto, to expel the exploded gases, at the same time obviating the necessity of raising the piston at the termination of the down stroke previous to the commencement of the up stroke, as now generally in use, but which becomes an almost insuperable difficulty with engines of a larger size." The patentee claims principally —"The combination of piston and balance weight in gas-engines; a peculiar construction of pistons in air and gas engines; the construction of an internal endless rack actuated by silent clutch gear acting on the main shaft by pinion direct, or by two or more intermediate pinions; the use in gas-engines of a suspended rack attached to beam or lever gearing in pinion and clutch on fly-wheel shaft; using balanced pistons in air and gas engines; using an explosion chamber, wherein a charge is drawn by vacuum while the piston is at rest; driving out residual gases by atmospheric pressure, and then producing a partial vacuum for admission of next explosive charge." I have neither seen nor heard of an engine working on the above construction, nor do I think I ever shall. I have no doubt that the patentee before this has found out what a hopeless task it is to attempt to dodge the law of gravitation. At the same time I utterly fail to see the utility of employing an air-pump to draw out residual gases, as it would evidently take quite as much power to work an air-pump as it would to lift a piston, while there would be the decided disadvantage of employing two pistons instead of one, which, in a general way, most people think quite sufficient trouble to keep in order; and if the air-pumps, as shown in Figs. 2 and 3, sheet 1, drawn to scale, are of the same area as the working cylinder, so that in the act of producing the proposed vacuum they will simply absorb the whole working power of the engine, a result the patentee most probably will endorse as the result of his experience.

No. $\frac{3370}{1876}$—G. F. Redfern, a communication from Otto Sack, and I. Rennart, Cassel, Germany. This invention consists in improvements in the construction of gas-motor engines, whereby the engine occupies less space than those hitherto constructed, and the action of the engine is made more regular by the manner in which the effect produced by the explosion of the mixture of air and gas is utilised. A cylinder of suitable construction is provided with a differential piston, the explosive chamber is placed at the side of the cylinder, and is provided with a slide valve, for the admission at each revolution of the driving shaft of the required quantity of the explosive mixture, which being inflamed enters the cylinder below the piston, acting upon the smaller surface thereof, and before the piston arrives at its highest point a valve cock allows the mixture to enter above the piston, and act on its larger surface. When the piston has completed its stroke the valve cock, operated by a link motion, allows the escape of the gases. The cylinder and explosion chamber are surrounded by water. An arrangement is provided for lubricating the piston with distilled water. The piston is connected to the crank in the usual manner. The driving shafts are made hollow, so that they may serve as reservoirs for oil. The valve cock is operated from a grooved disc on the crank shaft, moving a lever inclesed within a casing to keep it from the water, but the water circulates through the hollow valve cock. The slide-valve is operated by a tapped disc, having a steel tappet, on which slides a pulley on the forked end of a rod, a spiral spring serving to bring the slide back to its normal position after it has been raised. On the top of the slide-valve is a pipe coming from the compresser, and provided with a suitable valve and a governor for regulating the action of the throttle-valve. The compressor is in direct communication with the air-pump, which is double-acting, and is operated by gearing. The pump sucks in air and gas, and thoroughly mixes and forces them in a condensed state into the compressor. The patentee also describes an improved method of providiug an explosive mixture in connection with the engine from petroleum, kerosene, and paraffin oils. For engines of 20 horse power and upwards the explosive mixture is produced in a separate apparatus.

No. $\frac{3435}{1876}$—Louis Simon, Wilford-road works, Nottingham. This provisional specification relates to improvements in the coustruction of engines to be worked by power derived from air and oil combined, and consists mainly in so constructing engines that the whole of the working parts are in connection with the main shaft, by or from which other machines can be driven. The engine is self-contained—that is to say, it compresses atmospheric air and pumps oil, such as petroleum, from a reservoir, the two being then combined in suitable proportions in a chamber, and caused to pass into a cylinder, where they are exploded for the development of power by expansion, and made to act upon a piston in the ordinary way of steam, for the movement of the various parts. The power cylinder is inclosed in a water jacket, kept supplied by a small pump worked by the main shaft, the water being taken from and returned to a trough forming part of the foundation, or in any other convenient manner.

No. $\frac{3444}{1876}$—J. H. Johnson, a communication from J. Wertheim, of Bomheim, Frankfort, Germany. This invention consists of a combined atmospheric gas-engine, in which the explosive power and the pressure of the atmosphere are both utilised as motive power. In carrying out this invention a cylindrical explosion chamber is connected by means of a siphon or bent pipe with a reservoir. In this pipe, at its lower part, is a paddle-wheel, with curved float boards or paddles, serving to receive and transmit the developed power. The connecting pipe and reservoir are filled with any suitable liquid. Air and light gas, mixed in a certain proportion, is then introduced into the explosien chamber and ignited. The explosion now following forces the liquid through the connecting pipe into the liquid reservoir, and the liquid, by means hereafter described, is forced to pass the said curved float boards on the lower part of the wheel, causing it to revolve. A vacuum is formed in the explosion-chamber and in the connecting pipe after the explosion has taken place. The liquid will then consequently return by the pressure of the atmosphere from the reservoir to the explosion chamber, and will pass the upper part of the curved float boards of the wheel, furnishing the power to turn the wheel and to refill the connecting pipe and the explosion chamber after having caused the expulsion of the waste products from the combustion. A fresh quantity of light gas and air is now introduced and ignited, and the process recommenced, and so on in succession. The use of water as an intermediate agent in the production of a vacuum was first applied to gas-engines by Hugon in his patents $\frac{615}{1860}$ and $\frac{653}{1863}$; but resulted, after the expenditure of vast sums of money, in disastrous failure. It is hard to see how the products of the explosion of a gaseous compound, reaching at the moment of explosion 5,000° Fahr., can be mixed intimately with a body of water by successive and quickly recurring explosions, without developing an amount of steam fatal to the existence of any vacuum whatever.

No. $\frac{3620}{1876}$—Mr. P. W. Boulton, of Tew Park, Oxfordshire. This invention consists of improvements in engines worked by the combustion and expansive force of an inflammable fluid mixture. The description and consideration of this patent will be better understood in connection with the details of two subsequent inventions by the same patentee—Nos. $\frac{765}{1877}$ and $\frac{766}{1877}$.

No. $\frac{4422}{1876}$—W. R. Lake, a communication from G. R. Brayton of Exeter, New Hampshire, U.S. This invention for improvements connected with the pistons of air and gas engines, was illustrated and described in this journal, page 378, Vol. XXV., and on page 464 of the same Vol. I pointed out that the same design had been made the subject of several prior patents—a circumstance of too frequent, almost everyday occurrence, but none the less a standing disgrace, not only to our patent laws, but also to those who administer them.

No. $\frac{4987}{1876}$—R. Hallewell, engineer, Blackburn. This invention relates to improvements in gas-motor engines, and, firstly, "To that class of engines where the expansion of gas and air, on being fired, acts upon the piston as the motive power, and transmits by connection the motive power direct to the engine shaft. For the purpose of insuring a more gradual combustion of the gas, with consequent gradual accumulation of force, I provide for the cylinder a perforated false bottom, through or by way of which the inflammable gas passes to the cylinder. The valves are so timed as to permit the piston drawing into the cylinder a quantity of atmospheric air, whereon the gas is injected under the perforated plate by means of a pump (or it may be drawn in by the continuous movement of the piston), and passes through the perforations in a divided state, and its consumption is gradual, a rapid firing or explosion being avoided." Secondly, "to the construction of engines having three cylinders. In a vertical engine of this class above the main explosion chamber is a smaller or inverted cylinder or air-pump, the latter communicating by means of a pipe with the third cylinder, which in its construction and fitting-up resembles an ordinary double or single-acting high-pressure cylinder. Between the top of the explosion chamber is open, and the inverted cylinder or air-pump shere is space and stuffing-box, through which a piston-rod works, and which rod connects the pistons in the two cylinders, the bottom of the inverted cylinder or air-pump is closed except by way of an inward-working or flap-valve. When the piston of the inverted cylinder ascends, the air above the piston is discharged by way of a pipe or opening in the top of the cylinder. The action or working is as follows: On a charge of gas and air being fired in the explosion chamber under the piston of the explosion cylinder, the piston in the latter and the piston in the inverted cylinder are forced upwards. This movement discharges the air from the open top of the explosion chamber, whilst the inverted cylinder or air-pump becomes charged with air by way of the flap-valve referred to. The atmospheric pressure upon the piston of the explosion cylinder now forces down the piston, its rod being connected to the piston of the inverted cylinder or air-pump; the latter piston compresses and forces the air out by way of the connecting pipe through one or other of the ports of the third cylinder, the piston and rod of which by ordinary connections transmit the power to the main shaft of the engine." To say the least of these two inventions they are very clearly described, a pretty sure sign the inventor knows what he is driving at, a very uncommon trait of specifications in general. The first of these designs has been to a certain degree anticipated by N. A. Otto, in a communication to Imray, $\frac{1946}{1873}$, but in this instance it is presented in a far more likely and workable form. The principal objection to a firing process which extends the whole length of the stroke is the large amount of lubricating material required inside the cylinder, and the large amount of water required outside to render it workable, and keep the cylinder at any moderate degree of temperature. The valve gear is well designed, and, with the exception of the inseparable drawbacks indicated, reflects credit on the inventor. With regard to the second part of the invention, it is well designed and carried out. The arrangement which compresses air in the inverted cylinder or air-pump, so as to nearly double the atmospheric pressure obtained in the explosion cylinder when admitted to the working cylinder, is original and good. But one defect adheres to any possible arrangement on this principle. The engine to develop any useful amount of power must be cumbrous, and the difficulty of keeping three pistons in order can be readily understood, to say nothing of the friction involved. Mr. Hallewell has done all that can be done with the principle, but it is incurable.

No. $\frac{4988}{1876}$—R. Hallewell, Engineer, Blackburn. This invention relates to improvements in gas and water motor engines, and in gas-motor engines. The first part of the invention relates to that class of engines in which water is used intermediate between the working cylinder and the explosive charge. This combined gas and water motor engine, one form of which is constructed with a main and minor cylinder of siphon form upon the minor cylinder, is a third cylinder containing a loose piston. Between the junction of the latter cylinders is the explosion chamber. The main cylinder is open at top and contains a piston connected by piston-rod with the crank of the engine shaft. The cylinder containing the loose piston is made with a valve or valves for the discharge of air during the upward movement of the piston, and for the readmission of air during the descent thereof. In some cases I employ a piston-rod and clip for holding the piston in its raised position. A portion of the major and minor cylinders under the piston and below the explosion chamber is occupied by water, while the loose piston rests upon the inner rim of the minor cylinder, and immediately above the explosion chamber. The action is as follows:—When the main piston is raised and the crank nearing its highest point or centre of motion, the explosion of gas and air is effected, and the loose cylinder is forced upwards and is momentarily held or trapped in its raised position by the action of the valves referred to or by clip apparatus. The partial vacuum caused by combustion is now to be destroyed by the ascent of water, which is forced downwards in the main and upwards in the small cylinders by the main piston in its dowaward stroke, the motion being given to the latter by atmospheric pressure. The main piston and crank are now at their lowest position, and as soon as the crank has passed the lowest centre the loose piston is released, and, together with the water, descends, the weight of which acts directly on the under side of the main piston, forcing it upwards. Meanwhile the water and pistons have resumed their original positions in readiness for the next explosion of air and gas. Various methods are also described for clipping and holding the loose piston of the Wenham Atmospheric Gas-Engine, and for improvements in the valve apparatus relating to engines described in a previous specification of the inventors, No. $\frac{2826}{1875}$.

Jno. F. Dickson.

(To be continued.)

A NEW PHOTO-PRINTING PROCESS

[14137.]—Noticing several questions in yo columns concerning the zincographic and oth processes of printing, I should like to direct t attention of your correspondents to the mode photo-printing processes, which, it seems to me, w eventually take the lead. Zincography, or a method of obtaining printing surfaces which invol the biting-in of metal plates by means of acid, is, necessity, a tedious series of operations, the resu of which, moreover, is not always so successful could be desired; but there is reason to believe th methods of producing printing blocks by means photography will be invented soon, and to help fo ward the discovery I will ask you to publish t following description of a process invented by Gobert, the director of the printing department the Bank of France, which he gave in a paper re before the French Photographic Society:—

"I have been studying," he said, "to replace lithographic stone by plate glass, of which we ha no fear of having a scarcity, and I have succeed beyond my expectations; the only novelty being the employment of ground glass. As to the pho graphic and lithographic manipulations, they well known, and I have not changed them." Gobert takes a ground glass, made rough either an acid or by any mechanical means. On the fine ground surface he pours the following mixtu Albumen, 100oz.; bichromate of potash, 3oz.; plate being held all the time by an india-rubl holder. When covered the plate is turned ups down, and hooked upon a piece of string hangi from the ceiling by means of an iron eye screw into the handle of the plate-holder; the plate is n made to turn rapidly, in order that the centrifu tendency may bring the solution on the surface even and as thin as possible. It is necessary have the prepared surface as thin as possible. Wh dry it is put into the screw press or printing fra under the object to be reproduced; if placed in sun an exposure of one or two seconds suffices; i the shade, naturally more is required. When expo the plate is taken into the dark room, and with any preliminary operation it is inked over with o nary printing ink; the ink sticks to every part makes it look like a blackboard. The glass is t plunged into a tray containing water, when imm diately the ink breaks up like, as it were, a sea ice, from all the parts on which the light had action, and leaves the image standing out in b relief. All that is necessary now is to send it to ordinary lithographer to have as many prints may be required. From 200 to 1,000 may be prin off the same plate.

Specimens of bank notes printed by M. Gobe process have all the sharpness and fineness that be desired; and, although the plate does not per of the printing of a large number of copies, ther a probability of overcoming that difficulty, wh after all, is a small one, as the printing block is easily produced. Possibly some one will discove means of utilising the principle in the preparatio blocks to be used with letter-press, and also reproducing ordinary photographs instead of me line drawings.

Oberho

OVERWINDING.

[14138.]—In view of the many accidents that h occurred of late at the different mines in Engl and Scotland, and also at the Grand Hotel, Pari few words as to two of the many causes of accid —overwinding and breakage of ropes—may no out of place in your columns, and the importanc the subject is fully borne out by the fact that Home Secretary has given instructions to the m inspectors to urge upon mine-owners the importa of attaching efficient detaching hooks to all cages,

Now, it is well known to all parties connected mining that there are numerous perfectly effic detaching hooks and apparatus in use that will certainty prevent the possibility of either loss of or damage to cage or shaft, in course either of o winding or breakage of rope, in course eithe ascent or descent of cage; and if such an effic detaching apparatus had been in use at Blan (where the unfortunate engineman now stands c mitted for manslaughter), there would have been other effects following the overwinding than a sl loss of time in reattaching rope to cage, and lives of the unfortunate miners would have b spared to their families; and surely at Blantyre m than enough of families have lost the breadwin without, by the non-adoption of obvious and w proved means and appliances, running such risk

In this district (Cleveland) hardly a mine but an appliance to prevent such possibilities, and many instances, had they not been so adopted m lives would have been sacrified. Considering lives are constantly being sacrificed through s neglect, it is high time that the adoption of s such efficient preventive means was made com sory, and so give an assurance to the miners, tha they run the gauntlet of the many dangers d below, at least, they will be brought safely bank.

W. S

ORGANIC ACIDS—MONOBASIC, DIBASIC, TRIBASIC, AND POLYBASIC—PREPARATION AND PROPERTIES OF ACETIC, LACTIC, AND BENZOIC ACIDS.

[14139.]—THE organic acids constitute a very important class of compounds. They are monobasic, dibasic, tribasic, or polybasic, according as they contain one, two, three, or more semi-molecules of oxatyl $(COHO)_2$. Formic acid, HCOHO, is monobasic, forming only HCOKO, since it contains only one semi-molecule, COHO, of oxatyl.

Oxalic acid is dibasic, because it contains two semi-molecules of oxatyl, and forms COHO, COKO, and $(COKO)_2$.

Citric acid contains three semi-molecules of $(COHO)_2$, and is written

$$\left\{\begin{array}{l} CH_2COHO \\ CHCOHO \\ CHHOCOHO \end{array}\right.$$

is which one, two, or three of the atoms of hydrogen in the three semi-molecules of oxatyl can be replaced by one, two, or three atoms of a monad metal, such as potassium; thus we have the following salts—viz.,

$$\left\{\begin{array}{l} CH_2COKO \\ CHCOHO \\ CHHOCOHO \end{array}\right. \quad \left\{\begin{array}{l} CH_2COKO \\ CHCOKO \\ CHHOCOHO \end{array}\right. \text{ and } \left\{\begin{array}{l} CH_2COKO \\ CHCOKO \\ CHHOCOKO \end{array}\right.$$

Pyromellitic acid, $C_6H_2\ (COHO)_4$, contains four semi-molecules of oxatyl, and is therefore tetrabasic—that is, the H in the four groups of COHO can be displaced by one, two, three, or four atoms of a monad metallic element.

Mellitic acid, $C_6(COHO)_6$, contains six semi-molecules of oxatyl, and is hexabasic. The intermediate pentabasic acid $C_6H(COHO)_5$, is unknown.

The monobasic acids, having the general formula, $CnH_2n + {}_1COHO$, is derived from the methyl series of alcohols. The oleic or acrylic series, having the general formula, $C(CnH_2n)\ ^{11}(CmH_2m + {}_1)\ COHO$, is derived from the vinyl series of alcohols. The lactic series, having the general formula, $C(CnH_2n + {}_1)(CmH_2m + {}_1)\ HOCOHO$, is derived from the glycol series of alcohols. The glyoxylic series, having the general formula, $C(CnH_2n + {}_1)\ HO_2COHO$, is derived from the glycerine series of alcohols. The aromatic or benzoic series, having the general formula, $CnH_2n - {}_7\ COHO$, is derived from the phenyl series of alcohols. And the pyruvic series, having the general formula, $CO(CnH_2n + {}_1)\ COHO$, are the semiketones of oxalic acid. The fatty or acetic series contains formic, acetic, propionic, butyric, valeric, caproic, oenanthylic, caprylic, pelargonic, capsic, lauric, myristic, palmitic, margaric, stearic, arachic, behemic, hyaenic, cerotic, and melissic acids, having the formulæ, H, CH_3, C_2H_5, C_3H_7, C_4H_9, C_5H_{11}, C_6H_{13}, C_7H_{15}, C_8H_{17}, C_9H_{19}, $C_{11}H_{23}$, $C_{13}H_{27}$, $C_{15}H_{31}$, $C_{16}H_{33}$, $C_{17}H_{35}$, $C_{19}H_{39}$, $C_{21}H_{43}$, $C_{24}H_{49}$, $C_{26}H_{53}$, and $C_{29}H_{59}$ respectively, to each of which the group COHO is attached, rendering them all monobasic acids.

The oleic or acrylic series contains acrylic, methyacrylic, angelic, pyroterebic, damaluric, damolic, moringic, physetoleic, oleic, elaidic, doeglic, and erucic, having the formulæ C_2H_3, $CMe^{11}Me$, $CEt^{11}H$, $CEt^{11}Me$, $CEt^{11}Et$, $CMe^{11}HCH_2$, $CP+{}^{11}H$, $CBu^{11}H$, C_6H_{11}, $C_{12}H_{23}$, $C_{14}H_{27}$, $C_{15}H_{29}$, $C_{17}H_{33}$, $C_{18}H_{35}$, and $C_{21}H_{41}$ respectively, to each of which the group COHO is attached.

The lactic series contains glycolic, methyl glycolic, lactic, ethyl-lactic, aceto-lactic, paralactic, oxybutyric, dimethoxalic, ethomethoxalic, diethoxalic, valerolactic, leucic, and paraleucic acids, having the formulæ CH_2HO, CH_2MeO, CHMeHO, CHMeEtO, $CHMeC_2H_3O_2$, $(CH_2)_2HO$, CHEtHO, $CHMe_2O$, CHMeEtO, $CHEt_2O$, $(CH_2)_2EtO$, $(CH_2)_3EtO$, and $(C_4H_8)^{11}$, CH_2HO respectively, to each of which the group COHO is attached.

The glyoxylic series contains glyoxylic and glyceric acids having the formulæ $CHHO_2$ and CH_2HO CHHo respectively, to both of which the group COHO is attached.

The aromatic or benzoic series contains benzenic, benzoic, xylic, alpha-xylic, toluylic, alpha toluylic, creosotic, cuminic, and alpha-cymic acids, having the formulæ C_5H_3, C_6H_5, $C_6H_3Me_2$, $CH_2(C_6MeH_4)$, C_6MeH_4, $C(C_6H_5)H_2$, $C(C_6H_5)H_2O$, $CEt(C_6H_5)H$, and $C_6Et_2H_3$ respectively, to all of which the group COHO is attached.

The pyrubic series contains pyruvic, convolvulinoleic, jalapinoleic, and ricinoleic acids, having the formulæ COMe, $CO(C_{11}H_{23})$, $CO(C_{14}H_{29})$ and CO $(C_{18}H_{35})$ respectively, to all of which the group COHO is attached.

The dibasic acids may be conveniently divided into the furmaric, tartaric, malic, and succinic, having the general formulæ $(CnH_2n - {}_1)_2\ (COHO)_2$, $(CnH_2n - {}_1HO)_2$, $(COHO_2)$, $CnH_2n - {}_1HO$, CnH_2n, $(COHO_2)$, and $CnH_2nCmH_2m\ (COHO)_2$.

The furmaric series contains furmaric and itaconic acids, having the formulæ $(CH)_2$, $(COHO)_2$, and $C_3H_4(COHO_2)$ respectively.

The tartaric series contains tartaric and glycomalic acids, having the formulæ $(CHHO)_2(COHO)_2$ and $C(CHHO)_2(COHO)_2H_2$ respectively.

The malic series contains malic and tartronic acids, having the formulæ $CMeHO(COHO)_2$ and $CHHO(COHO)_2$ respectively.

The succinic series contains malonic, succinic, pyrotartaric, adipic, pimelic, suberic, anchoic, sebacic, and roccellic acids, having the formulæ $CH_2(COHO)_2$ $(CH_2)_2(COHO)_2$, $C_3H_6(COHO)_2$, C_4H_8 $(COHO)_2$, $(CH_2)_5(COHO)_2$, $(CH_2)_6(COHO)_2$, $(CH_2)_7$ $(COHO)_2$, $(CH_2)_8(COHO)_2$, and $(CH_2)_{15}(COHO)_2$.

Tetrahydrophthalic, hexahydrophthalic, tartrophthalic, and alizaric acids are dibasic, and have the formulæ $(C_3H_4)_2(COHO)_2$, $(C_3H_5)_2(COHO)_2$, $(C_3H_4HO)_2(COHO)_2$, and $C_6(CH)_6(COHO)_2$ respectively.

The tribasic acids contain citric, tricarballylic, and aconitic, having the formulæ $C_3H_5O(COHO)_3$, C_3H_5 $(COHO)_3$, and $(CH)_3(COHO)_3$ respectively.

Pyromellitic acid $C_6H_2(COHO)_4$ is tetrabasic. A pentabasic acid is unknown. Mellitic acid C_6 $(COHO)_6$ is hexabasic.

Acetic acid, CH_3COHO, is prepared by the destructive distillation of wood at a red heat in iron retorts. During the distillation tarry matter, wood naphtha, acetone, methyl acetate, &c., are given off. These products are condensed in receivers, and the liquid is decanted from the tarry matter. When this liquid is distilled, wood naphtha comes over, then the acid with some of the tar. Sodic carbonate or calcic hydrate is added to the distillate, when tar rising to the surface is skimmed off. The crude acetate is evaporated to dryness. The dry residue is gently roasted to get rid of impurities, and is decomposed by H_2SO_4 if it is a sodic acetate, and by HCl if a calcic acetate. It is also manufactured from sawdust shavings, chips, &c. The sawdust is supplied through a hopper on to an endless chain, which is worked over rollers by a steam-engine, the sawdust being carried along the lower part of the retort in contact with a furnace. The volatile matter passes into a condenser, and the carbonised sawdust falls into a cistern of water. By another plan an archimedian screw, worked by machinery, passes the sawdust, &c., from one end of the retort to the other, during which the volatile matters pass through a pipe from the tube to the condenser, while the carbonised wood falls out at the other end. One hundred parts of the dry wood of birch, beech, oak, ash, white poplar, and Scotch fir give 4·4, 4·3, 3·9, 3·7, 3·2, and 2·1 parts of pure acid respectively. It may be obtained in a state of purity by distilling potassic diacetate thus: $(CH_3)_2COKOCOHO = CH_3COKO + CH_3COHO$. It is prepared by the oxidation of alcohol by allowing the alcohol to trickle over shavings soaked with vinegar. It is also obtained by the reaction of sulphuric acid on sodic acetate. From the symbolic formula the molecular weight is 60, and one litre of the vapour will therefore weigh 30 criths. It is a colourless liquid, having a specific gravity of 1·06, boiling at 118°C., and freezing at 17°C. It is found in animal fluids, and the juices of vegetables. The strong acid has a pungent odour and an aromatic taste. On combustion it produces water and carbonic anhydride. Water dissolves it in all proportions, and it is soluble in alcohol. When heated it volatilises, leaving no residue. It yields acetylic chloride when acted on by phosphorous chloride, thus: $3CH_3COHO + PCl_3 = POHHO_2 + 3CH_3COCl$. When acted on by chlorine in the daylight three chlorinated compounds are produced by the chlorine taking the place of one, two, or three atoms of hydrogen in the radical CH_3; thus we have $CH_2ClCOHO$, $CHCl_2COHO$, and CCl_3COHO, and HCl is produced in the reaction. Aluminic, ferric, plumbic, potassic, and sodic acetates are its most important salts.

All acetates are soluble in water. On heating a solid acetate with strong sulphuric acid and alcohol, acetic ether is formed, thus: $CH_3CONaO + H_2SO_4 + EtHO = OH_2 + HNaSO_4 + CH_3COEtO$. Acetates, when ignited, yield acetones, thus: $2CH_3CO$ $NaO = CH_3COCH_3 + CONao_2$. When drysodic acetate is heated with soda-lime marsh gas is formed, thus: $3CH_3CONao + CAHo_2NaHo = 3CH_4 + COCao^{11} + 2CONao_2$. Ammonic acetate in presence of ammonia dissolves calcic and plumbic sulphate. Ferric chloride produces in a solution of an acetate a deep red-coloured solution, ferric acetate being formed. When an acetate is mixed with dilute H_2SO_4, and heated, acetic acid is set free, and a sulphate of the base is formed. Argentic nitrate produces in neutral solutions a white precipitate of argentic acetate, which is soluble in ammonic hydrate. Calcic chloride gives no precipitate with acetates.

Lactic acid (CMeHHOCOHO) is prepared by dissolving about 5 grammes of tartaric acid and a kilogramme of cane sugar in 6 litres of boiling water and allowing to stand for a few days. Afterwards add one litre of sour milk, containing 30grs. of bad cheese and 400grs. of oxide of zinc, and put away for about ten days at a temperature of about 40°C. The zinc unites with the lactic acid, forming zinc lactate. The mixture is heated till it boils, and is filtered, and the filtrate evaporated, when the zinc lactate crystallises in prisms. After re-crystallisation it is dissolved in water, and SH_2 is passed through the solution, when the acid is set free and zinc sulphide is formed. The acid solution is evaporated on a water bath, the residue is dissolved in some water, and agitated with ether, which takes up the acid. The solution of the acid in ether is evaporated, when the lactic acid remains as a colourless thick liquid. Chalk may be used instead of zinc oxide, when beautiful tufts of acicular prisms of calcic lactate are formed. These crystals are re-crystallised, and treated with one-third of their weight of H_2SO_4, and heated with alcohol, which dissolves the lactic acid, leaving calcic sulphate. Pure lactic acid remains on evaporating the alcoholic solution. It is formed by the oxidation of propylic glycol, thus: $CH_2MeOCH_2HO + O_2 = OH_2 + CH_2MeoCOHO$.

Potassic hydrate converts chloropropionic acid into a lactate, thus: $CMeHClCOHO + 2KHO = OH_2 + KCl + CH_2MeoCOHO$. It is also produced from ethylidenic cyanhydrate, thus: $CH_3\,CH_2Cyo + KHO + OH_2 = NH_3 + CH_2MeoCOKO$. It is produced by the action of nitrous acid on alanin, thus: $CHMe(NH_2)COHO + HNO_3 = N_2 + OH_2 + CH_2MeoCOHO$. It is formed in sour milk, in malt vinegar, in plants, and in animals. Nascent hydrogen acting on pyruvic acid forms this acid, thus: $COMeCOHO + H_2 = CH_2MeoCOHO$. It is a colourless, transparent, syrupy, uncrystallisable liquid having a specific gravity of 1·22. Water, alcohol, and ether dissolve it in all proportions. It has an acid taste, and it is odourless. Cane sugar, milk sugar, dextrine gum, and starch pass readily into lactic acid under the influence of decomposing animal matter. It can be converted into propionic acid by saturating it with gaseous HI in the cold, then sealing in a tube and heating to 140° C, thus: $CMeHHOCO + 2HI = CMeH_2COHO + OH_2 + I_2$. When it is heated to about 260° C. it is decomposed aldehyde, carbonic oxide and water being formed. Nitric acid converts it into oxalic acid. It coagulates albumen. When the lactates are heated with H_2SO_4 they deposit a solid brown substance, and give off carbonic oxide. To detect it in a solution evaporate to the consistency of a syrup in a water bath, add ethylic alcohol, and a little of a solution of oxalic acid. Add baryta water, which precipitates baric oxalate, while the baric lactate remains in solution. Filter and add a solution of calcic sulphate, which precipitates baric sulphate, filter and evaporate, when crystals of calcic lactate are formed in tufts which can be verified by the microscope.

Benzoic acid, C_6H_5COHO, is prepared by sublimation from gum benzoin, of which about one-seventh consists of this acid. The gum benzoin is placed in a shallow iron pan covered with a sheet of filtering paper, over which is placed a cone of writing paper as a receiver. When the iron pan is heated the benzoic acid volatalises, and condenses on the paper receiver in needle crystals. It may be prepared by boiling the gum benzoin in powder with calcic hydrate for several hours, filtering the insoluble lime and resin from the calcic benzoate, and, after concentrating the solution, add hydrochloric acid to precipitate the acid, which is obtained pure by sublimation. It is prepared by the oxidation of benzoic aldehyde or oil of bitter almonds thus: $C_6H_5COH + O = C_6H_5COHO$. It is produced by decomposing phenyl cyanide by potassic hydrate thus: $C_6H_5CN + KHO + OH_2 = C_6H_5COKO + NH_3$. It is prepared by converting naphthalin into phthalic acid by prolonged boiling with nitric acid, when phthalic acid is deposited in lamellar crystals on evaporation. Convert into calcic phthalate and heat for several hours to a temperature of about 340°C. with calcic hydrate without free access of air, when calcic benzoate is formed thus: $2CaC_8H_4O_4 + CaHO_2 = 2COCaO^{11} + Ca2C_7H_5O_2$. Dissolve and precipitate with HCl or H_2SO_4. It is produced by the joint action of carbonic anhydride and sodium on phenyl bromide thus: $C_6H_5Br + CO_2 + 2Na = C_6H_5CONao + Na\ Br$. It is produced by oxidising gluten or casein, and by boiling hippuric acid with hydrochloric acid, when it assimilates the elements of water, and forms butyric acid thus: $C_9H_9NO_3 + OH_2 = C_6H_5COHO + CH_2NH_2COHO$. It is produced by treating styrol, C_8H_8, with potassic permanganate solution, when this acid is formed thus: $C_8H_8 + O_5 = OH_2 + CO_2 + C_6H_5COHO$. It is produced by acting on cinnamic acid with fused potassic hydrate thus: $C_8H_7COHO + 2KHO = C_6H_5COKO + CH_3COKO + H_2$

Benzoic acid is monobasic, and occurs in light feathery snow-white glittering crystals. It has a very fragrant, pleasant, aromatic odour, due to the presence of traces of the essential oil. It produces a peculiar hot sensation when some of the crystals are placed on the tongue. Water dissolves it slightly, and ether and alcohol freely. Its molecular weight is 122, and one litre of the vapour weighs 61 criths. It melts at 121°C., and boils at 240°C. Its vapour burns with a smoky flame. All benzoates, except those of tetral metals, are soluble in water. It sublimes when heated in a tube, forming needle-shaped crystals. Ferric chloride in a solution of a benzoate gives a red precipitate of ferric benzoate. Calcic chloride gives no precipitate in solutions, being soluble. Plumbic acetate gives a white precipitate of plumbic benzoate in solutions of sodic or potassic benzoate. When ammonic benzoate is treated with HCl it is decomposed, benzoic acid being precipitated in crystals. **Hugh Clements.**

A CONTINUOUS BRAKE.

[14140.]—The following clipping from a recent *Melbourne Argus*, can hardly fail to be of interest to your readers:—"A very successful trial of a continuous railway brake, the invention of Mr. Woods, the Minister of Railways, was made yesterday on the Sandhurst line. At about 10 minutes past 9 a.m. an experimental train started up the main line to try the new brakes, and it comprised five passenger carriages, a brake van, and a post-office van, and was drawn by one of the ordinary main line passenger engines of 34 tons. The Minister of Railways was in the train, as well as some of the heads of the railway sub-departments. The train having left Spencer-street at 10 minutes past 9 a.m., travelled to Woodend, 48 miles distant, and 1,840ft. above the level of the Melbourne terminus, and was back at 1.7 p.m. On the journey it sometimes travelled at the rate of 60 miles an hour, and the trials of the new brake were made when it was going at its fastest. On the down journey (away from Melbourne) there, of course, did not occur the best opportunities to test the new brake, since the general gradient in that direction is a rising one, but even on the down trip opportunity was found to prove its value, and it was found capable of stopping a train going at the rate of 50 miles an hour within the distance covered by three telegraph posts, or between an eighth and a ninth of a mile. Returning on the descending grade, the train was stopped seven times between Woodend and Sunbury, a distance of 23¾ miles, and here a still more conclusive test was applied. Again the new brake worked well. A train coming down an incline at the rate of 60 miles an hour was stopped within the space of one-third of a mile, the value of which achievement may be partly understood when it is mentioned that by means of the old brakeing appliances it is sometimes found altogether impossible to stop a train on a decline through the inefficiency of the brake power. Mr. Woods states that he invented the new brake some 15 years ago. Further he does not desire that anything shall be published about it, inasmuch as he has not yet sufficiently secured or protected his patent rights in the invention. The brakes have been made from his (the commissioner's) plans and directions by the artificers employed in the Williamstown workshops."

The Melbourne Telegraph of the 20th ult. says:—"A very satisfactory trial was made yesterday of a new continuous railway brake, invented by the Commissioner of Railways. An engine and tender, with a guard's van and seven carriages, started at 9 o'clock, with Mr. Woods and a small company of experts. The brake is intended to be worked by the driver of the engine, and to apply simultaneously to every vehicle in the train. Yesterday, however, it was only fitted up on the carriages, and not on the engine or van. The train ran between Melbourne and Woodend, and every trial was eminently satisfactory. In going down a grade of 1 in 50 the train was pulled up by Mr. Woods's brake in 35sec., while on a grade 1 in 200 it took the ordinary brake now in use on the Government lines 4¼min. to stop the train. With a heavy loaded train, and the brake fitted right through it, the stoppage will be almost instantaneous."

Further trials of this new brake thus highly commended will be looked forward to with much interest.

New Zealand.

THE MATHEMATICS OF MUSIC—MR. COLIN BROWN'S STRICTURES AND ANIMADVERSIONS.

[14141.]—For some cause or other, which I do not pretend to divine, Mr. Colin Brown does not deign to reply to the questions of fact relating to this subject which I have put to him (letter 13958); but I have no doubt it will be allowed that it was quite within my privilege to ask him those questions, and that, in due regard to his honour as a disputant, it was also imperative on him to reply, since he had undertaken to pass judgment upon my views as I conceive, before he understood them.

These, for example, are some of the expressions which he has thought fit to use:—"All his arguments," says he, "resolve themselves into the usual formula of ladies' logic, 'just because'—(letter 13280). "It is only another example of how facts can be twisted to suit a favourable hypothesis, and how an earnest inquirer can ride a hobby to death."

Now, Mr. Brown as yet has shown no real grounds whatever on which he can establish a right to indulge thus freely in all this argumentum ad hominem, which he has apparently found so palatable, since he has not retracted it. I acknowledge he made one futile attempt to justify himself when he had recourse to certain inviting, but false and ensnaring, similes for the purpose of illustrating an absurdity he imagined he saw in the statement that the series of ratios, converse or reciprocal to the harmonic series, expresses with equal truth the relations of the notes of the scale in their order from me¹ to me to that with which the harmonic series expresses their relations in their order from doh¹. With this attempt I am not satisfied, and in order to enable Mr. Brown to do the thing that is right I will briefly state here the main points of my views, which he has asserted are absurd or untrue. Firstly, I maintain that simplicity of ratio is the paramount principle of the mathematical relations of the notes, and that the fact is obvious in the structure of the diatonic scale, and in the two sorts of chords which, pari passu, compose it, since it is established that these relations arise in unbroken series from the first four primes, 1, 2, 3, 5. Secondly, that as from these primes two reciprocal series of ratios arise, so also there exist in the scale two converse orders of notes, distinguishable as the harmonic and hypharmonic orders: first, the harmonic order, doh, ray, me, soh, te; and the hypharmonic order, me, rah, doh, lah, fah.

By this time it may be that Mr. Brown has perceived that these are not mere assertions supported by twisted facts, but are simply true statements of realities; and, if so, is it not due from him to acknowledge he has done me an injustice in the opinions he has expressed both as to their manner and substance? But if Mr. Brown has not yet made this needed discovery, I beg to direct him to one easy test to be found at the very root of the matter.

The two simplest series of ratios arising from the primes, 1, 2, 3, 5, are, first, 1 : 1, 2 : 1, 3 : 1, 5 : 1; second, 1 : 1, 1 : 2, 1 : 3, 1 : 5—the two series being reciprocal. The first series determines the simplest form of the major or harmonic chord. Take, for example, the harmonic doh (*i.e.*, major tonic) chord

$$\begin{aligned} 1:1 &= d_1 : d_1 \\ 2:1 &= d : d_1 \\ 3:1 &= s : d_1 \\ 5:1 &= m^1 : d_1 \end{aligned}$$

The second series determines the simplest form of the minor or hypharmonic chord. Take, for example, the hypharmonic me chord, otherwise designated the minor chord of lah—

$$\begin{aligned} 1:1 &= m^1 : m^1 \\ 1:2 &= m : m^1 \\ 1:3 &= l_1 : m^1 \\ 1:5 &= d_1 : m^1 \end{aligned}$$

If Mr. Brown will now deliberately try this proposition, and say whether he concedes its truth or not, and if he does not concede its truth, if he will demonstrate its fallacy, I shall in either case take it as a favour, and, as I doubt not, other readers of the English Mechanic also will so take it.

March 18th. **Fred. J. Jackson.**

PURIFICATION OF SEWAGE.

[14142.]—The sewage question must have been a source of considerable revenue to the patent office during the last 20 years, for it appears that upwards of 400 patents have been granted during that time for different processes relating to the purification and utilisation of sewage. Yet the Local Government Board, with all these patents before them, and their own expensive and extensive investigations to boot, appear to be quite paralysed, and unable to advise local boards how to dispose of their sewage, so as not to create a nuisance.

Three years ago many local boards of health suspended all action on sanitary matters, with the expectation that the Local Government Board would get them out of their difficulties by their promised report on the subject of how to get rid of their sewage, but when the report of Rawlinson and Read was published in the beginning of 1877, the local boards that expected great things from it were thoroughly disappointed to find nothing new in it, nor any indication of any plan or process whereby sewage could be purified to such an extent that it could be discharged into a running stream, so as not to be a nuisance.

The Local Government Board supersed the General Board of Health, and the two boards taken together have been in existence for nearly 30 years, with almost unlimited powers to investigate and advise on the question of the treatment of sewage. What has the Local Government Board done to advance our knowledge on this important subject during all these years? Nothing up to the present moment to show that sewage can be purified so as not to be a nuisance. I grant that the several commisions and committees that have been appointed from time to time to investigate and advise on this subject have collected and published a great many valuable facts and statistics on the matter, which go far to show the incapacity of town councils and local boards to deal with such an important and decidedly difficult question, but they have not shown a single instance wherein sewage has been or can be purified in such a manner as not to be or become a nuisance. Surely this is not a satisfactory state of things. Instead of having our sewage purified, we are getting all our clear running streams all over the country polluted with an abominable nuisance, and the Local Government Board can do nothing to help the various [illegible] towns and sanitary districts out of their

Supposing there never had been a Local Government Board in existence, could we have been in a worse condition with respect to pollution of our rivers, or the means of purifying our sewage than we are at the present moment? I think not. But if the Government had passed an Act at the time the General Board of Health was established, compelling every town council and parish authority to abate the nuisances arising from cesspools or sewage within their districts under heavy penalties, and if the magistrates had been compelled to inflict the penalties whenever the nuisances were proved, the difficulties would have vanished by this time.

Had the consuming of smoke and the condensation of the vapours from alkali works been left to the wisdom of the Local Government Board, nothing would ever have been done to abate the nuisance, but we should have had a lot of blue books with statistics on the subject.

On the other hand, take our gas works, which are nearly all under the management of private or public companies, over which the Local Government Board has no control; yet it is a well known fact that they are the best managed, most economical, and most profitable works in the country. They have been and are now continually improving both the purity and illuminating quality of the gas, but let the Local Government Board or any other Government board once get the power to control the gas works, and there will be an end to all further progress in gas improvements. We shall have nothing but "meddling and muddling," and the gas will be left in the same unmanageable state as the sewage is in at present. Then we shall have papers read on the subject at the I. C. E. on the gas question, such as Mr. Bazalgette's able paper on the "sewage question," stating that "no progress had been made during the last quarter of a century, and that the question was exhausted, and that no further improvements are to be expected in the future." It will be dark times for England when our gas is brought under the control of the Local Government Board as proposed by some people.

Wm. Burns.

PORTABLE FRET MACHINE.

[14143.]—At different times I have seen various inquiries for a fret machine that will fasten on to any table with a movable treadle action. I have completed a machine that will answer to these requirements, and the following is a description of it:—The machine fixes on to the side of a table with a screw clamp. In the part of the clamp where the screw goes through is an arm, into which one end of the spindle that carries the driving pulley fits. The other end of the same spindle goes through the back of the clamp (which forms the body of the machine). On the end of this spindle inside the body is fixed the transmitting pulley, and on the outside is fixed a fly-wheel.

From the body of the machine going parallel with the edge of the table, and partly on the table (cast with the body) is an arm carrying the table to saw on. The arms are 14in. long, and are driven in the following way:—There are two straps from the treadle—one from the top, and the other from below. The top strap goes to the driving pulley, and is fastened on one side. The bottom strap goes through a pulley on the frame of the treadle, and is fastened on the other side of the pulley.

Under the treadle is fixed a spring to bring the treadle back after being pressed down by the feet. The top strap draws the pulley one way round and drives the machine. The bottom strap draws the pulley back again. Fixed on to the driving pulley spindle (the pulley running free) is a transmitting wheel with a groove on its circumference for a strap. On the side of the same wheel is an annular groove in which runs a silent click. A strap is put on the transmitting wheel and drives another pulley half its size on to which is put an eccentric and strap which cause the saw-arms to reciprocate. The eccentric is connected to a separate arm fitted on to the same spindle as the saw-arm. The saw-arms are balanced at the back by a connecting-rod. The spindles of both saw-arms are on centre points, and the eccentric and its pulley also. The connecting-rod is on knife-edges.

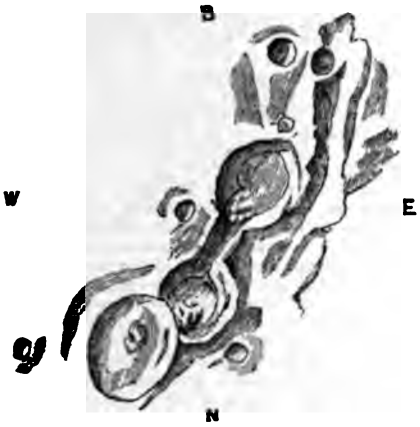
The silent click is made as follows:—The driving pulley at a distance from the centre equal to the distance from the centre (of the transmitting pulley) to the middle of the annular groove is cut a slot parallel to the diameter. In this slot runs the circle of a small wheel constituting the pawl. One end of the slot is in a right line with the diameter of the pulley and at right angles with its diameter. The consequence is, when the pulley goes one way round, the small ratchet wheel runs free, and the other way it catches. By this means a great speed is acquired with very little action of the feet. I shall be glad to let any one have the drawing who cares to advertise his willingness to pay for the tracing being made.

W. J. B.

[It would have been much better to have forwarded a sketch for publication.—Ed.]

THEOPHILUS, CYRILLUS, AND CATHARINA.

[14144.]—The accompanying sketch, which, I believe, is fairly accurate, was made at about 5 p.m. on the 9th of January last, and is so unlike the maps with which I have compared it that perhaps some of your readers might like to compare it both with their maps and with the moon. Indeed, having had occasion lately to examine somewhat in detail certain portions of the various maps that are published, I was much struck with the discrepancies I found in them, and I feel very strongly the need that exists of careful drawings of the various lunar formations as a step to the production of a map far more perfect than any we have at present.



W. J. B. R.

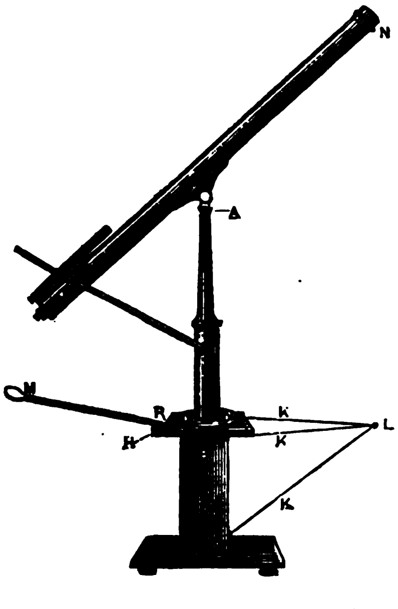
ASTRONOMICAL NOTES.

[14145.]—I am much obliged to "Mac" for his kind opinion, and regret that I cannot answer his inquiry, as I am at present from home, and have not my observing-book with me; but it is not improbable that he may have glimpsed my minute star, as the silver film of my mirror is much damaged by long use and the intrusion of insects (an annoyance which might be obviated by having a cover fitting close to the speculum). I dare say I only used the letter *p* in a very general sense, and his *n*. of *p*. may be a more accurate description.

Cheltenham. T. W. Webb.

EQUATORIAL MOTION.

[14146.]—A correspondent asked in the last volume for a simple method of obtaining an equatorial motion, but as I have not the paper by me I cannot refer to the letter by number. The accompanying shows an adaptation of Lord Lindsay's method given in Vol. XXIV., No. 613, which I find works very fairly. It has, I may say, been highly approved of by Mr. W. J. Lancaster. A, a screw inserted to prevent the azimuth motion, which is obtained by the pin, B, turning in the solid pillar, C, D is a divided circle, F, an arrangement with clock wheels to obtain a slow motion, the edge of the wheel, D D, being bound with an indiarubber band, and turned by the axle of one of the clock wheels. The steadying rod is graduated and read off where clamped, at G. The rods, K, which hold a small wheel, L (A L being the imaginary polar axis), may easily be removed, also the handle, M. The line which passes from N over L is clamped at H. A reference to Lord Lindsay's article will, of course, render this a little clearer.



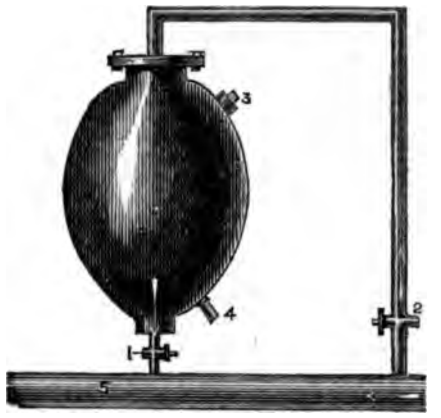
Redgate House, Tenbury, G. P. Turner.
March 18.

GALVANIC SHOCK FROM THE TELEPHONE.

[14147.]—I was exhibiting a telephone I have made at a friend's house one evening last week, and a lady who is a great invalid was holding it to her ear to listen, when she exclaimed it was giving her a galvanic shock. I thought at first it must be all imagination on her part, but I made some further experiments that quite convinced me it was as she said. I have tried several other persons, and I have found one or two that can detect a pricking feeling, but only very slightly. I should be glad to learn if anyone else has felt any similar sensation in using the telephone, as I should not have thought there was sufficient current to produce any sensible effect. The muscles of the lady's hands were quite drawn up, and powerfully contracted while the telephone was being spoken through. She was not holding it to her ear at the time, so could not tell when the speaking took place; but whenever it did her muscles were contracted. W. T. C.

INJECTING SOLUTIONS INTO STEAM BOILERS.

[14148.]—I herewith inclose a rough sketch of a plan for putting any liquid into a steam boiler while the steam is up without the liquid going past the pump. The apparatus consists of a casting something like sketch, that will hold about 3 or 4 gallons. No. 1 and 2 are two ¾in. taps, and 3 and 4 are two taps or plugs (we use plugs). When you want to put the liquid in, you must shut 1 and 2 taps and open No. 4 to let the water out. When that is done, you shut No. 4 and open No. 3, and put the liquid in with a tun-dish, then shut No. 3 and open No. 1 and 2 and the liquid will be gone in a few minutes with the feed water. This plan cleans the pipes and economisers as well as the boiler. We have used it for years and it answers very well. The cost is very little to apply it. No. 5 is the feed pipe from pump to boiler. Nemo.



COLLIERY CATASTROPHES.

[14149.]—P. M. Chester, in letter 14100, asks for some explanation of my letter 14047. I said that gas, which was liberated from the coal shot down by powder, and the fresh surface exposed, would not be exploded by the ignition of the powder because of its "purity." It would probably ignite and add to the flash of the powder blast, but would do nothing more provided the ventilation was perfect.

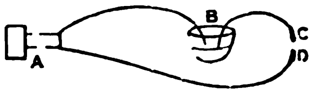
P. M. Chester seems to be ignorant of the fact that firedamp requires admixture with air to the extent of one part of the former to from about seven to fifteen parts of the latter before it becomes explosive. I may add I believe the temperature of the mixture to very much affect its explosiveness. The higher the temperature of the mixture, as in deep mines, the greater must be the dilution to render it safe.

P. M. Chester further contradicts what I said about the ignition of firedamp by a red-hot iron, and advised me to get the idea out of my head by trying the experiment. I am pretty well convinced that he has not done so. However, to prove what I said to be correct, I will give a summary of some experiments conducted by G. C. Greenwell, Esq., in 1853, at the Townely Colliery, situated a few miles west of Newcastle-on-Tyne. At the above colliery was a strong blower of gas, which was piped to bank, and, after being passed through naphtha, was used as ordinary gas to illuminate the heapstead, engine-room, &c. Mr. Greenwell found that the gas could be ignited by a red-hot iron previous and after its passage through naphtha. Thus clearly proving the carburetted hydrogen of the mine capable of ignition as I pointed out. I think P. M. Chester will not take upon him to contradict the authority above mentioned.

Durham. C. M.

TELEPHONY.

[14150.]—After trying Mr. Bennett's experiment (letter 14105, p. 17), and finding it work admirably, I varied it as follows:—

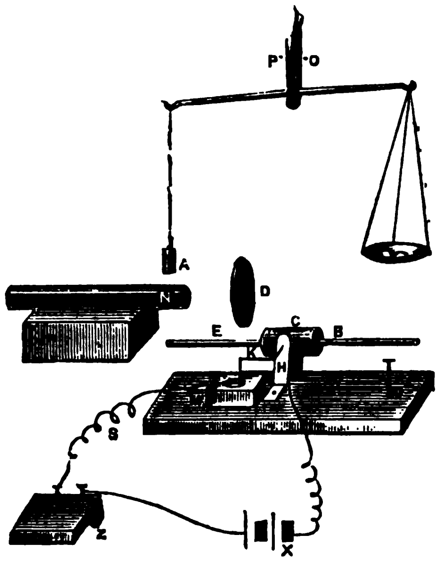


A, the telephone, which is of course applied to the ear. One of its terminal wires is partially immersed in water contained in the vessel, B, in which another short wire, C, is also immersed. On the circuit being completed at D the sound is distinctly audible in the telephone. All the wires are of copper. At first I thought I must be mistaken, so added a little acid to the water, and this time there was no ground for doubt, as the sounds were nearly as audible as in Mr. Bennett's experiment. I then joined the wires at D, and completed the circuit by dipping the wire, C, into the water, but could get no sound. I then attached a piece of tinfoil to one wire, and, placing it in the water, was able to get a slight sound on touching the surface of the water with the wire, C, which was greatly augmented, however, by bringing C into contact with the foil (under water). If the wire is held in one hand, and the other one is dipped into the water, the sound is still heard, although somewhat subdued, notwithstanding that the electricity passes through the body, and that there is only one metal in the water. This is more than I can make out, and shall be glad if some one will explain it to A Beginner.

TELEPHONE LECTURE EXPERIMENT.

[14151.]—Lectures on the telephone are now common, and many of your readers may be glad to know of the following very striking experiment. It is intended to demonstrate to an audience the changes which the movements of the diaphragm produce in the condition of the magnet, thus giving rise to the induced currents.

One of the pans of a small pair of scales is removed and a short piece of bar iron is suspended by a thread in its place. The scales are then fixed in the clamp of a retort stand, and the remaining pan is weighted so as to exactly counterbalance the iron. Two pins, P Q, are inserted into the cork lining of the clamp, their purpose being to act as stops and limit the oscillations of the index to a very small angle. The bar magnet, N, is placed on a block of wood underneath the iron, A, and the clamp is adjusted so that, when the index is pressing against P, A may be rather more than ¼in. from N. The position of the pin, Q, must be such that when the index is pressed against Q, A may not be removed beyond the sphere of attraction of N. If now a telephone disc, D, is held ¼in. away from the pole of N, the attractive power of the magnet will be diminished, and A will rise as far as the stop, Q,



permits. On the disc being withdrawn, the magnet resumes its power, and the piece of iron resumes its original position.

But these movements cannot be seen at a distance since they are necessarily small. I therefore adopted the arrangement shown in the figure. It is drawn on a larger scale than the rest of the diagram.

E B is a piece of crinoline spring, about 3in. long. It is passed through a cork, C, the end, B, being very slightly longer than the end, E. An axis of copper wire is inserted through the cork. One end of it is prolonged and bent into the form of the letter L, as shown at K. Two supports, of which H is one, are made of sheet brass. M is a small block of wood, having a hole at the top which is filled with mercury. X is a battery, Z is an electric bell. Connections are made by wires as shown in the figure. The use of this apparatus is as follows:—It is placed so that when the heavier end, B, of the steel is resting upon the pin, O, the end, E, is ¼in. below the scale pan. The wire, K, should then be adjusted so that the point may be 1-16in. above the mercury. Now, when the experiment before described is repeated, the scale pan in descending will press upon E, thus causing X to dip into the mercury, making electrical connection between the wires, S and T, and ringing the bell, Z. If the apparatus is properly adjusted (which is easily done), this operation may be repeated with great rapidity. The moment that the disc is presented to the magnet the bell rings; no sooner is it withdrawn than the bell stops.

Speravi.

ON THE MEASUREMENT OF THE ANGLE OF APERTURE OF MICROSCOPE OBJECT-GLASSES.

[14152.]—THE experiments of Drs. Nickolls and Bull having called for further trials and explanations, I now demonstrate my views in a more explicit manner. I have long held the opinion that no method of measurement hitherto used has given any results at all approaching to accuracy, and in many instances the angle of aperture of microscope objectives has not reached even to half the number of degrees attributed to them. The mistake arises, as I have repeatedly urged, from the entrance of oblique pencils or rays extending in a direction away from the central or axial one, so that it is the angle of the extreme rays at the margin of the field of view that we measure instead of the angle proper.

In order to confine the apex of the cone or pencil of rays to one central point in the axial focus, I proposed that the sector measurement should be performed with a very narrow slit or minute perforation set precisely in the focus; but this, though right in theory, was found to be difficult and impracticable for high powers, as even the narrowest slit that could be used must have a diameter causing an error of angle to be indicated greatly in excess, and it was impossible to assign the exact limit of angles because no distinct image could be seen through a minute slit. In order to obviate this objection and obtain a result that should be consigned to an exact centre line, a half screen bisecting the field in the focal plane was next proposed, the screen to be shifted alternately during the measurement. But this plan was abandoned as altogether fallacious, for it is the property of a lens that every open point on its working surface admits a ray from every portion of the field of view. The effect by obscuring the alternate halves is simply nil, the sum of the two measurements being equal to that of the entire uncovered lens. I mention this because Drs. Nickolls and Bull suppose that as the result corresponds nearer with the open measurement, it must be considered accurate.

I next proposed to eliminate the marginal pencils of the field by means of a small stop set in the focus of an eyepiece adaptation. This has also been found to give unreliable measurements, but still it affords no disproof of the accuracy of the principle to which I have called notice. Of this I now give additional demonstration.

I selected a 1-5th of fine quality, which worked as an immersion. This position prevents quibbling concerning various positions of adjustment. The aperture as measured by the sector through a slide, with water between that and the front lens, was 120°. The focal distance as immersion was ·041 (I use a Zentmayer form of stand, which is fitted with a micrometer scale and vernier directly on to the fine motion slide, so that depths can be measured very accurately), The diameter of transmission on the surface of front lens was ·07. This is ascertained by allowing a drop of milk to dry on the front, and measuring the diameter of the light spot from parallel rays, entering the back, using a low-power object-glass and micrometer eyepiece for the measurement.

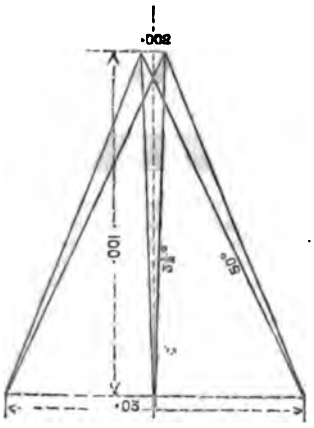
The field of view included a diameter of ·03 on a stage micrometer. Now, having the exact focal distance from the surface of the front lens as a starting point, it remained first to ascertain what were the apparent apertures taken through various-sized stops set close on to the front, having definite diameters that could only admit the base of a cone of rays, from an angle taken from the axial focal point, up to a known diameter of stop. The arrangement that I use is a form of adjustable slit, consisting of two strips of very thin platinum foil. One piece is cemented on to a parallel slip of thin plate-glass, which is made to slide under two staples by a micrometer screw acting against a counter spring. The fixed strip of foil is attached to one of the staples, so that when the screw is quite home the edges meet. The various widths at which the instrument was set were measured under the microscope with eyepiece micrometer. Having got the desired width, the object-glass to be measured was attached, and the body of the microscope lowered till the slit came in contact with the front lens, a drop of water having been placed over the slit, to prevent undue refraction and obtain more light.

The apparent angles included by these different limiting edges or stops were measured by the usual sector method of rotating the microscope on a turnplate, graduated into degrees, and ascertaining the vanishing point of a distant light, or preferably by means of an examining lens at the eyepiece, so as to observe the disappearance from the field of an actual image.

The real or true angles were estimated from the distance of the focal point, up to the known measure of the edges of the stop. Avoiding fractions of degrees, the following table gives the comparative results:—

Working diam. of front lens.	False aperture.	True aperture.
·07	120°	89°
·06	118°	80°
·05	116°	70°
·04	103°	58°
·03	88°	45°
·02	68°	31°
·01	56°	16°
·005	53°	8°
·002	50°	3 5°

The last item with a stop 1·500th of an inch in diameter indicates an aperture of 50° by the usual methods, whereas the true angle is only 3½°—an error being shown in excess of more than fourteen times.



The annexed diagram demonstrates the cause of this error. The central angle shown is the true aperture assigned by the width of the small stop at the base. The oblique angles represent the pencils including the field of view and showing light, or an image, in the eyepiece up to an angular range of 50°. As I have so repeatedly urged, it is these outside rays which are superadded to angle of aperture taken by the usual measurement, and which are the cause of erroneous indications greatly in excess of the true angle.

F. H. Wenham.

PURIFYING WATER.

[14153.]—I AM anxious to know whether there is any cheap and readily available means of purifying water for drinking purposes other than filtration, in which I have only a limited belief, and regard simply as a means of removing solid impurities. Is there any trustworthy method of ascertaining whether a water should be suspected, and suspicion having been aroused, is there any means of purifying that water other than distillation? For instance, what is the action of the permanganates on water. I am told that the organic matter of the water seizes on the oxygen in the permanganate, and becomes oxidised and burnt up. Assuming that species of Bacteria are the specific poisons of certain diseases, will the addition of the permanganates to water destroy the Bacteria and render the water safe to drink? If so, to what extent should the permanganate be added? Until the colour begins to remain, after standing—how long? What effect would the permanganates have upon waters heavily charged with lime? In a back number *Journal für Praktische Chemie* Herr Kän says that tannin or tannic acid is a trustwort of the purity of water. When analysing specimens of well water from a churchyard Leonhard, near Nuremberg, Kämmerer test water by means of tannin. For this purp cubic inches of the water were placed in cylinder; to each sample was added 0·18 cubi of a freshly prepared, cold, saturated solut tannin, and left standing in vessels closed a tight. The first sample instantly became clo the separation of a rapidly increasing, c precipitate, which, at the end of an hour, fo thick gelatinous precipitate, and after st for days did not settle clear and colourless sample from the second well acted in a manner; at the end of an hour there was a gelatinous precipitate, which soon took a grey light green, and finally dark green colour, du trace of iron in the water. The third sample re its clear appearance a longer time, and in t four hours only a slight turbidity could be ob yet in 24 hours a thick starchy precipita formed. The organic nature of the precipita undoubted, but was further proved by char when it gave off, like a residue obtained by e tion, a strong odour of burned horn, and left b very small amount of ash in proportion volume. For the purpose of testing for organic acids, sulphuric acid was added to quarts of each sample of water, which wa distilled off to one-fifth its original volume; small quantity of the tannin solution added residue caused an immediate coagulation to jelly. Since sulphuric acid precipitates tanni its aqueous solution, and this precipitation milky, and is difficult to clarify, it was t possible that the strong reaction in these r might be referred to the precipitation of the by the sulphuric acid. But this supposition agree very well with the volume of the prec which seemed disproportionately larger th quantity of tannin employed. Comparative ments were made with tannin precipitat sulphuric acid, and gelatin precipitated by and showed that, on heating, the tannin disso the sulphuric acid and water before it reach boiling temperature, and on cooling was preci again, and soon settled, leaving the liquid The precipitate formed by tannin in a solut gelatin is not dissolved by dilute sulphuric aci when boiling, but seems rather to increase precipitate formed by tannin in the residue distillation reacted precisely like the latter; o ing to boiling they seemed rather to increas to diminish.

After he had found by further experiment t turbidity produced by tannin solution in th samples of water were not caused by albume by gelatin, Kämmerer feels that he is justi drawing the following conclusions:—1. The be no longer any doubt of the presence of gel well water. In some cases it is found in co tively large quantities. 2. Tannin is a suita agent for detecting this and similar substanc this test ought never to be omitted in anal water for hygienic purposes. 3. The prese salts and other compounds found in water may the precipitation by tannin. To judge of the of water from the tannin reaction, it must st least 24 hours. 4. Every water that suffers co able turbidity with tannin must be held dangerous for drinking. It seems to make ference whether the precipitate falls at once after some time, as the time depends less substance to be precipitated than on the oth stances dissolved in the water which retard t cipitation.

Would Mr. Allen kindly express an opinion questions herein mooted, and say especially w suspected well water might be used with imp it has been boiled?

S. M

NOTES FOR WATCHMAKERS A OTHERS.

[14154.]—THE following "notes" extracte an American technical journal may be us your readers, and will probably suggest othe cations. For instance, I should like to whether any one has tried the method recom for restoring lustre, and whether burnishe might be safely submitted to the action of t

Main Springs.

When a main spring is cleaned most inexpe workmen will take hold of one end and p spring about half its length straight out to sa This practice will break springs when nothi will; and springs treated thus generally brea the watch has been delivered to the custom a few days. Breaking into many pieces is to the acid in the oil which is used. W suppose the main spring is a fine one, and h evenly tempered and properly cleaned: if, n oil is used, or that of an inferior quality if the acid it contains will eat into the spring, a finally destroy its texture. The coil near centre breaks first, and as it recoils it breaks every coil in the barrel, and sometimes each coil is broken twice. The spring has become so impregnated with acid that it has no life left.

To Purify Oil.

To make the oil pure, take a good-sized bullet or other piece of lead which has a thick coating of lead rust, cut it up fine, put it into the oil, and let it stand for two weeks. This causes the acid to settle, and it then resembles milk at the bottom. Now pour off the top, and your oil is pure. Common clock oil can be treated in this manner and made better than some watch oil.

To Restore Lustre.

If not too much darkened it may be restored by dipping the wheel in pure muriatic acid. Test your acid by dipping a piece of polished steel in it; if it destroys the polish, reduce the acid with rain water until it will not. Rinse the wheel well in water. This will also restore the polish to steel that has been blued by heat.

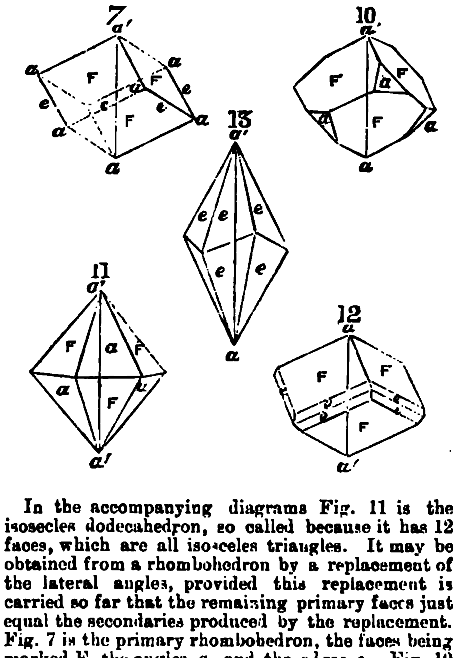
Grinding Glasses.

Provide two pieces of cork, one concave and one convex (which may be cut to shape after fitting to lathe). Take a copper cent or other suitable article and soft solder a screw to fit the lathe and then wax it to the cork; then get a twenty-five cent emery wheel, such as is used on sewing machines, and you have a complete outfit for cutting your watch glasses. Polish the edge on the zinc collar of the emery wheel, or use a piece of zinc to do it. The other cork should be waxed to a penny and centred. The spectacle lenses may be cut on the same emery wheel, if the wheel is attached to the lathe so as to revolve. Another method is to take a common piece of window glass (green glass is the best) and make a grindstone of that, using the flat surface to grind on. Cement it on a large chuck, the glass being from 2 to 2·5 inches in diameter. Any one not familiar with this method would be surprised to see how fast the glass is cut away, for either spectacles or watches. In grinding watch glasses put them flat on the chuck glass—not on the edge.

J. T. M.

THE KENTISH RAGSTONE AND CRYSTALS.

[14155.]—HUGH CLEMENTS, in his letter (14093, p. 15), on this subject in the ENGLISH MECHANIC of March 15, again goes off into collateral subjects, which have really nothing to do with the question at issue between him and me. As I wish to keep to this I must recapitulate a little. In the MECHANIC for January 11 Hugh Clements had a letter (13824, p. 428), in which he stated that he had found some crystals in the Kentish ragstone, and also stated distinctly that they were pentagonal dodecahedrons, and that, on making a qualitative analysis, he found that the said crystals were composed of calcic carbonate and an appreciative quantity of iron. On reading this I was very strongly of opinion that he was mistaken, and that he had not really found calcic carbonate crystallised in pentagonal dodecahedrons, or any other form belonging to the cubic or monometric system of crystallisation, but that the crystals he had found were really of some form belonging to the hexagonal system, and which could be derived from the obtuse rhombohedron, which is the primary form from which all crystals of calc spar can be derived. Further considering the matter, I thought it extremely likely that he had mistaken a peculiar form of hexagonal prism which has 12 octagonal faces, for a pentagonal dodecahedron, and I wrote a letter (13917, p. 503), which appeared on February 1, and in which I described the two forms of crystals and the manner in which they were respectively formed from their primaries, an explanation which I had to repeat at greater length, illustrated with diagrams, in a subsequent letter (14019, p. 579), which appeared on February 22nd. This latter letter was in answer to one of Hugh Clements's (13956, p. 530), February 8, in which, in reply to my former letter, he adhered to his statement that his crystals were pentagonal dodecahedrons and nothing else, going off into a number of secondary questions, contradicting nearly everything I had said, and laying down his own opinions in a very dogmatic and "ex-cathedrâ" manner. In my letter (14019, p. 579), I stated that I adhered substantially to my opinions expressed in my first letter, and, in response to a wish expressed by Hugh Clements, explained how the two forms of crystals in question were derived from their respective primary forms by the help of diagrams, which have been very accurately engraved (p. 579). The next step in the correspondence was a letter (14078, p. 629), March 8, signed J. H. Collins, in which the writer, while expressing his opinion that I was probably right, suggested another possible explanation—viz., that the crystals found by Hugh Clements might be pseudomorphs of calc spar after pyrites. This I think very much more unlikely than my explanation. I now come back to Hugh Clements's last letter (14093, p. 15), and to the present position of the original question at issue between us—viz., are the crystals of calc spar found by Hugh Clements pentagonal dodecahedrons or not? He now says, "I still consider the crystals referred to bear a greater resemblance to the form of the pentagonal dodecahedron than they do to that of the six sided prism with pentagonal faces. Of course, it is possible, and perhaps I may say probable, that the crystals are six sided prisms, so very much modified, that it is impossible to distinguish between them and the dodecahedrons." Now I have not the least hesitation in saying that any mineralogist, with practical knowledge of the subject, would at once distinguish between calc spar, in the form of six-sided prisms, with pentagonal faces, no matter how they might be modified, and pentagonal dodecahedrons; if by no other means, certainly by cleavage, which is good in calc spar, and which would at once show whether the primary form of the crystal was a cube or a rhombohedron. I do not at all wish to let myself be drawn by Hugh Clements into the discussion of secondary questions, but I may just say that I still adhere to my statement that in calcic carbonate the six-sided prism is a secondary form of the rhombohedron, and I say so because the cleavage in a crystal of that substance, in the form of a hexagonal prism, is parallel to the original faces of the primary rhombohedron, and not to those of the secondary prism. This is what shows that the rhombohedron is in calcic carbonate the primary form; no matter what form that substance may crystallise in, the cleavage will be parallel to the the original faces of the primary rhombohedron. As to Hugh Clements's reiterated statement that the rhombohedron is a secondary form of the hexagonal pyramid, I send diagrams showing how the latter is derived from the former, and the proof that the hexagonal pyramid, or isosceles dodecahedron as I shall call it, is the secondary form in calcic carbonate, and that the cleavage is never parallel to all the faces of a crystal of that form, but always to those only of the primary rhombohedron. Though theoretically the rhombohedron can be derived from the isosceles dodecahedron, the cases in which the latter is actually the primary form, and the former the secondary, are (if any) very few. I cannot remember a single mineral in which it is so, though, of course, I cannot say that it is impossible that there may be a few.



In the accompanying diagrams Fig. 11 is the isosceles dodecahedron, so called because it has 12 faces, which are all isosceles triangles. It may be obtained from a rhombohedron by a replacement of the lateral angles, provided this replacement is carried so far that the remaining primary faces just equal the secondaries produced by the replacement. Fig. 7 is the primary rhombohedron, the faces being marked F, the angles a, and the edges e. Fig. 10 shows the lateral angles partly replaced by the secondary faces, a a a; and Fig. 11 shows the resulting isosceles dodecahedron, the remaining parts of the primary faces of the rhombohedron being marked F, and the secondary faces produced by the replacement of the lateral angles of the rhombohedron being marked a. The isosceles dodecahedron may also be obtained by replacement of the basal edges or angles of the hexagonal prism. Many minerals, crystals of which occur in this form, have cleavage parallel to the primary faces, F; but none that I know of has it parallel to the secondary faces, a. Fig. 13 is the scalene dodecahedron, which may be obtained from a rhombohedron by a bevelment of the lateral edges. Fig. 12 shows the lateral edges, e e, of the rhombohedron partly bevelled. Fig. 13 is the perfect figure, the faces, e, being all secondary, and produced by the continued bevelment of the lateral edges of the rhombohedron. In all these figures the principal axis, a' a', of the crystal is shown; those two forms of triangular dodecahedron bear much the same relation to each other in their mode of formation from the rhombohedron as the two forms of hexagonal prisms shown in Figs. 8 and 9 in letter 14019, p. 579, Feb. 22.

Any difference, however, between Hugh Clements and me as to crystallisation has nothing whatever to say to the real question at issue, nor do I think it of very much consequence in any respect, as I account for it in a great measure in this way: Hugh Clements uses the words primary and secondary absolutely, and with reference to some theoretical system of crystalogeny. I use the same words relatively, and with reference to the actual crystallisation of the particular mineral under consideration, and as I have stated in a former letter (14019, p. 579), when two forms of crystals can be mutually derived from each other, one is often primary and the other secondary in the crystals of one mineral, whilst in the case of another mineral their relative positions in this respect are reversed—*e g.*, in galena the cube is the primary, and in octohedral and dodecahedral crystals of this mineral the cleavage is cubical or parallel to the faces of the primary cube; whilst, on the other hand, in fluor spar, in which the octohedron is the primary form, the cleavage in cubical crystals is octohedral or parallel to the faces of the primary octohedron, and in blende or sulphuret of zinc the primary form is the dodecahedron, and the cleavage in cubic and octohedral crystals is dodecahedral or parallel to the faces of the primary dodecahedron; so also in calcic carbonate the cleavage is parallel to the original faces of the primary rhombohedron, and in magnetic pyrites it is parallel to the original faces of the primary hexagonal prism; whilst in quartz the cleavage, though difficult, is obtainable in both those directions; and though the isosceles dodecahedron, called by Hugh Clements the hexagonal pyramid, occurs in this mineral, it must be considered a secondary form, as cleavage cannot be obtained parallel to all its faces but only to its alternate faces, or the original faces of the primary rhombohedron, or to the faces of the six-sided prism. In very many minerals crystallising in the hexagonal system the cleavage is at right angles to the principal axis of the crystal, but as this is the same in all forms belonging to that system, it goes for nothing in determining the primary form of the crystal. The number of primary forms is very few; they are limited in the cubic and hexagonal system to those which I have just mentioned. I do not exclude the isosceles dodecahedron, though I have doubts as to its being entitled to be ever considered a primary form. Is is not a very extraordinary circumstance that in a very large number of minerals the cleavage should be parallel to the faces of the rhombohedron—that is, to the faces of a form which is (according to Hugh Clements) not only secondary but hemihedral—and only to the alternate faces of the form, which is (according to the same authority) not only the primary of the rhombohedron but of the entire hexagonal system, whilst the minerals (if there are any) in which the cleavage is parallel to all the faces of this same primary form are very few. Can Hugh Clements name any and give an authority? In fact, if it should be considered necessary to refer all the forms of crystal belonging to the hexagonal system to one primary form, I think that the rhombohedron should be the one—for this reason, that a very large number of minerals have cleavage in the direction parallel to the faces of the rhombohedron, and that this cleavage could not be properly referred to any other primary form, whilst cleavage in the two other directions in which it is found to exist in those minerals can be referred to the rhombohedron, that in the direction perpendicular to the principal axis being the same in all the forms, and that parallel to the faces of the hexagonal prism being in the direction crossing the lateral edges or angles of the rhombohedron parallel to its principal axis, which is also the way in which that cleavage should be referred to the isosceles dodecahedron, if that form were considered the primary. This latter cleavage and that parallel to the faces of the rhombohedron are often co-existent in the same mineral, as in quartz and tourmaline, which goes far to show that both can be properly referred to the rhombohedron, and that the rhombohedron might be very fairly considered the primary form of all crystals belonging to the hexagonal system. I do not think it will be necessary for me to write again on this subject. I do not care to let myself be drawn any further into a controversy on any of the collateral issues as to the formation of crystals which Hugh Clements has raised. I wrote in the first instance chiefly lest any of your younger readers should hastily come to the conclusion that calc spar crystallised in the form of the pentagonal dodecahedron, or any other form belonging to the cubic system, on the strength of such a statement as that which Hugh Clements so unhesitatingly made in his first letter on the subject. If he had mentioned his crystals in the same way in his first letter that he has in his last, I would not have thought it necessary to write at all. Long as I have made this letter I have passed over three-fourths of Hugh Clements's letter as irrelevant, though I am glad to see from the lecture he has given us on the axes of crystals, &c., that he has been making himself up in the distinctions between the several systems of crystallisation, and I [illegible] feel pretty sure that we shall not again have the announcing that he has found a mineral which crystallises in one system in the form of crystals belonging to another. As an undoubted and [illegible] fact, would not Hugo [illegible] think it worth his while to send the crystals for examination to some good practical as well as theoretical mineralogist? Yes, perhaps, Mr. [illegible] [illegible] refer him to one, and let the readers of the English Mechanic know the result. I, for one, would like very much to know what these crystals really are.

G. J. H.

SPECULAR REFLECTION.

[14156.]—The following is translated from a paper published in the [illegible] [illegible] Unterhaltung und Belehrung, No. 15, [illegible], 2 Apr., [illegible]. Upon perusing it your readers will perceive that Mr. Brett's theory of specular reflection has, like Professor Pritchard's trough of mercury, been anticipated by the Germans. But their ideas of humour, or rather the idea of humour of the particular humourist who signs himself "G." and who, I suspect, is the distinguished director of an important observatory, only permitted him to lay the scene of the discovery in the Far West, already rendered classic ground by the imagination of Jules Verne, in his "Voyage à la Lune." It remained for Messrs. Brett and Christie boldly to bring the question before a learned society*, and to attempt to discuss it on any other day than the 1st of April.

Qui Astra Legit, Legit et Historiam.

Essen, April 1.

The discoveries which have recently been made in the photographic section of the American Astronomical Society of Cincinnati deserve to attract the interest of the whole scientific world.

As is well known, the above-named society has for some time past been directing its attention to an inquiry into the physical nature of the stars, and it is owing to the ingenious combination of photography with astronomy that our wonderful advances have been made.

The apparatus which the society has at its disposal is the most perfect that mechanical and optical science has yet been able to produce, and is a source of envy not only to the photographers of America, but also to the observatories of both continents.

When it is borne in mind that this society receives absolutely no help from Government, but meets its very considerable expenses solely by the voluntary contributions of its members, one can easily appreciate the love of science which exists in the Far West, a land so lightly supposed to be the home of a crass materialism and exaggerated speculation.

The photographic section of the American Astronomical Society has accomplished what our photographers have so far failed to produce—viz., an enlargement of a small photograph, without, at the same time losing definition and detail. Owing to the excellent character of their instruments and preparations, as well as to a peculiar method of procedure (which they still regard as their own secret), they are in a position to produce enlargements of photographs to any desired size without any loss of clearness. The greater the enlargement, the more numerous are the details; and, when examined under the magnifying glass, such pictures exhibit the most perfect photographic surface, while those taken by ordinary methods, when similarly treated, merely show the fibres or structure of the collodion or paper. It can easily be imagined how important this fact is for attaining the object which the society has in view—*i.e.*, the investigation of the physical nature of the heavenly bodies.

The picture of a star properly enlarged must afford the most interesting clues, and accordingly for some time past the photographic section has busied itself exclusively with the enlargement of star-photographs. We shall take the following passage from a communication on the subject which the *New York Photographic Herald*—a paper singularly well-informed on matters of this kind—treats in an article of considerable length :—

Professor Monkhouse went with the plate into the dark chamber, in order to develop the picture. Fully an hour elapsed before he returned to his colleagues in the laboratory. He showed signs of unusual excitement. A slight pallor had overspread his countenance, while the moisture in his eyes betrayed the fact that he had been the subject of unusual emotion. His colleagues regarded him with inquiry and astonishment. They suspected that some extraordinary event must have occurred to produce such a wonderful alteration in this calm, cold observer.

"Gentlemen," he began, with a voice tremulous with emotion, "we celebrate to-day a triumph, the like of which the world has never before seen—we have made an advance, the magnitude of which you [illegible] anticipate, and the consequences of which are simply immeasurable—look, judge for yourselves."

He handed the plate, on which a picture had now become visible, to Mr [illegible], who examined it along with Mr Kark. An exclamation of surprise escaped their lips. "Here are men!" "I see camels and asses!" "Good Heavens! what is this? water, mountains, trees, men, women, children, a whole caravan!" So their exclamations crossed each other.

Professor Monkhouse, who had entirely regained his composure, remained silent, and evidently enjoyed the astonishment of his colleagues, who were examining each detail of the plate with eager scrutiny.

"I consider everything I see here," said Professor Kark, "a mere figment of the imagination. We are the victims of an optical illusion. This point, if enlarged 24 million of millions of times, would of course give us the picture of the star γ Lyræ. That I understand and quite admit. But that this star is peopled with human beings, that things there resemble exactly those on our own planet, whose nature, according to all the discoveries hitherto made, is totally different from that of any fixed star—*this* I find it quite impossible to believe."

Professor Monkhouse listened with a smile to the words of his colleague, nodding assent now and then: and as the latter ceased to speak, he replied: "You are perfectly right in believing that what you have before you is not a picture of the star γ Lyræ. You have before you a picture of a small portion of our own earth. The star, whose photograph we have just taken, returns the rays of light to us in the same combination in which it originally received them. Its surface must be a perfect mirror; which would support my supposition that it is composed of the noble metals only. Given a sufficiently high temperature, it will be covered with fluid metal like quicksilver, and this forms the reflecting surface. Light takes about 1,759 years to come from that star to us. Double this number, and you have the period which it requires to get there and back. Now, examine this picture, think of the time when it was originally formed, and then recall to mind your Biblical history. You are now looking at *the passage of the children of Israel through the Red Sea.*

Three thousand five hundred and eighteen years ago that event happened, the picture of which you are now examining. The rays of light which streamed forth from the theatre of that event were not lost. Most of them were, no doubt, dissipated through the universe, but some were intercepted and returned again to our earth by reflection. Chance willed it that our photograph should be taken exactly on a day to which we could assign a historical event. We have negatives for each of the following days, and we shall be able to join the children of Israel in their march through the wilderness. Inasmuch as we can select stars at any desired distance, we have the means given us whereby we may take at any time a picture of any given day of the past. Should we, for instance, wish to know what spectacle presented itself to the eyes of Columbus when he first trod the soil of America, we have only to make the following simple calculation—Columbus first set foot on the Island of Guanabani on October 12, A.D. 1492. Since then 377 years 137 days have elapsed. By halving this number we get 188 years 251 days. The star table tells us that the star ι *Cassiopeia* is distant from us by exactly this number of light-years. By taking a photograph of this star we can, by means of the picture so obtained, be present at the landing of Columbus. Ancient history is no longer a sealed book with dark pages. We no longer need to study history in the antiquities of our earth—in remains and fragments. From this time forth we shall read it in the heavens. No time, no place, is too far shut out from us. Each star gives the picture of a different century—of a different cycle of centuries. We shall be able to look back into times the most remote and discover the history of the creation of our own earth. G.

HALLEY'S COMET.

[14157.]—The number of apparitions of this comet, which have been fixed with a great degree of probability, amount to 24, a greater number than has been recorded of any other comet, with the exception of perhaps the comet of Encke. On the other hand it must be admitted that for the first fourteen centuries since the Christian era the passages of the comet in question have been judiciously estimated, rather than accurately calculated. If, however, we dismiss from our minds for a moment the doubts which may exist respecting the assumed times of perihelion passage, and examine them with the view of ascertaining whether they exhibit a certain amount of regularity in accordance with the theory of perturbation, and if we find this to be the case, then this result and the assumed times of passage may be considered to be mutually confirmatory.

Upon looking at the data given below we see at once that the mean periodic time cannot reasonably be supposed to be much over 77 years, or much under 7[illegible] years, whence we see that there will be an enormous inequality due to the action of Jupiter, whose period would be from 18 to 40 times that of the comet. It will remain then to ascertain whether we cannot fix within more narrow limits the mean period, and the period of the inequality, solely considering the observations. And, further, whether these two periods deduced from observation are not in reasonable accord with one another, taking a rough view of the theory of perturbations. Angström, the Swedish scientist, has attempted something of this kind about 11 years ago. His results, however, are inadmissible, as I think. He succeeded in representing the observations as well as could be expected by supposing the mean period to be [illegible] years, and that there was an inequality due to the action of Jupiter, whose maximum was 1½ years and duration 34 periods of the comet, and also another due to Saturn with a maximum of 2¼ years, a period of 1[illegible] years, and which was, moreover, due to the square of the disturbing force. Now, in view of the circumstance that the comet approaches Jupiter more nearly than Saturn, and that the Jovian inequality has a period more than three times that of the Saturnian, without taking account of other matters which tend even more in the same direction, we shall perceive that the Saturnian inequality, instead of being larger, could not possibly have been detected in comparison with the Jovian.

Besides, it would be more satisfactory to obtain good results by means of one inequality as involving fewer assumptions.

If we assume a mean period of 77 years, an inequality whose duration is 19 periods, and whose maximum is 4·5 years, we shall obtain the following results :—

B.C. 11·73	− 4·3	989·70	− ·38
A.D. 66·05	− 3·2	1066·28	+ ·27
141·34	− 0·88	1145·39	+ ·14
218·30	+ ·77	1223·52	+ ·36
295·30	+ 1·8	1301·79	+ ·22
373·84	+ ·97	1378·83	+ ·87
451·5	+ 1·85	1456·48	− ·48
530·84	+ ·82	1531·62	− ·58
608·8	·0	1607·84	− ·59
684·8	+ ·53	1682·73	− ·37
760·44	+ ·97	1759·23	+ ·59
837·26	+ ·07	1835·88	− ·08
912·25	+ ·43	1910·42	—

I have ventured to place in the table the result obtained by Pontecoulant for 1910, as the observed time for that epoch will no doubt be very close to Pontecoulant's predicted result.

The first and fourth columns of the table explain themselves. The second and third are the remaining deviations, after taking into account the inequality. The deviations without the inequality would be as follows, very nearly :—

− ·1	− ·62	− 2·31	+ 3·3	+ 2·54
− 1·	− 1·3	− 2·03	+ 4·58	+ ·43
+ 1·	− 3·53	− ·03	+ 4·62	− ·2
+ 1·	− 4·48	+ ·10	+ 5·26	− ·46
+ 1·	− 3·49	+ 2·07	+ 3·42	− 2·78

It will be seen that the assumption of the inequality represents the observations within the limits of probable error, except as regards the two earliest apparitions and the fifth and seventh. I can only suggest that the times of these four passages are erroneously estimated. That there should be errors to such an extent is not at all surprising. It would be strange if there were not. There can, however, I presume, be no doubt as to the existence of the inequality considered, whose origin would be at 989·23 A.D., where its effect is nil. The unexplained residuum will consist of the other inequalities combined with the errors of observations. The comet approaches Jupiter more nearly than any other of the superior planets, and its action would be very much greater than all the rest put together. It is to be remarked that the principal part of the action of Neptune and Uranus would be due to long inequalities, very nearly of the same period as the one I have ascribed to Jupiter. These comparatively small inequalities would be masked in the observations by that due to Jupiter.

As might be expected, Angström, by the use of two inequalities, has succeeded in representing the observations more closely than was possible with one, but then his inequalities were inconsistent with theory. It remains to be seen how far the inequality I have considered is in accord with theory. The argument of the inequality will be

$$13c + 2\varpi + 2j,$$

where c is the mean anomalistic movement of the comet; ϖ that of the perihelion; j, the mean motion of Jupiter. In order that the period of the above argument should comprise 19 periods of the comet, it would be necessary that the perihelion should have a retrograde motion of 3·7″ annually with regard to a fixed equinox, which is a very probable amount.

It is absolutely necessary to take into consideration the motion of perihelion in estimating the period of the inequality. Without that motion the period would have been thrice as great as adopted. Angström omitted this.

If the progress of analysis shall ever render it possible (as I think will be the case) to calculate accurately the absolute perturbations of Halley's comet, then the principal part of such perturbations will probably be found included in an inequality approximately identical with the one I have suggested.

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* Mr. Brett's idea that the spot of light seen upon Mercury in transit is a reflexion of the earth, seems exactly to correspond with the April joke of "G.," who, it will be observed, dates his communication from *Essen*, which we conclude is intended to mean the dinner-table. Mr. Christie, however, in sober earnestness adopts the idea of this Narcissus with a telescope, who, in spite of the brightness of the surrounding photosphere, sees his own image reflected from Mercury.

It must not be forgotten that Halley's comet, like most of the rest, passes or skirts the asteroid zone, and may meet with collisions or unknown perturbations in those regions, as may have been the case, according to a suggestion that has been made, with Biela's comet, and likewise with Encke's. In the latter, causing, for one revolution, an apparent disappearance of the effect of the resisting medium.

W. C. B.

DISTILLATION OF COAL.

[14158.]—IN regard to Dr. Mills' letter (14133), I beg to state that, in my answer to "Justitia's" accusation of my pirating from his (Dr. Mills' publication on "Destructive Distillation," I had no intention of calling in question the originality of that work, but merely wished to show that my letter on coal distillation was not taken from that source. In doing so I pointed out that the information given was not contained in the book, and therefore could not have been taken from it; and also that Dr. Mills' theory of coal formation, one of the points mentioned, was in print long before the publication of the "mannalette." Dr. Mills' researches on "Cumulative Resolution," which he seems to have made a special study, may be found, I think, either in the "Philosophical Magazine" or in the "Proceedings of the Royal Society"; but the particular reference which I made was to a reprint of the Cantor Lectures on "Carbon and its Compounds," delivered before the Society of Arts, by Prof. Barff, which appeared in the ENGLISH MECHANIC of December 11, 1874, and from which I make the following extract:—

In speaking of cellulose ($C_6H_{10}O_5$) Prof. Barff says: "Suppose I take this quantity twice, that will be $C_{12}H_{20}O_{10}$. We will call the first one molecule of woody fibre, and we will call these two molecules. Now, suppose I take from these two molecules the one molecule of water, we shall then have remaining $C_{12}H_{18}O_9$. Now it must be manifest to every one here that this compound contains more carbon than the other does in proportion to its other constituents; and if we go on doing the same thing, doubling the formula of the new substance, and taking away the elements of water from it, we shall get a substance containing more carbon still; and, at last, we can go on until we get a substance known under the name of anthracite coal."

Now, this is exactly the theory of "Cumulative Resolution" as given by Dr. Mills. Whether the idea originated with him or with Prof. Barff I can offer no opinion. That is a matter they must be left to settle between themselves.

Jup. Rex.

[14159.]—IN reply to "Jup. Rex." I have to state that the ultimate purpose of my letter has been attained, and the desired information elicited.

Whether he derived the facts concerning the distillation of coal from Dr. Mills' book, or "cribbed" them from the same gentleman's lectures is a matter of indifference—to me, at least. In either case their source should have been acknowledged. It is to be hoped that "Jup. Rex." may be more fortunate in his future communications.

Justitia.

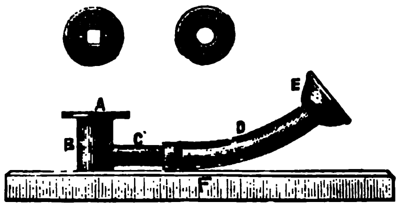
TELEPHONES, CORE OR NO CORE.

[14160.]—HAVING made telephones both with and without cores, I have come to this conclusion regarding them. If loudness is wanted they are better without cores, but if distinctness of articulation is desired, then by all means use a core in front of magnet. Regarding the steel from which the magnets are made, I think "spring steel" is as good as any, as it can be tempered very hard. I have tried "silver steel," but it did not answer well, as I could not get the magnets strong enough made from it. My magnets are 5in. long, and ⅜in. diameter, with a core of soft iron soldered on not more than ¼in. long and of same diameter. It is a much more simple plan to solder the core on than to tap magnet and screw it in. By magnetising with a strong horse-shoe magnet I found them capable of lifting a small hand-vice I was using, which weighs five ounces—so this is surely strong enough. I have used No. 36 and No. 29 wire for telephones with good results The ends of coil should be soldered to binding screws to insure a good contact. Using two telephones at each end for conversation, let one be at the mouth and the other at the ear, but to hear a song let the singer sing into both telephones, and the listener put both his telephones to his ears, and the song will be heard with great distinctness. It seems a difficulty to some to cut the ferrotype plates without buckling them. The plan I adopt is first to mark a circle on them of the size required, and then cut it out with a pair of scissors. This can be done very easily without spoiling the plates in the least. I find that if the ferrotype plate be taken off telephone, and the ear put close to magnet, at the same time holding the telephone near to a magnetic machine in motion, the cracking sound caused by the making and breaking contact is easily heard. Again, if a tin plate be laid on the telephone and the current from magnetic machine passed through, it sounds like some one knocking with a hammer inside. No doubt before long we shall hear of telephones very much superior to any yet made, as already several modifications have been made with advantage.

Biasfree.

THE PHONEIDOSCOPE.

[14161.]—FOR the information of those who may be working in the very large field of experimental study opened out by the introduction of the telephone, and its sister instrument, the phonograph, I send a description of the phoneidoscope. Various suggestions have from time to time been made in your pages as to the manner in which the iron disc in the telephone vibrates when it receives impressions of sound, and especially that of the human voice. We are certain that the metal plates do take up these sounds in their completeness, both with respect to pitch, quality, and relative intensity, for without the last two we could have no articulate, and without the first no musical, transmissions. The subject, however, has not yet been fully worked out, nor has any really satisfactory explanation of the phenomena in question been given. With a view to elucidating the matter, and affording a means of making these intricate plate vibrations apparent to the eye, Mr. Sedley Taylor devisd his phoneidoscope. In this instrument a film of soap-bubble solution, when in a state of tenuity sufficient to show interference colours by reflected light, is brought under the influence of the aërial disturbance resulting from vocal or other sounds. Definite figures then form themselves in the film corresponding to each different sound as it is presented. Such figures consist of coloured bands and circles, symmetrically placed, and varying in arrangement according to the shape and size of the orifice used, but constant in form for a sound of given pitch and quality with the same orifice.



The instrument is shown in my sketch. A brass cylinder, B, has inserted at its lower end the tube, C, and carries at its upper end the circular and horizontal plate, A, which is annular, its perforation corresponding to the diameter of B. C communicates with the conical mouthpiece, E, by means of the indiarubber tube, D. The whole, for convenience is mounted on a stand, F. The purpose of A is to support discs of sheet brass, through which apertures of various shapes and sizes have been cut. When the phoneidoscope is in use these apertures are made to contain the film of soap-bubble solution to be experimented upon. We thus have a plate consisting of an extremely delicate medium, and which, by reason of the fact that the colours reflected from its surface are an indication of its degree of tenuity at any point, affords us a help to realise the state into which it, or, indeed, any plate is brought under the influence of sonorous vibrations. The figures are infinite in variety, and the results as beautiful as their origin is simple. So sensitive are these films that they readily distinguish sounds of the same pitch but of different timbre. Thus, if the vowel sounds of the human voice be sung into the instrument, each one will be represented by its own distinct colour figure, although they may all have been intoned on the same note.

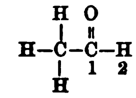
I have not had the opportunity myself of carrying on any investigations with the phoneidoscope, but having seen some of its beautiful and suggestive phenomena, took upon myself the task of introducing it to your readers. I may mention that it can be purchased complete in London for a very reasonable price.

Phthynx.

ALCOHOLS—ALDEHYDES.

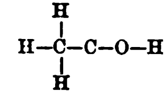
[14162.]—IN reference to letter 14090, page 14, an account of Kolbe's method of naming alcohols may be of some interest. This chemist proposed to call methylic alcohol "carbinol," and to name other monohydric alcohols as derivatives thereof. Thus ethylic alcohol is termed methyl carbinol, because it may be viewed as derived from carbinol by replacing one atom of hydrogen by methyl. Similarly propylic alcohol may be called ethyl carbinol, and so on. This method has the advantage of clearly indicating whether a given alcohol is primary, secondary, or tertiary; thus, butylic alcohol is propyl carbinol; secondary butylic alcohol is methyl-ethyl carbinol, indicating that one hydrogen atom of the original carbinol is replaced by methyl, and another by ethyl; tertiary butylic alcohol is trimethyl carbinol, showing that all the hydrogen atoms are replaced. This system has been further modified by Odling, for particulars of whose plan see Fownes, 2nd vol., page 117.

In dealing with the aldehydes (letter 15092, p. 15), Mr. Clements omits to give the new view as to their constitution, which view seems best to explain their reactions. The most marked characteristic of the aldehydes is the extreme readiness with which they absorb oxygen, and pass into the corresponding acids. Now, if we take



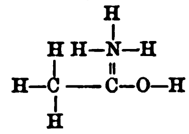
$$\begin{array}{c} \mathrm{H}\ \ \mathrm{O} \\ \mathrm{H{-}\overset{|}{\underset{|}{C}}{-}\overset{\|}{C}{-}H} \\ \ \ \ \ \ \ \ \ 1\ \ 2 \\ \mathrm{H} \end{array}$$

as the graphic formula of acetic aldehyde, this tendency to become oxidised is not very explicable, for the added atom of oxygen must go in between the carbon and hydrogen marked 1, 2, and as a matter of fact it is all but impossible to insert oxygen between carbon and hydrogen in this way. The alcohols differ from the corresponding hydrides, merely in having an atom of oxygen interpolated, but not only do the hydrides exhibit no tendency to become oxidised, but it is also impossible to oxidise them without destroying them altogether. I know alcohols can be formed from the hydrides, but the process is certainly not one of direct oxidation (as is the formation of acids from aldehydes) but rather one of substitution. Again, the formation of aldehyde-ammonia is difficult to understand, using the old formula for both carbon atoms being fully saturated. There seems no reason why another molecule should be taken up, nor indeed is it easy to see how it can get hooked on. And the same remarks will apply to the constitution of the polymeric modifications of acetic aldehyde. If, however, we assume that the formula is



$$\begin{array}{c} \mathrm{H} \\ \mathrm{H{-}\overset{|}{\underset{|}{C}}{-}C{-}O{-}H} \\ \mathrm{H} \end{array}$$

these difficulties vanish. It is then easy to understand the tendency to become oxidised to acetic acid, or hydrogenised into ethylic alcohol. The power of forming combinations with ammonia is also readily explicable, for NH_3 can, of course, act as a diad radical, and acetic-aldehyde ammonia may be written



$$\begin{array}{c} \mathrm{H} \\ \mathrm{H\ \ H{-}N{-}H} \\ \mathrm{H{-}\overset{|}{\underset{|}{C}}{-\!-}\overset{\|}{C}{-}O{-}H} \\ \mathrm{H} \end{array}$$

The tendency to polymerise is also easily explained on this view. All these facts considered, it is, therefore, better to view the aldehydes as containing *diad* carbon, and having the constitutional formula,

$$\left\{\begin{array}{l} CnH_2n + 1 \\ CHo \end{array}\right.$$

It may be urged against this view that the aldehydes are analogous to the ketones (which contain the group CO), and should therefore be formulated on the same type. The analogy is, however, much more apparent than real, inasmuch as the ketones lack the great characteristic of the aldehydes—namely, ready oxidisability. It is obvious that the formation of aldehydes by oxidation of alcohols is much better explained on the supposition that the change consists merely in removing two hydrogen atoms, leaving the semi-molecule of hydroxyl in its place, than by assuming that the atoms dodge about in the manner necessary to yield the formula

$$\left\{\begin{array}{l} CH_3 \\ COH \end{array}\right.$$

I will deal with Mr. Clements' communication on isomerism (page 19) next week, but may now remark that the formula No. 1 for cellulose is impossible, because it makes carbon a hexad. I congratulate my friend on his neat little paragraph anent the use (?) of alcohol.

William John Grey.

LATHE FOOT-WHEEL AND TREADLE.

[14163.]—MAY I be allowed to explain to our friend, "A. I. C. E.," let. 14107, the reason why I use a spring to my treadle? It is because it takes off so much dead weight from the cranks, and consequently lessens the friction on them, and on the lathe crank shaft centres. I do not discard (or recommend it to be discarded) the dead weight on the wheel to bring the crank to the 40° position, but use it in conjunction with the spring.

Childs.

HORSE POWER FOR DRIVING WOOD-WORKING MACHINERY.

[14164.]—A FEW weeks back you broached the applicability of horse-power to drive wood-working machinery, and I had hoped this subject would have been followed up. I think it would interest many of your readers to know how far it would be practicable, and whether speed enough could be obtained. For instance, I have a family of boys who have an idea of starting in a year or two for one of the Australian colonies with wood-working machinery for joinery purposes—on a small scale—to be driven by horse-power, if possible. Letters on the subject would be read with interest by others, I know, in the same shop; or anything else on wood-working machinery.

N. Z.

REPLIES TO QUERIES.

◆

*** *In their answers, Correspondents are respectfully requested to mention, in each instance, the title and number of the query asked.*

[31517.]—**Analysis of Soils and Manures.**—Having given a rough outline of the method to be followed in the analysis of soils (p. 483, Vol. XXVI.), I now, in continuation of the subject, take up the analysis of manures, confining myself only to the general principles of the process, leaving "Agre" to extend these principles in all their minutiæ. *Estimation of moisture:* Weigh off 5—10 grams of the manure in a tared porcelain dish. Dry in an oil oven at 125° C., until the weight remains constant. It is seldom necessary that a correction need be made for the small quantity of ammoniacal salts which are volatilised while drying. But, should it be required, all that is necessary is to fit up a test tube as a Woulfe's bottle arrangement, and aspirate a current of air from the exit on the oven through the test tube containing a few c.c. of standard acid. The difference in weight before and after drying, minus the ammonia trapped in the test tube, equals the moisture. The quantity of ammonia is estimated by running back the acid solution with standard soda, and calculating the ammonia as carbonate. *Estimation of total volatile matter:* Take from 4—8 grams of the dried sample in a platinum dish and ignite, being careful not to employ too high a heat, or too strong a current, otherwise the alkaline chlorides will volatilise, and the phosphates fuse, enveloping a portion of the carbonaceous matter, which may then escape combustion, and thus lead to error. The colour of the ash is carefully noticed. It ought to be white, or greyish white. If it is red or brown, sophistication may be suspected. *Estimation and analysis of portion soluble in water:* Weigh off 10—15 grams of the manure, digest for some time, with occasional stirring, allow to settle, and pass the liquid through a tared filter paper; repeat the digesting several times, and finish off by transferring the whole of the insoluble portion to the filter dry at 120° C., and weigh, difference equals portion soluble in water. Mix the filtrate and washings thoroughly, and make up to a given bulk, say 400 c.c. Transfer one-third to an evaporation basin, and evaporate with the addition of excess of sodic carbonate and potassic nitrate, dry, ignite, redissolve in water acidulated with hydrochloric acid, now add excess of ammonic hydrate, and then acetic acid, filter, dry, ignite, and weigh the precipitate as FeP_2O_5. *Estimation of Lime:* Take 100 c.c. of the filtrate, and add excess of ammonic oxalate, cover the glass, and let it stand in a warm place until the precipitate has completely subsided, decant off the clear fluid on to a filter without disturbing the precipitate, now wash the precipitate with small successive portions of hot water, and allow it to dry in the funnel, collect the dry precipitate in a platinum dish, incinerate the filter paper separately, collecting the ash in the same dish, ignite at the very faintest redness, allow to cool, and drench with carbonic acid water, dry at 170° C., and weigh as carbonate, or ignite intensely, and weigh as calcic oxide. *Estimation of magnesia:* To the filtrate from which the lime has been separated add ammonic hydrate and hydric sodic phosphate, agitate vigorously, cover the beaker, and allow to stand 12 or 15 hours in a warm place, after which collect the precipitate on a filter, rinse out the glass with a whalebone spatula and a portion of the filtrate, wash the precipitate with a solution of ammonia, 1 in 3, until the fluid passing through leaves no residue on being evaporated. Dry the precipitate, transfer to a platinum crucible, put the lid on, heat gently at first, and finally to intense redness; incinerate the filter paper separately, add ash to the contents of crucible, and ignite again. *Estimation of phosphoric acid:* For this will be required a standard solution of uranic nitrate, a strong solution of acetate of soda, and a solution of potassic ferrocyanide. The uranic nitrate solution is standarised by means of a solution of hydric potassic phosphate of known strength. For this purpose take pure dry non-effloresced phosphate of soda; triturate the crystals in a porcelain mortar, and press the powder between sheets of blotting-paper until the last sheets are no longer moistened with it. Weigh off 10·085 grams and dissolve in a litre of distilled water. Every 100 c.c. will equal ·2 gram of P_2O_5. Next weigh off roughly about 40 grams of pure crystallised uranic nitrate, dissolve in a litre of distilled water, with brisk agitation. Now measure off exactly 50 c.c. of the sodic hydric phosphate solution, and add 5 or 6 c.c. of an acid solution of acetate of soda, made by dissolving 100 grams of the crystals in 900 c.c. of water, with the addition of 100 c.c. of acetic acid. Heat to about 95° C. on the water bath, and run in the uranic nitrate from a burette graduated into tenths, at first copiously, and then gradually as the appearance of a red-brown colouration increases when a drop of the solution is brought in contact with a solution of ferrocyanide of potassium. It is best to have the solution of ferrocyanide of potassium in the form of drops on a glass plate set over a sheet of white paper. Notice the number of c.c. used, and proceed thus: Suppose 12·5 c.c. were required, this number should be made up to 20, or every 125 to 200, the solution of uranic nitrate will then be of such strength that 20 c.c. will equal 50 c.c. of the hydric sodic phosphate solution, or 20 c.c. will equal ·1 gram of P_2O_5, or 1 c.c. equals ·005 of P_2O_5. The estimation of the phosphoric acid in the manure is carried out precisely according to the directions given above. Several trials may be made, taking 50 c.c. for each trial. The following equation will show the reaction that takes place between the uranic nitrate and the hydric sodic phosphate.

$$2U_2O_3(NO_3)_2 + 2POHoNao_2 = (U_2O_3)_2\,P_2\,O_5 + 4NO_2Nao + OH_2.$$

Estimation of sulphuric acid: Take the remaining portion of the filtrate and acidify with hydrochloric acid, add baric chloride, heat gently for some time, allow the precipitate to subside, decant the clear fluid through a filter, wash the precipitate with distilled water on to the filter, dry, ignite, and weigh as baric sulphate. *Estimation of alkalies:* To the filtrate from the above add milk of lime to throw down any magnesia, iron, alumina, and phosphates, should they be present. Boil and filter, evaporate the filtrate with the addition of ammonic hydrate, ammonic carbonate, and ammonic oxalate, add water, filter again, and evaporate, acidify with hydrochloric acid, dry, ignite gently, and weigh as chlorides. *Analysis of the portion insoluble in water:* Transfer the filter and contents after being dried at 120° C. to a platinum dish, and ignite, until the carbonaceous matter is completely eliminated; allow to cool, and boil with successive portions of moderately strong hydrochloric acid. The sand and residue is filtered off, washed with hot water, dried, ignited, and weighed. The filtrate is now made up to a known volume, and examined for lime, magnesia, phosphoric acid, sulphuric acid, iron and alumina, according to the directions given under "analysis of portion soluble in water." *Estimation of ammonia:* Weigh off a quantity of the manure according to the proportion of ammonia it is suspected to contain. Introduce into a flask furnished with a delivery tube, bent at an obtuse angle, to which is adapted a Liebig condenser, set in the reversed position. To the extreme end of the condenser a quill tube is fastened by means of a perforated cork, and made to dip into a receiver containing a known quantity of standard hydrochloric acid, which has been delivered through a chloride of calcium tube, containing broken glass or pumice. The hydrochloric acid ought to be coloured with a few drops of litmus. Drench the manure with a moderately strong solution of caustic soda, and boil until the evolved steam ceases to turn that portion of the acid solution blue which is immediately in contact with the delivery tube. The broken glass in the chloride of calcium tube is now thoroughly rinsed down, and the quantity of free acid ascertained by means of standard soda, from which is derived the proportion of ammonia in the manure. When well executed this process is not less accurate than that of precipitating the ammonia with platinic tetrachloride. The employment of caustic soda is not admissible in every case, as it has the power of converting certain nitrogenous substances into ammonia, but caustic magnesia may be conveniently substituted, and the operation carried out precisely as given above, only that the apparatus may be simplified to a great extent, dispensing with the obtuse bend and the reversed condenser, as there is little or no risk of frothing. In the analysis of superphosphates the process is somewhat modified, inasmuch as the organic matter in the aqueous extract is directly determined, as also that in the insoluble portion. Proceed to make an aqueous extract as directed under "estimation and analysis of portion soluble in water," and evaporate down with the addition of milk of lime, to distinct alkaline reaction. Dry the residue at 170° C., weigh, ignite the weighed residue, and weigh again; difference expresses the quantity of organic matter in the aqueous extract. The remainder of the process is just the same as that described above. With regard to the insoluble portion, dry at 120° C., and weigh, dry again at 170° C., and weigh; difference gives the total amount of insoluble matter. Now ignite gently, until the residue becomes white, allow to cool, and weigh again; difference gives the organic matter. It is sometimes considered more convenient to estimate the total phosphoric acid in superphosphates gravimetrically. Should that be required weigh off 1—3 grams of the manure, and intimately mix with a mixture of equal parts of KNO_3 and $NaCO_3$; heat gently for some time, allow to cool, and treat with hydrochloric acid, pass through a filter, add ammoniac hydrate to distinct alkaline reaction, and then acetic acid, until the white precipitate of phosphate of lime is redissolved; filter off any ferric phosphate, and to the filtrate add nitrate of uranum, boil for some time, and set aside to cool; add 5 drops of chloroform, agitate vigorously, and allow the precipitate to subside, decant the clear fluid on to a filter, and repeat the washing and boiling with fresh portions of distilled water; dry, separate the precipitate and incinerate the filter separately, receiving the ash in the crucible, ignite the whole, and weigh. Should there be the least trace of green colour in the ignited mass, moisten with nitric acid, and ignite again. In the examination of certain bone preparations it is sometimes required to determine the amount of fat. To effect this digest 5—10 grams of the sample with boiling shale or petroleum spirit in a flask furnished with a small reversed condenser, allow to cool, decant the spirit into a small weighed basin, repeat the operation with a fresh quantity of spirit, evaporate the spirit, and dry at a temperature of 130° C., and weigh the fat. As the estimation of the total nitrogen in manures has been given over and over again in these columns, and as there are very few text-books but what give detailed directions of the process, I have thought it quite unnecessary to describe it here. I will, however, be most happy to assist "Agre" over any difficulty that he may encounter. I append tables of analysis to show how the results are generally stated.

Moisture and organic matter *	17·60
Phosphoric acid †	36·48
Lime	36·16
Alkaline salts	4·40
Carbonic acid, oxide of iron, &c.	3·36
Siliceous matter	2·00
	100·00

* Containing nitrogen equal to ammonia 0·77

† Equal to tribasic phosphate of lime 78·52

SUPERPHOSPHATE.

Moisture	10·52
Organic matter and ammonia	18·40
Soluble phosphate of lime	15·79
Insoluble phosphate of lime	3·21
Sulphate of lime	38·18
Free sulphuric acid	2·17
Alkaline salts	3.68
Sand	8·05
	100·00

Of course, if the analysis is carried out as given above, the tabulation of the results would be somewhat more elaborate.

Soluble in water	Organic matter Ferric oxide Calcic oxide Magnesic oxide Alkalies Sulphuric acid Phosphoric acid
Soluble in hydrochloric acid	Organic matter Ferric oxide Calcic oxide Magnesic oxide Aluminic oxide Sulphuric acid
Insoluble	Silica Moisture

—R. Tervet, Clippen's Oil Works.

[31878.]—**Bogie Tank Engines on the Somerset and Dorset Joint Railway.**—May I be allowed to state, for the information of "New Clock" and "C. E. S.," that the engines in question—35 in number—were built by the "Avonside Engine Company, of Bristol?" At all events, they have their name-plate on them. I have been on the foot-plate of No. 11 engine, and in conversation with the driver, and found that she did run to Derby, as stated by "C. E. S." They are some of the most compact and powerful engines I have seen lately, useful for any kind of work, run easy, light in consumption of fuel, and fitted with good steam brakes to pull up sharp. There were three of a similar build by "Neilson, of Glasgow," running on the line for a short time, but they were removed to make room for these others.—Childs.

[31976.]—**Compound v. Ordinary Condensing Engines.**—John S. Sunderland did a bad day's work when he abandoned his faith in the compound engine. The one solitary fault with which he charges it is "the loss of heat in the transmission of steam from one cylinder to the other," there being, he says, "a certain quantity of heat absorbed in keeping up the temperature of the pipes and the waste room, which heat cannot be said to be utilised." First, let me say that in a properly-designed pair of compound engines there exist neither "pipes" nor "waste room" between the cylinders. There is only a short but spacious receiver cast with the cylinders and well clothed to preserve it as far as possible from radiation and condensation. Of course it must be admitted that some heat is lost in the receiver, but I can assure J. S. S. that in first-class engines it is a mere trifle. J. S. S. goes on to say, "in the single cylinder engine all this heat is lost in the cylinder, and therefore performs duty." I fail to see the necessary connection between this conclusion and its premise. Indeed, it may be at once stated that heat does not necessarily perform duty because it is in the cylinder that we lose sight of it. It is chiefly by maintaining such illogical positions as this that J. S. S. fails to discover the advantage the compound system has over the single-cylinder engine. He says that with equal initial and terminal pressures in the two types of engine "we have in each case the same amount of heat to begin with, and at the termination we find that in each case we have lost the same quantity." Higher up he has the same thing in other words: "Every rational person will admit that as the loss of pressure in each case has been the same, the same amount of heat has been absorbed by the single-cylinder engine as by the compound engine." Now this, at first sight, appears to be as J. S. S. describes. Yet, although I hope to still pass muster as a "rational person," I cannot admit the conclusion of J. S. S.; indeed I will prove to him that in reality it is far otherwise. The "amount of heat absorbed" by the two engines is the very core of this question of relative economy. If J. S. S. would form a correct idea of the operations at work in a steam-engine he must look upon the metal of which the engine is constructed as being in every part an open receptacle into which heat can readily be poured, and from which it can be as readily sucked out. Now, with this idea steadily before his mind, let him inquire whether, under the conditions given, there is any such thing as equality of heat absorbed. The top steam-port of the high-pressure cylinder of the compound opens; steam enters at, say, 75lb. absolute per square inch; and the piston passes down until a certain capacity is filled with steam. While this is going on the bottom end of the cylinder is open to the receiver and filled with steam at, say, 25lb. absolute, or considerably above boiling point, and, therefore, retaining the latent heat of steam. The difference in temperature between the live steam at top side of piston and receiver steam at bottom side is very small, say, 60° Fahr. All the time steam is entering there is a slow current of heat passing down the barrel of the cylinder and through the piston from the live steam to the cooler steam below; and as this heat passes more follows up from the boiler so long as the steam-port remains open. When the point of cut-off is arrived at the measure of heat for that half stroke is finished. Now turn to the single-cylinder engine; the top port opens as before and continues open till the same capacity has been filled as before. But while this is going on the bottom end of the cylinder is open to the cold condenser at a pressure of, say, 2lb. absolute, or far below the point at which the latent heat of steam (that 1,000° which is like a cat in the belly of every engineer) can be retained. The difference in temperature between the live steam at top and the vacuum below the piston is enormous in this case, chiefly because one is above and the other below the boiling-point. There is in consequence a tremendous and rapid flow of heat down the metal of the cylinder and through the piston, and as this flows on it is followed up by fresh heat from the boiler, so that by the time the point of cut-off is arrived at a far greater quantity of heat has passed than was the case with the compound, although there is only an equal capacity filled with steam. And further than that, the cylinder being open to the cold condenser for half the stroke, every particle, so to speak, of heat has been sucked out of the metal of the barrel, the ports, the piston, and cylinder end. Then when the fresh steam is admitted all this metal requires to be refilled with heat, besides the quantity that "runs over" mentioned above. Now, J. S. S. will observe that this heat required to refill the metal and that which runs over into the vacuum side, though "lost in the cylinder" is far from doing useful duty. Indeed it is worse than useless, for it of course, in a measure, spoils the vacuum, or, in other words, causes more power to be expended on the air-pump to keep the vacuum at the prescribed point. J. S. S. will thus see that as dirt is said to consist of "matter in the wrong place," so economy in an engine consists of "heat in the right place." I hope he will acknowledge that he erred in his reply in assuming the equality of heat absorbed by the two engines.—MARINE ENGINEER.

[32123.]—**Earth Worms.**—Before this question is answered I should like to know whether a portion of an earthworm is furnished with a new head.—GARDENER.

[32131.]—**Rolling Stock.**—The lightest is on the Festiniog line, the heaviest on the Great Western.—LOCO.

[32132.]—**Injectors.**—There was a discussion on this question a little time back. An injector drives water against a higher pressure because it adds velocity (momentum) to pressure.—AUDAX.

[32170.]—**Pianoforte Playing.**—I strongly recommend "F. H." to obtain and work through Hallé's "Pianoforte School." It consists of a number of pieces of all degrees of difficulty, varying from compositions suitable for mere children up to such tasks as Mendelssohn's famous "Rondo." Each piece is fully fingered, and the tempo marked by the metronome. "F. H." had better get one at a time, and master it before getting the next.—WM. JOHN GREY.

[32170.]—**Pianoforte Playing.**—I do not object to "Ne Sutor's" statements as far as they go, but did he notice that the querist said he knew all the scales? Now, I think when any one can finger all the scales properly he can do more than some of those who profess to play Beethoven. It is here that so many fail, because they get on to the instruction books. Why, our poor fellow has already had so many recommended him that it will cost him I know not what. I still say practise your scales and play Beethoven, for his sonatas are a complete pianoforte school. But I must apologise, for I am only self-taught.—FIDDLER.

[32187.]—**Setting Potatoes.**—I have been for several years making experiments on potatoes and potato-planting, and have arrived at the following conclusions:—Let me ask, first, are the potatoes required of a saleable or table size, or do you wish to get as heavy a crop as possible from the ground? If for table or sale, choose sets about the size of small fowls' eggs; but if for a good crop, choose the largest potatoes you can get, and cut them into as many pieces as you can, but be sure and have two eyes in each piece. Lay the pieces for 5 or 6 days in a dry situation before planting, for the cut parts to dry, and you will get a heavy crop. Last year, after planting my potatoes, I had a lot of spindles swept up that had been broken off some of the sets, and, as an experiment, I picked out 12 of the strongest, about 8in. long, and set them in some good light ground, with about 1in. of the tops above-ground. Not one failed, and they gave as good a crop as the potato sets close to them; but care must be taken not to cover them, or they will rot. Now for the ground and planting. If the ground is clay, and low-lying, don't plant potatoes; the chances are that you will lose three crops out of four by the blight. Some dealers advertise potatoes as blight-proof—the "Snowflake," for instance; but last season I lost all my crop of that by the blight. If your ground is light, then, the first mild day in February—or earlier, if you can—spread your manure, and dig it roughly in (I am supposing your ground has been roughed up in the fall of the year); then, as soon as you can with safety—which must depend upon your situation, and the amount of shelter from frosts you can get—plant your sets, by digging a trench, and placing the sets from 4in. to 6in. deep, and 18in. apart, if for table, or 2ft. apart if for heavy crop; cover them lightly, and dig the ground thoroughly until you get the distance for another row, which should be from row to row about 2ft. 6in., but for heavy croppers may be 3ft. As soon as they are above-ground earth them up, and keep the weeds down. About two earthings-up will be sufficient. Choose a dry time for digging and storing, as the least damp will encourage blight after they are stored. Always set early sorts—there is less chance of loss by blight. I can recommend "Early Rose," "Snowflake," and "Magnum Bonum," for heavy croppers; and "Ashleaf" for very earliest.—NIOBE.

[32194.]—**Achromatic Eyepiece for Refractor.**—The ordinary Huyghenian, when rightly made, is achromatic, but the use of an achromatic eye-lens in a Huyghenian sometimes makes a bad lens work fairly. On a good object-lens I would not recommend an achromatic eyepiece, but where the object-lens is inferior it might be advantageous to use such an eyepiece.—W. J. LANCASTER.

[32207.]—**Diatoms.**—If you obtain a sample of each of the following diatoms you will have a fair collection of good popular diatoms, only I must tell you that I have left out of my list a number of most magnificent objects, which, however, may be mentioned by-and-by when you have exhausted the following list:—Arachnoidiscus Ehrenbergii, ditto japonicus, Pleurosigma angulatum, ditto formosum, Triceratium favus, Surirella gemma, Amphipleura pellucida, Navicula rhomboides, Campylodiscus cristatus, Cocconema lanceolatum, Pinnularia major.—W. J. LANCASTER.

[32207.]—**Diatoms.**—The Aulacodiscus, mentioned by Mr. Mawe Smith, in his reply on p. 21, is now called the A. Africanus. It was first considered a very beautiful species of the A. Kittoni; but differing in certain particulars, it received the above name. It may be interesting to "Diatomist" to know something of its habitat. The Congo river has no deltas, but pours its waters in one stream; however, there are extensive marshes on each side of the stream, intersected by numerous creeks. On the north side there are two very large creeks, one called the Pirate Creek, and the outer one the Banana Creek; it is on the outer bank of the last-named creek, towards the sea, this beautiful diatom is found, oozing out of the sand between high and low water, forming green spots quite ornamenting the beach for miles. The high-water mark is fringed with green by them, and they tinge the foam of the lapping waters with the same colour. They propagate there in countless millions. Any one who will take the trouble, and endure the heat of the tropical sun, may, when the tide is down, gather any quantity of them. I washed out a quantity of diatoms that filled a glass tumbler from a cigar-box full of sand scraped up by a little negro boy with a small tin scoop. When fresh found, the appearance, under a ¼in. objective, was very interesting. Through the outer coating was seen the markings of the frustules, and between the frustules green granular spots, somewhat darker than the rest. Occasionally the diatom would swing half round and back again. There was a thin cover glass over them which probably confined their movements.—BOLEMBEMBO.

[32227.]—**Field Glass.**—First unscrew the small screw which holds the eyepieces and bar in position, then remove the two tubes, and unscrew the ring round central tube. This will readily unscrew without any difficulty, then take out the spiral, well clean it, and replace it so that it will work easily, a little grease being put on the outside of spiral to make it work freely. You will find it work well if you carefully follow my instructions.—W. J. LANCASTER.

[32239.]—**Bicycle Bearings.**—I must differ altogether with Mr. D. L. Rennoldson as to the value of roller bearings. I have tried the parallel, as he recommends, the double cone, and the cycle, as fitted in the "Special Challenge," and consider that the latter improves the machine about 20 per cent., especially uphill or against a head wind. They give no trouble, and one drop of oil in each is sufficient for a long day's journey. As to durability, I rode my machine pretty hard last year over our rough Northumberland roads, and the wheel is as steady and true as when I got it. I cleaned the bearings for the first time last week, and the rollers were perfectly smooth, with a fine black polish. I certainly would not be without them now, were their cost twice what it is.—D. CROSS.

[32240.]—**Microscope.**—To MR. LANCASTER.—The microscope your sketch illustrates is above 70 years old now. I cannot give an opinion as to name of maker, but it might have been made by Adams during the latter part of the last century. The four lenses in the upper half form the eyepiece, and up till recently two lenses have been used instead of one as eye-lens. The lower is, of course, the object-lens, and the one above corrects in part the abberation of the object-lens, at the same time reducing the power of the microscope. This you can easily sketch out by producing the divergent beam from the object-lens to the second lenses, then the beam will be refracted, and, of course, less divergent until it reaches the field-lens, from which it emerges as a convergent beam, and so passes through the three eye-lenses until it crosses over just above top eye-lens.—W. J. LANCASTER.

[32249.]—**Cementing O.-G.**—Very many thanks to "F. R. A. S." and Mr. F. C. Dennett for their replies, though I must confess my heart sank within me on reading the heading of the former, and I was much relieved to discover the "exceeding badness" related to the orthography, and not to the telescope, the more so, as I gather from the conclusion a genuine "Dollond" is valuable. I had tried stops of all apertures without effect, but I am glad to say I have now traced the fault to its source. Happening to turn the tube on a small single star I noticed it was double, and that the second appearance was evidently a reflection. This put me on the right track, and by adjusting the regulating screws I succeeded in getting the eye-glasses and O.-G. parallel with each other, and now hope all will be right. As regards the test suggested by Mr. Dennett I may say my studies have to be pursued under difficulties; for, besides living in a smoky town, a very small strip of sky only is available to me; but I intend to erect a small observatory in a more commanding position now that I find the telescope is worthy of it.—W. H. DAVIES.

[32250.]—**Permanent Magnets.**—Get some of the best round steel for making tools. It is sold by any of the tool dealers in lengths of about 13in., then cut the lengths up into three pieces of equal lengths, or you can cut the two off, and saw the other length, then you would probably have two 4in. and one 5in. length. Now heat the two pieces required nearly to a white heat, and well hammer them all round, again heat to a little lower temperature, and cool in water as cold as you can get it, afterwards heat them till they have a straw tint. You may now clean them with emery, or in any other way you think proper, and magnetise them. When done the 4in. should pick an ounce weight up easily, and if you make them 6in. long they ought to pick up a 2oz. weight.—W. J. LANCASTER.

[32251.]—**Telephone.**—1. Cut them with a sharp pair of scissors; the scissors need not be too large, but there are two ways of cutting—one where you bring the prong down upon the metal towards your hand, and thus buckle the plate; the other where the outer half cuts the metal. Thus, suppose you hold the plate in your left hand and scissors in right hand, then let the near prong of scissors be towards left hand, and stop prong outside and away from plate. I have cut plates very easily like this, and without any bending. 2. Wind on to bobbin not more than ½oz. of either 34 or 36 for the half mile. 3. Roundly, 10ft. of 32 gives a resistance of one ohm; thus, if you used a quarter of an ounce of 32 wire you would have a resistance of 5·3 ohms. 4. (*a*), very good sound produced; (*b*) a little rounder tone in my own experiments, but no louder than *a*; (*c*), not good at all, better to have an insulator by far; (*d*), use light boxwood bobbins.—W. J. LANCASTER.

[32255.]—**Magneto-Electric Machine.**—Most probably the cause is the looseness of the spring, which presses down upon the axis of bobbin plate. Remove the screw which holds the spring in position, then take spring off, and bend it a little more, and again screw tightly in place, when you ought to obtain a good current. See that the spring inside box is free from oil, and that it presses up against the end of axle.—W. J. LANCASTER.

[32262.]—**Lighting Paraffin Lamps by Electricity.**—You cannot do this under a considerable expense, and then it would be far from satisfactory. You would have to heat the wick sufficiently with platinum wire to liberate a sufficient quantity of vapour to be ignited on the passing of a spark. The outlay would be enormous, and the success unreliable; sometimes a little draught would prevent one of the lamps lighting.—W. J. LANCASTER.

[32265.]—**Telescope.**—Your telescope is one of the old form of reflectors known as a Gregorian, and your difficulty in using it seems to be due to the fact that you have used it or endeavoured to use it with the sun-glass on. Now, I think if you will follow my suggestions you will be able to use your telescope with success. In the first place, see that the two speculums—the one at the bottom of tube and the other near the top (shield, as you call it)—are clean; then set to work to obtain an image of some distant gaslight, carefully focus with the nut, moving pinion in rackwork until the image is perfectly defined. Now, if the night is clear, turn it on to any object in the heavens—take, for instance, Mizar; this is the middle star in the tail of the Great Bear, and easily found. When you have adjusted the telescope a little you ought to be able easily to find that this star is a double one. If you do this successfully, then work away at some other of the well-known doubles.—W. J. LANCASTER.

[32273.]—**Telescope.**—Something wrong. Will you state in another query the maker's name of the 3in., the way it is mounted, and the kind of eyepiece you use? Do not throw away the lens until you know that it is worthless. There may be something else than object-lens wrong. Send full particulars as to construction, and I will try to help you.—W. J. Lancaster.

[32277.]—**Diatoms.**—Mr. Smith's diatom is an Aulacodiscus, as he supposes, but not *A. crux*. The true *A. crux* of Ehrenberg (see "Mikrogeologie") has only been found in the Virginian deposits. Ehrenberg gives, in the same work, another figure of *A. crux*, found in guano. This, however, is not the same as the deposit form, and is probably *A. scaber* of Ralfs. The African form is *A. africanus* of Cottain. It is, however, only a variety of *A. Kittoni*, Arnott.—F. Kitton.

[32278.]—**Insect Scales.**—I have found the following plan very successful in transferring scales:—Take a strip of writing paper ½in. in width, double it transversely, cut off a piece of the wing, and place it on the strip of paper close to the double, place it on the cover of a book or a piece of plate-glass, rub the paper with a paper-knife or the thumb-nail, open the paper carefully, and remove the wing with the forceps; place on a thin cover in such a manner that the crease bisects it, rub the paper with the finger, taking care the paper does not slip. On removing the paper most of the scales will be found adhering to the cover. This plan possesses two advantages: the upper and under scales are in juxtaposition, and the outer surfaces are uppermost.—F. K.

[32278.]—**Microscopical.**—If you want to obtain a few good scales instead of a conglomeration of scales—tissue, dirt, &c.—the way to obtain them is to hold the wing on a piece of stiff cardboard, and with a sharp knife scrape the wing the wrong way—do it very gently, so as to keep them whole; then, under a very low power, arrange them as nicely as you are able, and mount at once. You may mount them dry, or they are pretty even in Canada balsam—preferable in the dry state.—W. J. Lancaster.

[32281.]—**Microscopic.**—Make saturated solutions, then pour a drop on to the slide; let it cover the portion you require, and place in a warm cupboard and allow to crystallise; don't heat the slide too much, otherwise it will be too thick and will be of no value to you. Then make a thin ring of cement and place glass on and cement down, taking care not to heat the slide too much. There are hundreds of substances you can easily get from any chemist.—W. J. Lancaster.

[32291.]—**Microscopical Preparation.**—The second glass was evidently accidentally placed on the other by Bourgogne. I have had numbers of Bourgogne's objects, and have seen many broken ones, but never found such a case as you speak of. It would not be of any use whatever as a corrector; the thinner the glass the better for optical purposes.—W. J. Lancaster.

[32292.]—**Lantern Microscope.**—Remove altogether the erector, and use only the eyepiece lenses—viz., the eye-lens and field-lens. You will then have more light and a better definition; but if you want to make a good microscope for your lantern you should at once dispense with the eyepiece, and have a proper arrangement. Two lenses, either single or achromatic, are all you require, the ratios of their foci being as 2 is to 1, and their distances apart half their sum. A diaphragm must be placed in front of the smallest lens, and within the combined focus. This should be so arranged as to correct spherical aberration, and yet not to materially lessen the amount of light. The lenses should both be planes, and should have the plane surfaces outside. I will willingly give you any more information you may require.—W. J. Lancaster.

[32293.]—**Reading Lamp.**—The best burner I know of to answer your purpose is the round Silber burner. The light obtained with this burner is purer, steadier, and, while more brilliant, is yet softer than with any other burner I have ever used, and their number and variety have been endless. Such a burner can be mounted on the top of a shallow reservoir, even as shallow as one inch, and it will burn well for ten or twelve hours without any attention. I should really be very pleased to find a better burner than the one I have mentioned.—W. J. Lancaster.

[32302.]—**Midland New Carriages and the Re-introduction of the Pullman-Car Trains.**—If "Mathematicus" will refer to my letter, p. 140 of last volume, he will find that I stated that "new carriages were to be constructed by the company on the American principle, with small private compartments. Four of the first of these new carriages were finished on Saturday last, March 9th. On Monday, the 11th of March, the "Pullman-car trains", composed entirely of American cars, which have been discontinued since May the 14th, 1876, again commenced to run between London, Manchester, and Liverpool. One Pullman-car train leaves London at 5 p.m., the other leaves Liverpool at 10 45, and Manchester at 11.25 a.m., for London. The first and third-class cars have been very considerably improved, and there is "no extra charge" for riding in them. I send the following cutting from a local paper upon the subject of the new carriages:—"New Carriages on the Midland Railway.—On Monday new carriages were used for the first time on the Midland Railway. They are constructed on the Pullman-car principle, but are the property of the Midland Railway Company. They are 54ft. in length, exclusive of buffers, and are entered in the same way as the Pullman palace cars. The train was composed of four cars belonging to the Midland, and a parlour car belonging to the Pullman Company. The cars are of lofty proportions, and fitted up in a most handsome and convenient manner. Upon entering a car a smoking saloon faces the door, and to the left a passage conducts to a saloon for non-smokers, and further on are a number of semi-private compartments, the seats of which are arranged after the manner of ordinary first and third-class passengers. At the end of each car is a compartment for passengers' luggage. The cars are about the same weight as the Pullman cars. They attracted considerable attention, and were well filled. No extra charge is made for travelling by these new carriages, and there is every inducement for their being largely patronised. They run smoothly, and, like the Pullman cars, furnish additional safety in case of accident."—C. E. S.

[32304.]—**Magnets.**—If you want short magnets, they must be proportionally smaller in area; you cannot obtain the same amount of magnetism in the same volume if of a cubical or oblong form as you can in same volume arranged in length. About the best proportions I have found for bar magnets is length = 10, diameter 1. If you work to this scale you will get about the best possible results.—W. J. Lancaster.

[32308.]—**Instruments for Reducing Drawings.**—I should think the best instrument for your purpose would be a pentagraph. I am afraid you would find it a difficult instrument to make; but if you like to try, I will give you the information how to make it.—W. J. Lancaster.

[32314.]—**Bichromate Battery.**—Yes, the solution does waste. If you remove the zinc then the solution will not hurt. The two cells would ring the bell for about half an hour, and then would be used up. They are very good cells for short action, but are entirely used up in an hour.—W. J. Lancaster.

[32321.]—**Strength of Boiler Plate.**—I am obliged to "Practical Boilermaker" for noticing my query, and will try to be more explicit. I wish to construct an upright tubular boiler of copper, having as many brass tubes as can be got into it; the boiler to be 8in. or 10in. in diameter, and 14in. to 16in. high, exclusive of dome. I want to work it at 40lb. or 50lb. per square inch, with a cylinder 1¼in. diam. and 4in. stroke, and it should be capable of making at least 80 revolutions per minute, doing a duty of about half a man's power. The boiler will be heated by a lamp burning petroleum or other kindred oil, having a wick under each double row of tubes—that is, two rows of tubes will form a separate and distinct chimney for each wick. The wicks will all go the whole length of each pair of tubes under which they may happen to be, so that practically there will be flame passing up every tube. The object in view is to get a powerful boiler in a small space and as light as possible; and if the feed-water is heated nearly to boiling before passing into it, I do not see the necessity of having at one time a large quantity of water in the boiler, which, under these circumstances, ought, I fancy, to make steam rapidly.—Test Valley.

[32322.]—**Microscopical Field of View.**—First get a good idea of the size of the field before measuring, and keep both eyes open, so that you can see the disc of light and stage at same instant, then take a foot rule and lay it upon stage, just above aperture in stage. Now look through microscope with right eye, and look at the rule with left eye, then bring the end of rule to one side of the field, and measure diameter; this will give you size of field. To get the magnifying power you will require a micrometer for stage. You will then, knowing apparent size of field, and number of thousandths of an inch you can see, be able to determine the power of microscope in diameters.—W. J. Lancaster.

[32328.]—**Telephone.**—1. No, the tighter the better when once adjusted. 2. Fatal to success. The magnet must hold an ounce weight to insure most perfect success. 3. Probably by again hardening them and remagnetising. 4. Whichever way you please. The screws should not go through the plate, but round the outside of it.—W. J. Lancaster.

[32329.]—**Spring Bar.**—I send a rough sketch of spring bar, to which I have adapted a well-known scientific principle. *A a*, Fig. 1, a wrought-iron bar, and *c*, Figs. 1 and 2, a support of B B, wood bar, which, I think, a railway smith will understand without further explanations. Your correspondent asks for an opinion on his Fig. 2 as an improvement. In my opinion it is impracticable. Should a railway smith persist in trying his improvement, I would say try with a boat horse and not a tip horse.—J. Hogg.

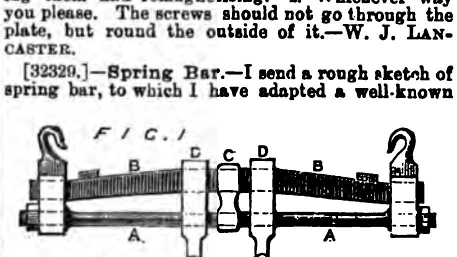


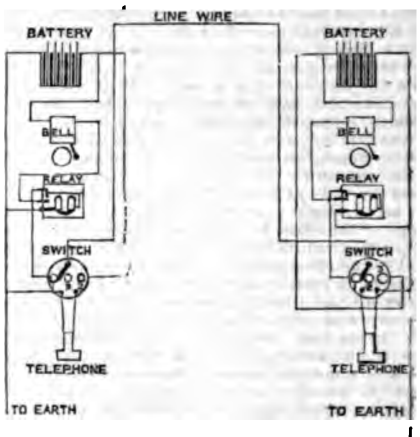
FIG. 1

FIG. 2

[32330.—**Aneroid.**—The central spindle works too tightly. You should give it to a watchmaker or an optician to clean.—W. J. Lancaster.

[32334.]—**Artificer for the Navy.**—There is no chance whatever of promotion to an engineer's berth. It is not necessary to have worked in a marine shop. They will take you from a locomotive shop if you have served a legal apprenticeship, and can produce a character as to ability. For further particulars I would recommend you to apply to Superintendent, Steam Reserve Office, Chatham.—R. D.

[32342.]—**Electric Bells.**—I send an illustration showing "X. X." how he can connect his bells and telephones by one wire. He must use a relay, as shown. The switch has 3 knobs—Nos. 1, 2, and 3. The handles of both switches must be turned on No. 1 when not in use, waiting calls, both on No. 2 for telephonic messages, and either on No. 3 for ringing bell to call attention at the other end. I should imagine it would be better to alter your bell to single stroke (the connections make the difference), and the relay will make it continuous. I should make the relay of small size, and to fit in at the back of the switch. If you should not understand the relay, its action is thus:—When handle is turned on No. 3 right-hand switch a current of electricity is sent through wire to the other end, through No. 1 knob to electro-magnet in relay, which draws down the spring until it touches the other wire, which sends a current through the battery, and strikes the bell. I trust the other connections will explain themselves.—C. O. G.



[32345.]—**Grain of Violin Wood.**—I am much obliged to the gentlemen who have answered my question: "Why should the grain of the hard back be placed at right angles to the grain of the soft belly?" They say it is never done, but that is no reason why it should not. May I venture to ask them the reason why the grain is placed parallel in back and belly, and what objection there is to an opposite proceeding? I need not say that I am in earnest, and wish for more information on what I consider an important point.—Fiddler.

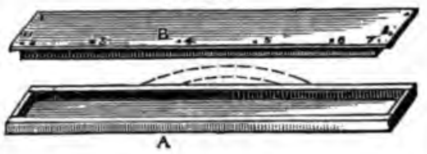
[32345.]—**Grain of Violin Wood.**—Despite his evident experience of woods "Bosh Faker" has, I think, fallen into error in supposing that the figure of certain hard woods, technically called the "flower," is only on one side of the tree, and that a tree grows more on the side exposed to the sun. 1. The "flower" appears only on boards that are cut sectionally, or, as it is termed, "on the quarter," those cut from the outside would show dark specks, called the bead, and would be very liable to split or crack. Oak staves are a familiar example of wood cut or rent with the flowery side out, and these it is almost impossible to split; and if any one takes the trouble to examine the endway grain of such boards the reason will be apparent. 2. Contrary to what might be expected the very tendency of all vegetation to turn towards the light will be seen, on looking into, to be owing to a quicker growth on the dark side, though it is probable the sun exerts an attractive influence as well. But, I think, the cause of bent trees will be found more in the prevalence of certain winds than in light and shade in the North; at any rate they have a tendency to lean towards the east, and here we have a predominance of westerly winds.—W. H. Davies.

[32348.]—**Telephone.**—I noticed the peculiar effect, due to the intent listening, at once, and found that by using the instrument for any considerable period of time it gave rise to humming, and, finally, headache. This, I think, is due, not to any action on the tensor tympani or on the membrane, but to an overstrain in the cochlea. I am rather sorry there is so much strain.—W. J. Lancaster.

[32349.]—**Zincography and Blocks for Surface Printing.**—Mr. Mortlake asks in a tone of genuine surprise why the British workman will not discard a time-honoured, troublesome, expensive, and uncertain process, for one infinitely easier, cheaper, and ertain as to results. Does he not know that ritish workman is the most conservative indi- in the whole kingdom, and that he is deter- to stick to his own trade though he starve on l regard all innovations as "dangerous," and ng his rights as a citizen? It has always been d, probably, always will, as long as human lasts. Look at the introduction of steam for ptive purposes. All the coach proprietors then ted with one accord that they would be ruined loss of their passengers; but, in spite of their ur, steam made its way, and who will pretend that we are worse off now than before its use? useful novelty has its decriers, and zinco- y must expect its meed of abuse. Lithographers o think that, because the work would be done ch cheaper, they would lose a corresponding n of their profit, never calculating in their ignorance that the additional quantity, which be sure to be the result of its introduction, amply repay them, and afford them scope for er and wider field of work. What is now really d is a union of two or three energetic men of ss in each large town, to thoroughly push the showing samples of results, and quoting lower than the ordinary lithographers. The public certainly appreciate this, and if the partners fficient capital and perseverance to carry on ade in spite of opposition, it would be sure to aying concern in the end. With reference to ractical part of the query I will give what s and particulars I can, but it is very difficult roughly describe a process like this, where the s depend so much on the manipulation and skill operator. The workman is accustomed to go by rule of thumb than by scientific accuracy, by long practical experience, is enabled to of the effect to a nicety, by signs that would irely unintelligible to an ordinary observer, so the tyro does not succeed in his first attempt he is pretty nearly certain not to—he must not all blame on the process, but put it down to n want of experience; but, I think, that, with struction given here, and continued prac- he amateur will be able to turn out very fair of a medium degree of fineness. The zinc plate he transfer laid on is first gently warmed over or spirit lamp; when cooled finely-powdered s dusted over it out of a linen bag; this is d over the plate by means of a round camel- rush, an even circular motion being main- . When sufficient resin has adhered to the it is again warmed, to insure its firm connec- ith the fatty design; the plate is then cooled l water, and allowed to remain a few minutes per cent. solution of commercial nitric acid, depth of about ·005 of an inch is obtained. lepth has to be determined by frequent experi- as it is very important it should not be led. The plate is now bitten to such a trivial that the lines are not under-bitten to any ciable extent, and it may be mentioned that rst etching is the key-stone to the rest. If it wrong" you cannot doctor up your plate, ou may save further trouble by beginning . When dry, it is again dusted with resin, and d, the fringe of resin thus adhering to the f the lines, serving to protect the etched part ny further action of the acid; the plate is then l over lightly with strong gum mucilage, which ediately washed off. A roller charged with raphic ink (No. 2, mixed with middle varnish, is st) is then passed over it, backwards and for- several times, so that more ink may adhere to nes. Coarser resin is now sifted on, and it is l more strongly. This causes the ink to melt, ver the resin fringe, and thus form a secure roof varnish. To a careful observer the lines will r thicker after every heating. The strength of d is now increased to 5 per cent., and the plate en about ·015 of an inch; when dry it is again d. heated, cooled, gummed, inked, resined and just as before, each time the processes being d further than the last. Ordinary plates—such illustrations to the *Figaro*—have to be bitten bout 8 to 12 times, while very fine ones, such nsfers from steel engravings, have often to be as many as 20 times—of course proportionately r each time. These instructions, as I have said will enable any one of ordinary manipulative to engrave zinc plates very fairly, but it es something more than mere formulæ and to finish off the fine tint and crayon drawings autifully and delicately as they are done by , Alex. Zimmerman, and other clever French vers. Years of practice are wanted, and each idual has his own particular pet mode of work- hich suits him best, and which he considers as ior to all others, and jealously retains as a trade .—ERNEST A. NUTH.

351.]—**Dark Tent.**—As the photographic n is rapidly approaching I give a detailed er to this question, in hopes of assisting any of s" who are desirous of practising wet-plate graphy for landscapes this next season. I made tent from instructions given in Cassell's creator," but modified it to suit my own circum- es. Before describing its construction I may hat it answered its purpose admirably in every ct; but still, wet-plate outdoor work is, gene- speaking, a most laborious amusement, and esults I have obtained with dry plates are so factory and trustworthy that although I still ss my apparatus for wet plates ready for work at any time, I very seldom use it. But to our text. First construct a shallow box, A, 24in. long, 18in. wide outside, and 2in. deep inside, the bottom being ⅝in. and the sides 1in. thick. Next construct the lid, B, which is a board ⅞in. thick at top, with the ledge, ⅝in. thick and 1in. deep, nailed on to it, at a distance of 1¼in. from the edge, so that the lid, B, fits close down upon A when the tent is closed. I may here say that

FIC. 1



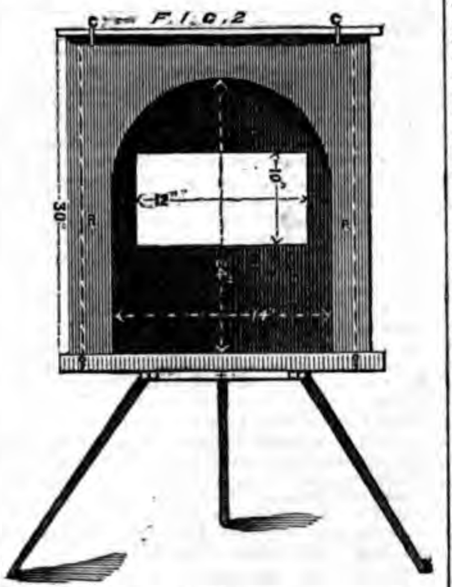
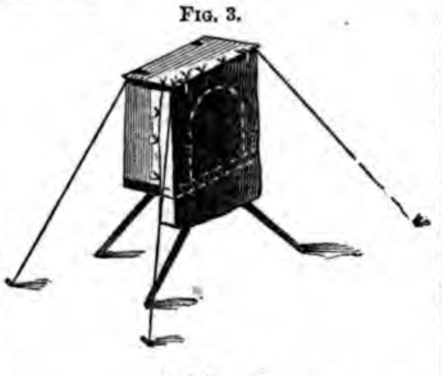
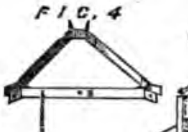


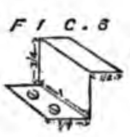
FIG. 3.



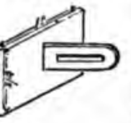
FIC. 4

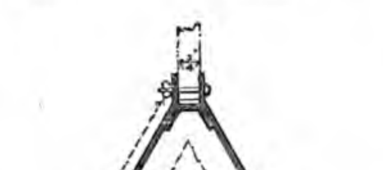


FIC. 6



FIC. 7





FIC. 5

the wood used must be pine, or some equally light wood, for the sake of portability, and although I give the above dimensions as existing in my tent, should I construct another I should reduce the bottom of A to ¼in., and the sides to ⅝in. thick, and treat B in the same way. If the wood were well seasoned I am convinced that even then the strength of it would be quite sufficient to stand all the rough usage it would get, which would doubtless be no very small amount, judging by my own experience. Having got the bottom and top of the tent made, the next step is to form the body of the tent. This is done by tacking twilled calico, one edge round the inside edge of A, and the other edge round the outer edge of B. The width of the calico should not be less than 30in., as if less the tent will not be high enough. There must be three folds of calico, the two outer ones black and the inner one yellow. A window must then be made by cutting a piece 12in. by 10in. in the back of the tent, through both folds of black, into which opening two folds of yellow calico must be stitched, making, with the lining, three folds in all, which will be found quite sufficient to protect the operator from fog, and yet supply plenty of light to work by. The door of the tent, 24in. high and 14in. wide, is then cut in the front, and the tent will then present the appearance shown at Fig. 2, with the exception of the stand, which will be subsequently described, and four straps tacked at back and front to fasten the tent when closed, C C C C. Eight holes are bored through the front edge and corners of B, through which the tapes which hold the curtain in front of the tent door are passed. The curtain is made like the body of the tent—two folds of black and one fold yellow calico. It must be 5ft. 6in. long, so as to hang 30in. below the bottom of the tent, and 52in. wide. The top must be gathered until it is only 26in. wide, and tapes stitched so as to come opposite the holes 1 to 8, shown at B. The yellow lining of the curtain need not come within 20in. of the bottom. Three tapes must be sewn on each side of the curtain, which fasten on to tapes on the end of tent. Four pegs and strings will be required to prevent the tent being overturned by a gust of wind. Fig. 3 shows the tent when pegged down and ready for work, from which the position of tapes, &c., may be understood. It is not drawn to scale. The tent is expanded by inserting two ½in. rods of dry pine, which must be long enough to keep the body tightly stretched, R R, Fig. 2. The bottom and top of the tent may be next stained and varnished, and have a broad strap fastened at the back of tent. If in front it would be in the way when working (see A, dotted line), and the tent itself is finished. The operator would, however, feel hardly as comfortable as might be desired when manipulating a "whole plate," with his tent precariously perched upon a wall or other temporary support, nor would the standing of the tent upon the floor, and kneeling before it be any more conducive to that ease which is necessary for the operator to feel to perform good work. A stand is therefore a necessity. Mine is constructed as follows:—A triangle is made of ⅛in. sheet brass, ¾in. wide (see Figs. 4 and 5), of the following dimensions.—Length of sides, 8in.; length of projections for holding legs, 1in.; width of projections, ⅞in. The legs are removable, being fastened in by the bolts and winged screws (Fig. 5). The legs are made of pine, 36in. long, ⅞in. square at the top, and taper to ½in. round at bottom. They are ferruled and steel-tipped at bottom, and have brass plates on each side at top to prevent splitting. This tripod is fixed by means of three brass clips to the bottom of the tent. Two of the clips are of the shape shown at Fig. 6, being made by bending two strips of brass and drilling the holes for the screws. The other is shown at Fig. 7. These three clips being screwed on to the bottom of the tent, as shown in Fig. 5, the tripod may be fixed in a few seconds by laying it upon the tent bottom in the position there shown by the dotted line, and then sliding it back until the loop on Fig. 7 projects through the slot on the front of the triangle, shown at S, Fig. 4. The strip of brass which is fastened by the short chain is then slipped into the loop, and the tripod is securely locked to the tent. The whole operation may be done in three seconds. When moving from the scene of one operation to that of another I carry the tripod separated from the tent (the top of the tent being next to the bearer's legs, to prevent the trousers being torn by the brass clips on the bottom), but when travelling by road or rail I remove the legs of the tripod and fix the triangle to the tent, which protects the clips from injury. The curtain need not be removed unless the tent is requred to shut up quite close. A tin tray 10in. square and 1in. deep is also required to catch the developer, &c. Water I dispense with, and I should recommend any one else to do likewise, as there are few places where water pure enough for photographic purposes can be obtained at a moment's notice. All that is necessary is to flood the plate, after developing, with a mixture of golden syrup treacle and water, equal parts, to which enough alcohol has been added to cause it to mix freely with the developer already on the plate. Drain the plate a little, flood a second time, drain again, and then place in the plate box. When arrived at home the plates must be washed till all traces of the syrup are removed—they may be then fixed and intensified as usual. If it is found that the plates must be left till the following day before fixing, they must be thoroughly washed to remove all traces of the syrup, and then reflooded, or the developer left in the film will cause it to become soluble in the cyanide. The plates will stand exposure to strong sunshine for several seconds without injury if the syrup has been used as directed. In flooding the plate the first time care must be taken to carry the wave over the plate without any pause, as in developing, or the negative will be stained. In conclusion let me recommend the use of albumen as a substratum, as the "grip" [illegible] strata, may have been very productive.—William [illegible].

[32252.]—**Lenses.**—[illegible] for the purpose.—W. J. L[illegible].

[32290.]—**Lawn Mower.**—"C. C." [illegible] cannot be [illegible] say I have seen [illegible] the usual way and a piece of [illegible] box.—Kirton.

[32293.]—**Induction Coils.**—1. Two layers of 22 primary wound evenly nearly [illegible]. The tube to insulate [illegible] in diameter, [illegible] thick when turned: outside of this will be [illegible] inner diameter of paper tube 1-16in. larger. Secondary wire [illegible] or [illegible] will bring outer diameter to [illegible] or [illegible]. No. 2. Yes: as some printing paper is thicker, two thicknesses will be ample if your wire does are under 1-16in. thick. No. 3. No. 36 will be better than [illegible] 2[illegible] better still. You do not say what thickness your tube is, or if using one.—Omega.

[32296.]—**Organ Queries.**—"S. C." can hear good organs by Walker at St. George's Church, Belfast, Exeter Hall, Romsey Abbey Church, Hampshire. Good organs by Hill can be heard at York Minster, St. George's Hall, Windsor Castle. Westminster Abbey organ is virtually one of Hill's, Stratford-on-Avon, Parish Church, Ashton-under-Lyne, Town Hall, Birmingham, Great George-street Chapel, Liverpool, Music Hall and University, Edinburgh. Organs by Green can be heard at St. George's Chapel, Windsor and Rochester Cathedral. Others have been more or less enlarged, taking away their character; there is one by Green in Loughborough parish church. Organs by England can be seen at the parish church, Hinckley, and St. Stephen, Walbrook. I did not write with intent to disparage any particular builder or builders, I was simply describing faithfully the character of tone to be found in old organs, and of which we hear such wonderful things, and if "S. C." will look at my letter again he will find that I ask those who wish to hear a good old organ or two to hear one by the said firms; it was unnecessary to quote others. I do not ignore the other makers mentioned, since I consider Mr. H. Willis the best practical builder in this country. The work by Mr. Lewis is particularly good, but I never heard tone that I dislike so much. Cavaillé makes admirable instruments in point of workmanship and tone, too, of many of his stops, but the full organ will only please the French people; they are too brassy for devotional use. "S. C." would like other authorities in reference to the quality and weight of metal, so I need not mention that here, although I could name three or four firms who use such metal. I may mention here that the tone of the organs by the present Hill cannot be compared favourably with those by old Mr. W. Hill.—S. Taylor.

[32273.]—**Cleaning Bronze, &c.**—A very good recipe for cleaning bronze, steel, brass, &c., and one I have used with great success in cleaning gasholders, troughs, &c., is as follows:—Take 1oz. oxalic acid, 6oz. rottenstone, ½oz. gum arabic in powder, 1oz. sweet oil, and a sufficient quantity of water to make a paste. Apply a small portion to the pan, and polish with a flannel or a piece of soft leather.—H. Crawford.

[32277.]—**Artificial Trees.**—If for a case 4ft. square get a block of wood about 12in. × 6in. × 2in., bore 20 holes through the centre, through 6 of these holes push pieces of 3-16ths of an inch round iron 4ft. long, clench them on the underside, twist them altogether about one-half or one-third of the length, bend one piece to the right and another to the left, twist the six pieces a few inches, bend as before, and so on. This will form the body of the tree. You will now require about 3 pounds weight of wire, ⅛in. gauge, cut in pieces 2ft. or 3ft. long, twist it round the tree, and bend it in any shape you like. To form the branches, bind altogether in a few places with copper wire. If you are a poor man black iron wire will do. To form the trunk use small pieces of virgin cork, fix to the tree with copper loops, cut the pieces the size you require, the smaller the pieces the better the tree will look. To form the roots use long pieces of cork, and nail them to the tree board, use glue and moss to hide the joints, cover all the wire branches with common hemp or tow, bind it round very tight, tie all ends with cotton, light a piece of paper, and burn all the ragged ends off, give all a good thick coat of glue except the cork; when dry give another coat of glue, cover it with tree moss cut fine, or colour as you like, give the cork a coat of very thin glue, and dust on dry colour, don't paint it. To make an old-looking trunk to the same kind of tree, only without the cork, bend a piece of stiff card round the tree, nail to the tree board, give a coat of glue, when dry cut a few small or one large hole any shape you like, glue arms made with card on to the trunk about 1in. diameter and 2in. or 6in. long, cut the out ends as ragged as you can, mix glue and whiting into a thick paste, cover the cardwork inside and out, make the roots with same, let dry, and dust on colour.—Chelt.

[32391.]—**Vortex Rings.**—Procure a band-box with a tightly fitting lid, in which cut a round hole 1¼in. diameter. Insert a piece of smouldering brown paper till the box is full of smoke. A tap on the bottom of the box will now start a ring from the hole, which, if the surrounding air be at rest, will [illegible]. The form and internal motion of the rings can be better studied when they are [illegible] the bottom of the box a [illegible]. The rings [illegible]. A candle may be blown out at a distance of several feet by aiming a ring at it. The smoke is the equilibrium form of [illegible] and [illegible] rotation about [illegible] may [illegible] a [illegible] make a wooden box, [illegible] and formed of a [illegible] stretched, and the other of wood with the necessary hole. The smoke in the box may also be made by sprinkling its bottom with strong ammonia solution and placing in it a dish of common salt and sulphuric acid to generate hydrochloric acid. The two vapours combine and form salammoniac in fine powder suspended in the air. The apparatus for producing the rings in water is more complicated and costly, but I will describe it if desired.—J. Brown, Belfast.

[323[illegible].]—**Vortex Rings.**—I have used a light wood box, 12in. square, 12in. deep, and 4in. circular hole in front, canvas, on which paper has been pasted, tacked on the back, with strip of indiarubber 6in. wide stretched tight on it to bring canvas back to position. It will propel 4in. or 6in. smoke rings 15ft.; will blow out candle at 12ft.—Omega.

[323[illegible].]—**Vortex Rings.**—Take a half-pound mustard canister (the lid will not be required); in the centre of disc at end bore a small hole about one-third of an inch in diameter; cover the open end with a sheet of writing paper, and tie it tightly on the canister. Now fill the canister with smoke by introducing a piece of smouldering brown paper in the small aperture. When full, lightly tap the paper end, and smoke rings will issue. To produce the same in water, fill a transparent glass vessel with clean water; bring a drop of milk very close to surface; when it falls a very beautiful white ring is produced, which separates into several more rings before it reaches the bottom.—F. C. B.

[323[illegible].]—**Vortex Rings.**—To make these with smoke, take a box, substitute for the lid a piece of woollen or indiarubber cloth, and cut a hole in the centre of the bottom of the box. For a box of 9in. cube the hole might be about 1in. diameter. To show the rings in water, I made a glass trough 3ft. 6in. long, costing about 3s.—M. L. I.

[323[illegible].]—**Manchester Bells.**—If "Campanologist" will get the general history and detail description of the new town hall, published by John Heywood, Deansgate, Manchester, price one penny, he will find all that he requires, with the exception of the diameter of the mouth of each bell.—R. H.

[323[illegible].]—**Circulation of Boiler.**—Cut off the ½in. return at the boiler, screw on it a bend or elbow, into this fix a pipe 3ft. long, put on another elbow at the top of this, into this fix a nozzle 2in. long. You will want a tank about 3ft. deep. Three inches from the top of the tank cut a hole to take the nozzle-bit, put a back nut on each side of the tank and screw up tight. Put a lid on the tank, and you will always have a supply of hot water, and by conveying cold water to the tank you would always have warm water to feed the boiler with. In my opinion 1½in. or 1¼in. pipes would give quite as much heat if not more, than you require. Put a stopcock in the 3ft. piece of pipe, or the circulation might be greater than you require. At all events, you can then regulate the heat to suit yourself. Fix a small stopcock in the lowest place in the return pipe to act as a siphon. You could take a piece of small pipe from this into an old drain or any other convenient place. This must always be left open a little. You will find out how much. If I have understood what you require I should think you will get heat enough with one-half the amount of steam you name.—Chelt.

[323[illegible].]—**Circulation of Steam.**—If, instead of returning ½" pipe to boiler, you place a tap to drain off water, the circulation will be complete. You can so adjust the tap that water only, or, if more heat is required, steam as well will blow off. I think you will not be able under conditions to make the other plan work. Return pipe can be led to pump cistern.—Omega.

[32398.]—**Circulation of Steam.**—Your supply-pipe is not too small, and presuming that the large pipes have a fall, so that the condensed steam may run freely away, and that your ½in. waste-pipe is carried below water level into boiler, there is nothing to prevent the arrangement from being a good one for heating or drying purposes. As to the "continuous" circulation round the pipes, correctly speaking there is none, the pressure being the same at both inlet and outlet.—W. G.

[32399.]—**Sympalmograph.**—Perhaps there is too much friction between pen and paper. If a glass-tube pen, it requires to have the broken edges at the point carefully rounded off by softening in the flame of a spirit-lamp till the tube is on the point of closing up. If the ratio of the length of the pendulum above the support to that below be too great, the friction quickly overcomes the momentum of the weights.—J. Brown, Belfast.

[32400.]—**Mechanical.**—In reply to the queries of "Henri W.," 1st. Assuming the shafts connected by one pair of spur wheels and one pair of bevel wheels as speed of driven shaft (375) to that of driver (25) is 15 to 1; so any two numbers whose product makes 15 (as 4 and 3¾) gives the relative proportion of number of teeth in large wheel to that of the pinion it works in. For instance, say—

Spur Wheels.		Bevel Wheels.
4 to 1	...	3¾ to 1
48 to 12	...	45 to 12
64 to 16	.	60 to 16
&c.		&c.

And 2nd. As the length of incline in proportion to height is 10 to 1, or the effect of gravity in rising the incline is equal one-tenth the load, including weight of engine 6 tons. Then assuming load = 1; [illegible] = 2[illegible] tons, or 11 = 330 tons; or 1 being = [illegible] tons. Then 2[illegible] − 6 = 17[illegible] tons. Ans.—B[illegible]shaw, near Bradford.

[32[illegible].]—**Marmozet Monkeys.**—I have seen these little pets enjoy meal worms more than any other kind of food. They prefer them "alive and (I may add) kicking."—F. F. C.

[3240[illegible].]—**Electrical.**—1. Yes. 2. Tinfoil must be less than paper: each alternate sheet joined to one wire, the others the same to another wire, one wire soldered to one side of break, the other soldered to the other side of break. 3. May be separate, but generally placed in base of machine. 4. By winding your wire on horse-shoe bar of iron, say 5in. long in arms and 5-16in. thick, you will have a magnet that will magnetise your steel much better than by winding wire on steel: steel must be hardened.—Omega.

[32404.]—**Electrical Coil.**—A coil such as described ought to be amply strong enough for medical purposes: the primary wire of 24-guage is, however, too small: 20 is the smallest which ought to be used: condensers are not used with medical coils, and they would be likely to do mischief to the coil, if not to the patient. The descriptions are wrong both as to making and connecting the condenser. The foil should be smaller than the paper, and the connections made to the spring and screw supports of the break: that is in the primary circuit, not the secondary. Permanent magnetism would be induced in steel by any coil in which any current circulates; but its strength depends on the quantity of current passing, and the proper adjustment of the wire to the battery power used. "D. C. S." should endeavour to master the principles involved in all the subjects before trying to do things without a proper comprehension of them.—Sigma.

[32408.]—**The Phonograph.**—I examined one of the phonographs exhibited at the meeting of the Physical Society:—1. Diameter of cylinder, about 4 or 4½in. 2. Diameter of diaphragms, about 3in. 3. Pitch of screw, about 8 threads to the inch. 4. Length of points, about 3-16in. They are rather blunt and polished. 5. The tinfoil was fastened to the cylinder by means of gum—a little brushed over the overlapping end is sufficient. I have made a phonograph, and shall be happy to answer further queries on the subject.—Speravi.

[32413.]—**Return Tickets.**—Perhaps the most important question is why any one should take them at all when no reduction is made on the full fare both ways, and the only saving is the trouble of taking a fresh ticket when required. No doubt the former plan of reduced fare for a short time was to encourage traffic by giving an inducement to making journeys which might not otherwise be undertaken.—Sigma.

[32414.]—**Heliopolis.**—In the notes to Beloe's "Herodotus" it says there were in Egypt two cities of this name. One of these, now called Mantanea, was probably the "On" of the Scriptures; and, according to Strabo, celebrated for the worship of the sun. There are but inconsiderable remains of this city. Wright's "Topographical Dictionary" says Mataria (the same as Mantanea) is a village of Egypt, five miles north-east of Cairo. A little to the north of this village are found the ruins of the ancient On or Heliopolis, one of the most celebrated cities of ancient Egypt. It is still marked by an obelisk, 67ft. high, and by the ruins of several sphinxes. Savary says:—"A barbarous Persian overthrew her temples, a fanatic Arab burned her books, and one solitary obelisk overlooking her ruins says to passengers, this once was Heliopolis." On is named in the Bible only in connection with the history of Joseph, who married Asenath, daughter of the priest of On; but this, I think, means the Deity of whom he was priest, not this official's residence. Herodotus says (Euterpe vii.):—"From the coast inland to Heliopolis the distance is nearly the same as from the altar of the twelve deities at Athens to the shrine of Jupiter at Pisa. . . . The distance from Pisa to Athens wants precisely 15 stadia of one thousand five hundred, which is the exact number of stadia betwixt Heliopolis and the sea." A stadium is 606ft. 9in.—Ponto.

[32416.]—**Electrical.**—To "Sigma."—Unquestionably the paper of the condenser is perforated, and the foils make contact and short circuit the intended condenser.—Sigma.

[32419.]—**Telephone.**—"T. P. A.'s" magnets are quite strong enough. There would be no advantage in having a return wire. Most probably the magnets are too far away from the discs. The remedy is of course obvious. I have a pair of telephones, which can be heard at a distance of about 30ft. They are of the ordinary construction, but have very thin sheet iron discs instead of the ferrotype plates usually employed.—M. S. T. E.

[32421.]—**Salt or no Salt in Food.**—Vegetables contain salt or its elements, chlorine and sodium.

refore, no salt were eaten, it would be found secretions. That it is beneficial is certain, e wild animal instinct teaches its use, and ls seek it greedily. Every one knows, further- that horses and sheep are both benefited by them salt in addition to that naturally con- in their food. It is also a well-known fact parts of Africa, where salt is very scarce, so is the craving for it, that it is used much as neats are with us—as a special luxury.—

24.]—**Carbon Block.**—I find wood charcoal ood for casting small ingots. The face should l or rubbed perfectly flat, and a place for the cut out with a small chisel, sculptor file, &c. should be made at the end, in which to melt etal. The mould should be covered with r piece of charcoal, also made perfectly flat. are scores of jewellers who use nothing but ntrivance for small ingots, as you can make ny size and shape you like. When no charcoal inable bath-brick or pumice can be used, but re apt to leave particles of grit in the metal, us cause holes in the plate when it is rolled sides spoiling the rolls. You might try equal f sand, blacklead, and plaster of Paris made paste with water. This will stand a very high ature. If you want to make proper carbon you will require moulds and a press similar to sed in the manufacture of the blacklead sold shops. Try what I have recommended, and if n't succeed write again.—OS.

8.]—**Brick Making.**—From long experience ld recommend Bradley and Craven's brick- machinery. Their machines very seldom get repair, turn out excellent bricks, and, in my , are the best machines made.—G. A. R.

1.]—**Legal Query.**—I gather from the state- in this query that the property in question is al estate. The share to which the query belongs to B absolutely. Neither C nor his could take any interest in it unless he had y received the share in his lifetime, or had d B.—SPERANS, Lincoln's Inn.

2.]—**Buttons made from Bone, &c.**—A any buttons are turned, but not, I should e, in an ordinary lathe. They require special s, and there can be very little difficulty in ining the material of which they are made. Ivory, mother-o'-pearl, &c., can only be lated in that method. Porcelain clay is used. This, of course, is moulded, also te. Paper pulp (papier mâché) is doubtless Celluloid is also available for the purpose, be made almost any colour, but you do not what purpose you require the material, so is rather difficult to advise you.—OS.

3.]—**Klos Violin.**—I am sorry I cannot you. You might read Dubourg, also Otto, violin, as likely sources of information. Any library has them.—FIDDLER.

3.]—**Blackleading Stove.**—"C. O." should id what kind of "stove" he means. I can end "Brunswick black," thinned somewhat rpentine, for register stoves and the like; kitchen "ranges" or stoves (like Smith and od's "Mistress," &c.) it does not last long. at heat of the parts around the fire burns it quently with a disagreeable odour. A good standing fire as well as graphite, but not g so often renewing, and not sending a pene- dust over every one and everything near the n, is a desideratum. Of course, "C. O." "blacklead" contains no lead; its use, there- not lead to lead-poisoning, amongst its dis- ges.—DAGHBERT.

.]—**Fluid used for Spirit Level.**—Spirits would doubtless answer the purpose, but I irits of wine is generally used. The former liable to decompose under the influence of I should think sulphate of indigo would be colour for you.—OS.

.]—**Electrical Indicator.**—As the in n "An Old Reader" requires would take oo much of your valuable space, and would and some rather elaborate drawings to make cit, I think he had better advertise his in your next issue, and I will communicate privately the particulars he requires.— E.

.]—**Filling Teeth.**—I have tried all and ways, but the only sound tooth I have ad I treated thus:—I scraped all the decayed off, then touched it with nitrate of silver— ar caustic, which turned the place black plied, but did not discolour the whole of h. This operation was done 25 years ago, out pain. I have had teeth stopped, but 't last long; in my opinion it hastens their struction. I think toothache and decay are ry complaints, as well as gout and rheu- The old-fashioned remedy for toothache is he liver in order, and then take quinine. od, too, only quinine and the liver don't think that whatever would act direct on the system would prove the best remedy. I will ore on this presently.—FIDDLER.

5.]—**Colour for Confectionery.**—Cochi- ll answer "W. M. S.'s" purpose. He can buy ared, at the Italian warehousemen's, bright armless.—PONTO.

UNANSWERED QUERIES.

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The numbers and titles of queries which remain unanswered for five weeks are inserted in this list, and if still unanswered are repeated four weeks afterwards. We trust our readers will look over the list, and send what information they can for the benefit of their fellow-contributors.

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QUERIES.

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[32465.]—**Harmonium.**—I wish to know the best kind of straight springs (acting like a door spring) to give a more equal pressure to bellows than the ordinary spiral springs. It is for a large instrument of 8 rows; the springs not to be more than 15in., and to allow for a fall of about 9in., the bellows being hinged in front and falling at back. Also is there any method by which the wind can be steadied in hand-blowing, such as having a small extra bellows? Have any of "ours" tried aluminum, in combination with other metals, for reeds? I also wish to form a celeste stop by throwing one set of reeds out of time by mechanical means, so that the reeds can form a stop of themselves or used in full organ.—H. E. S.

[32466.]—**Legal.**—I should be greatly obliged if any of your correspondents who are "learned in the law" would give me advice on the following subject:—I am the holder of a first mortgage on a certain property, the owner of which, after raising all the money he could by way of second mortgage or otherwise left England, and although it is now more than 20 years since I entered into receipt of the rents of the said property, yet neither he nor any one on his behalf has paid off the mortgage or any part of it. I therefore ask, is it a fact that in point of law I become the absolute owner of the said property after the lapse of twenty years? Am I responsible to the second mortgagee or any one else for any surplus rents after deducting my interest and all other necessary expenses for collecting the rents and keeping in repair the said property? I have reason to believe that the owner of the property is still living but not in any part of the United Kingdom.—CAPIAS.

[32467.]—**Longitude.**—Will any one inform me what method was adopted by exploring navigators of old to fix the longitude of new lands that they found and landed upon—that is to say previous to the introduction of chronometers and the method of finding the longitude by measuring the angular distance between the moon and sun or star.—POLARIS.

[32468.]—**Railway Companies and Goods Traffic.**—Could any of your numerous readers give me the chapter and date of the Act of Parliament relating specially to goods traffic on railways?—S. R. N. P.

[32469.]—**Inflammation of the Windpipe.**—Will one or more of your medical readers give an opinion if there is any place in England where one might be less likely to suffer from the effects of cold winds than on the Sussex coast? Every year I am a victim to bronchitis and stomach difficulties on the arrival of cold and boisterous weather. When the thermometer is below 50 degrees in the bedroom without a fire I may then look for an attack, which usually lasts two or three weeks and confines me to the house two or three months. From what I gather from the doctors I have a weak chest, weak heart, and weak stomach. Age 58.—SUSSEX COAST.

[32470.]—**Telephone.**—Will the advantage gained by using a soft iron pole-piece for telephone compensate for the extra trouble in putting it in? Should the wire be wound directly on the magnet or iron pole or should something be interposed?—J. WILSON.

[32471.]—**Photographic.**—Will some one kindly tell me how to recover the silver from waste sensitized paper? I should also be glad to know how to reduce the gold from a quantity of old toning bath.—FILIUS AGRICOLÆ.

[32472.]—**Wire Tramways.**—I should feel much obliged if any reader would kindly give some particulars respecting wire tramways, whether there is any better plan than that patented by Mr. Hodgson some years ago, if there are any lines at present in actual use, their lengths, power required, and weight carried per day, and average cost per ton per mile? Also their cost of construction, size of wire rope and weight carried of each load would be important to know, and any details respecting their machinery would be of service.—ETNA.

[32473.]—**Plaster of Paris.**—Would any of your readers kindly give some information as to the manufacture of plaster of Paris, the best form of kiln to be used, and the proper apparatus to be used for crushing or grinding it when burnt? The plan adopted here appears to me most primitive and uneconomical. The kiln consists simply of a circular hole in the side of a hill about 10ft. in diameter and 5ft. deep, which is lined with lumps of gypsum, an opening 3ft. high by 1ft. 6in. in width being left in front for firing. On the top of this a hollow cone is built up, about 10ft. diameter at bottom, and 3ft. in diameter at top, 6 or 8 feet in height, the thickness of the walls being from 2 to 3 feet, and when completed resembles somewhat a gigantic oystershell grotto. A heap of straw is then lighted in the interior and fresh straw is continually added, care being taken to keep it well stirred so as to produce a great flame; this operation lasts four hours. When the kiln has cooled down the lumps of burnt gypsum are pounded with a sledge-hammer and the plaster is ready for use. A kiln of this kind produces from 8 to 10 cubic metres of plaster (200 to 250 bushels). This material is used principally for rough rubble masonry in this country. It appears to me that this method is a most wasteful way of applying heat.—ETNA.

[32474.]—**Brake for Ore Tram Cars.**—I should feel much obliged to any of your readers who could give a description of a suitable and effectual brake for trams used for carriage of ore in mines. The adit has a gradient of 1 in 28 to 1 in 33, and a length of about 400 yards, and we find great difficulty in controlling the loaded trams, which sometimes get away. The gauge of this tramway is 2ft., the diameter of the wheels 1ft. 6in., and a loaded tram weighs about 1 ton 6cwt.—MONGIBELLO.

[32475.]—**Setting Boiler.**—Would any of the numerous readers of the E. M. kindly give me information as to the best way of setting a boiler, or rather tank, 4ft. in length, 2ft. in breath, and 4ft. deep, open at top? The liquid to be contained in this tank is required to be kept at a boiling temperature, and a slow combustion just sufficient to maintain this heat is all that is required. What should be the size of the furnace and its relative position with regard to the boiler, and whether it would be advisable to pass the flue round the sides after having heated the bottom? Dimension to be given to furnace, flues, and chimney will oblige—STROMBOLI.

[32476.]—**Earthenware Oven.**—Can any reader of "ours" tell me how to build a small oven for firing crockery and china after painting it with vitrifiable colours, one that would take in a good sized plate? I find a neighbouring glass-stainer's muffle only just fixes the colours without properly fluxing them.—HAMMER.

[32477.]—**Building Societies—Can they Purchase Property Legally.**—Nine directors of a building society, which is enrolled under the Building Societies Act, 1874, purchased from three of its members, with the funds of the society, a block of buildings consisting of fourteen or sixteen shops, along with three upper floors of rooms let for different kinds of businesses, and the said society conducts its business in part of one of the upper floors. £38,600 has been spent in purchasing the property. There are over 9,000 members, not one-tenth of whom attend any of the society's meetings. No notice has been given to the members of the intended purchase, no special meeting called, nothing is said about it in our reports, no income of the rents is shown in our yearly balance-sheets. Will some of our law correspondents kindly say is it a legal transaction for a building society to purchase property? Is it in accordance with clause 37 of the Building Societies Act, 1874? If it be a legal transaction, should it not be in our yearly balance-sheets, and should not the rents be shown in our yearly balance-sheets?—AN OLD MEMBER.

[32478.]—**Brewing.**—A few years ago a friend lent me a small book on brewing, by Hugh Scott. As I was not then in the business I did not take much notice of it. Will some of our correspondents (who have read the work) say if it would be of any assistance to me in making my brewings to a greater length? From the recollection I have it describes a system given for obtaining 14½ barrels of wort, of 33lb. gravity, from six quarters of malt. I am unable to do this.—MALT AND HOPS.

[32179.]—**Utilisation of Flax Shores for Fire-lights or Paper.**—Having considerable business with scutch mills, where flax is prepared for market, I have frequently thought that some better purpose could be effected with the shores which fall from the flax in the process of scutching than at present. As a rule the many tons of these shores that are daily made during the season are for the most part wasted. A small portion are used by poor persons for firing, and a small quantity gathered in heaps to rot for manure. I refer, of course, to mills driven by water-power, as when steam is employed they are used for firing the boiler. Could these shores not be made up with some resinous material into cakes at a small cost and sold for firelights, or could paper of a cheap kind be made from them? Any suggestions on this subject will very much oblige the writer, who would be willing to enter into correspondence with any one who could suggest a practical plan for using up what is now literally thrown away.—FLAX.

[32180.]—**Pianoforte Playing.**—I am commencing to learn to play on the piano, but having had the misfortune to lose the little finger of the right hand I would like to get the opinion of some of our professional readers as to whether there would be any probability of my ever being able to become a tolerable performer, or to qualify for a teacher of the instrument. I may say that I can play octaves with the second finger, so that I have no difficulty in reaching an octave or ninth with the thumb and third finger. Will "Ne Sutor" express his opinion? I am grateful for his kind and valuable advice on a previous occasion. Will he let me know what work he considers best for the study of musical history to make up for examination?—AMATEUR MUSICIAN.

[32181.]—**Selling Arms to Public Enemy.**—I recently maintained that there already existed laws here in the United Kingdom forbidding British citizens (under penalty) to sell arms and munition of war to a nation with whom we might be at war. Am I right or wrong? If right, please state punishment for infraction of said laws.—E. M. R.

[32482.]—**Narrow Gauge Query.**—I accounted for the odd half inch in the narrow gauge (on the authority of a publication of Colburn and Holley's) thus:—About the time of the birth of the railway system it was supposed that rails laid even 5ft. apart, measuring from out to out, would afford a good and sufficient bearing to the train. Now it so chanced that these early rails happened to be just 1¾inch wide each, thus making the width between the rails measured from in to in 4ft. 8½in. Had the rails always remained of this size no doubt we should have always spoken of the gauge as a 5ft. one (outside measurement), but when it became necessary to increase the height and breadth of the rails, as the flanges of the wheels were on the inside, of course engineers were compelled to retain the internal distance 4ft. 8½in. unchanged and put the increased size on the outside, thus destroying the distinctive characteristic of an even 5ft. gauge (outside measurement), and naturally the gauge came to be spoken of as a 4ft. 8½in. one. Is this correct?—E. M. R.

[32483.]—**Mercury Hg.**—Why is mercury usually kept in iron bottles?—R. W. S. R.

[32484.]—**Galvanising.**—Will any of "ours" kindly tell me what plant is required (and add, if they can, the probable cost) for galvanising on a small scale? The articles to be treated are small forgings, &c., not exceeding in any case about 18 inches long and a few pounds weight. There is no thin plate work.—R.

[32485.]—**Boiler Flues.**—Will some correspondent give me a rule for estimating the size and height of chimney shafts for Cornish boilers? I have to calculate a shaft for two boilers, each 9ft. long by 4ft. 6in. diameter, with one internal flue 2ft. 3in. diameter, and two conical cross tubes.—A Junior.

[32486.]—**Japanner's Kiln.**—I have had a deal of trouble with the kiln I am using at present. It is badly constructed. I cannot get heat enough to dry Pontypool varnish. I am going to take it down and build a proper one. Would any of "ours" assist me as to the best way to build it, give the size of pipe or flue, and say whether the pipe inside the kiln or the flue between the bricks is best? A small sketch would oblige—Slim Jim, X.Q.B.

[32487.]—**The Ear.**—Will any of your readers kindly inform me whether the organs of the ears are destroyed in deafness arising from scarlet fever? If not, please what is the cause, as at times I can hear very well and at other times I can scarcely hear at all? Both my ears discharge matter at times.—Inquirer.

[32488.]—**Driving Belt.**—Whether is a leather or a round rope belt best adapted for driving heavy machinery going at a high speed? A reply in an early issue will oblige—Macaulay.

[32489.]—**Zincography.**—Will E. A. Nuth, letter 14013, page 577, give the proper quantities for mixing the bichromatised gelatine solution, and also state what acid is used, and of what strength for engraving? Any other information as to probable difficulties would be valued by—Zinco.

[32490.]—**Watch Query.**—I have bought an adjusting rod (2 balls), but cannot tell how to use it properly. Will any of "ours" give me the necessary information?—C. P.

[32491.]—**Polishing Pivots and Pinions.**—Will "Seconds' Practical Watchmaker" tell me how to polish pivots and pinions?—Anxious Inquirer.

[32492.]—**Varnish Stains.**—What will take out varnish stains from oilcloth? Turps don't touch them.—Fiddler.

[32493.]—**Momentum.**—How many tons' weight will a ball 10cwt. strike, falling 15ft.? And what height would a 15cwt. ball have to be taken so as to strike the same weight? If any kind correspondent will give solutions to the above, he will oblige a reader very much.—Momentum.

[32494.]—**Screw-cutting by Hand.**—Many thanks to a "Dorset Member A.M.S.," &c., for his very valuable information respecting the above, but what about a square thread? A cleaning tool, I presume, is a chaser.—R. D.

[32495.]—**Colourless Spirit Varnish.**—Thanks for the information given by several correspondents. I have succeeded in dissolving a fair percentage of bleached lac, and have added a little sandarac, but find that when applied the wood appears to be frosted. Perhaps some one who has really made the varnish will say what is wrong?—Wallasey.

[32496.]—**Eyesight.**—During the last few years my eyesight has not been what it should. I used to have good eyesight, but now it seems to confuse things in a peculiar fashion. Can any one tell me from the following whether this is the result of weakness only in the eye, or whether of some defect:—I can read clearly the letterpress of the query columns of this paper at a distance of 18in., and by straining at a distance of about 2ft.; the large title print of this paper at a distance of 4ft., and by partly closing the eye at about 6ft. distance. I cannot distinguish properly people's features at a farther distance than about 100ft., although I can see telegraph lines and similar objects at considerable distances. If this is only weakness of eyesight, will bathing them with cold water do any good towards strengthening them? I am employed as a draughtsman.—Blind Bat.

[32497.]—**Mathematical Instrument.**—I have a mathematical instrument that is generally called by miners a dial, with a magnetic needle connected thereon, which has lately gone out of repair—that is, there is no certainty belonging to the needle, and it will not stand within several degrees to the same point at different times. I shall feel obliged if any one can give any instructions how to repair it, and get it to stand right?—A Learner.

[32498.]—**Paper Canoe.**—Would some correspondent favour me with instructions for building a paper canoe, giving details of method of preparing the paper, and of fastening it to the ribs, and any other hints necessary?—R. N. W. T.

[32499.]—**Times of New Moon.**—To "F. R. A. S."—In finding the time of new moon for February, May, and October, 1876, by the tables in Fergusson's "Astronomy" (edition 1811), there comes out a difference of 15′ 19″, 3′ 14″, and 6′ 22″ respectively from "Whitaker's Almanac." If you will tell me the cause of the difference you will oblige.—J. C.

[32500.]—**Cement.**—Can any one inform me of a cement or wax for filling up the pores of corks for flasks? As they have to stand a very high temperature (about 800° F.) indiarubber corks will not do.—E. B. C.

[32501.]—**Bichromate Battery.**—What is the electro-motive force of a quart bichromate cell? Is it suitable for the electric light; and, if so, how many elements (quart) would be required to give a fairly good light for lecture purposes? Can other batteries—for instance, Bunsen's—be charged with bichromate?—Rupes Vadum.

[32502.]—**Launch Engine and Boiler.**—I wish some practical engineer to answer the following questions, which may be beneficial to others beside myself:—1. In a double cylinder engine, 3¼in. bore by 4½in. stroke, required the size of main supply steam-pipe from boiler? I have referred to Molesworth's "Engineering Formula," but cannot come to any definite conclusion. 2. Required the size and most approved form of boiler for the above engine (horizontal required), with thickness and quality of plate to work at not less than 120lb. per square inch? 3. The size of pump plunger and length of stroke for above engine and boiler?—Psycho.

[32503.]—**Chemical.**—I should be much obliged if some correspondent would tell me what is formed when stannous and stannic chloride are added to a solution of a gold salt? Also why the precipitate is sometimes purple and sometimes brown?—M. S.

[32504.]—**Gong Buzzing.**—I have a gong which, when sounded, makes a buzzing noise; it is slight, still it shows that there is something wrong. What is it, and what can be done to remedy it?—John Anderson.

[32505.]—**Inhabited House Duty.**—A owns or occupies a house and land of annual rateable value of £100, and receives a notice of appeal intimating that the commissioners of taxes intend to charge him inhabited house duty upon £20 at 6d. in the pound (10s.), such notice being signed by the surveyor, he being the assessor for the present year. Now A does not attend the appeal day, consequently the commissioners confirm the notice, and grant a duplicate of the assessment, charging A 10s., which, upon application by the collector for the same, A refuses to pay, upon two points—first, that the house, without the land, is only worth £8 a year; secondly, that neither the surveyor nor commissioners have seen the house to assess it. Now the collector, according to his appointment and warrant, is compelled to levy a distress for the said duty. Supposing the house to be actually worth only £8, without land, who could A bring an action against for the distress—the collector, surveyor, or commissioners? Could he bring an action at all, after not attending the appeal which he had due notice of?—Collector.

[32506.]—**Emery Wheels.**—How should these be used for grinding—with water, or oil, or what, or dry?—John.

[32507.]—**Joints in Pipes.**—How are the ends of two pieces of sheet tin or zinc to be cut, so that when rounded into pipes I may make sure of their forming any given angle—as 90°, 120°, 145°—without leaving a hole, as I generally get at the outer corner?—John.

[32508.]—**Batteries.**—How are bisulphate of mercury batteries properly stayed from action? Should the zinc rod, or the carbon plate, or both, be removed? Will some one describe fully the bottle battery for bichromate, giving the proportions of chemicals, and stating how this too is put out of action, size being to work an electric bell through 200ft.?—John.

[32509.]—**Magnitude of Lunar Eclipse.**—Will one of our astronomers kindly tell what is the usual method adopted to calculate the magnitude of a lunar eclipse?—Amateur.

[32510.]—**Pianoforte.**—I have a very old square pianoforte by Dalmaine and Co. in good condition, but I cannot tune it up to present concert pitch, owing principally to the weakness of the wires, and also the pegs being without screw, thereby causing them to slip in their holes. Its compass is five and half octaves. Wishing to join it with the flute or violin occasionally, will some one of "ours" kindly say if it would be worth my while restringing it throughout, and, if so, will they kindly give me the gauge numbers of wires suitable?—J. G.

[32511.]—**Flute.**—Will some correspondent kindly give particulars of the latest Clinton model flute, and please state in what manner it differs from the Rockstro Boehm instrument, and if not troubling them too much will they briefly state the advantages, if any, of the above flutes over the pure Boehm cylindrical instrument?—J. G.

[32512.]—**Westinghouse Brake.**—Can "C. E. S.," or any body else, kindly explain the action of the triple valve? A rough sketch would oblige—Tom Connor's Cat.

[32513.]—**Enlarging Carte-de-Visites.**—I made some time ago a large square wooden box, and, cutting a round hole in one end, I fitted into it a small lens with this rough instrument (I could scarcely give it the dignified name of camera). I was enabled to throw on canvas from small carte-de-visites reflections of heads enlarged to a quarter of life size, the outlines and chief details of which I traced with a pencil, and finished afterwards in oil colours with very good results. I, however, wanted to enlarge the heads on the cards to life-size, but found, on attempting to do so, that the reflection became so weak and hazy it was impossible to trace it. Perhaps some correspondent who is acquainted with photography will let me know if it is possible to enlarge such heads to life-size at one operation in this manner? Probably there are lenses better suited for the purpose than the one I possess, which is of the commonest description.—Asper.

[32514.]—**Hopkinson Safety-valve.**—Will any reader inform me if Hopkinson's safety-valve is worked inside a two-flued Lancashire boiler, and how calculated? A sketch would oblige, or say in what back number it may be found. Also say which way the perforated holes (in one side of horizontal feed-pipe above furnace boilers) should look, upwards, downwards, or sideways?—Iron.

[32515.]—**Priming.**—I am told that the boilers with flush topped fireboxes prime more than those with crown tops. Is this true? If so, what is the reason? What is the best position for the dome to prevent priming?—M. S. and L. Cleaner.

[32516.]—**G. E. R. Engines.**—Would some one give the dimensions of the engines running between Lowestoft and Yarmouth? I believe they have outside cylinders, and single driving wheels about 6ft. diameter. Also the dimensions of the little Blackwall engines, with outside cylinders and single driving wheels?—Short Stroke.

[32517.]—**To Watch Jobbers.**—I have drilled up a pinion to put new pivot in, but cannot get the new bit fast in. Will some one tell me the way they are fastened in?—Young Son.

[32518.]—**Spectroscope Prisms.**—To Mr. La caster.—Can you inform me how I can grind the prism for a direct-vision prism (Amici's)? Also an adjustab slit for same?—D. Sells.

[32519.]—**Cleaning Copper Cans.**—Will any reade kindly inform me of the best method of cleaning copp pans, saucepans, &c., before retinning?—Copper Smith

[32520.]—**Emery-wheel.**—Would any reader answe the following:—Mine is a 1in. wheel, 12in. diameter, f gulleting circular saw. What speed should I run it Which way round is best? Would it injure the temper saw? When there is much to be cut away would it b better to take a little at once, and keep going round an round until finished? Any other hints regarding it working would be thankfully received.—S. M.

[32521.]—**Uranus.**—In the ephemeris of Uranus give for March 2, Uranus was stated to be 9h. 55′ 8″ R.A., an still to be 5′ north of γ Leonis. Now γ Leonis is 10h. 13 14·6″ R.A. The above cannot be reconciled with the R.A which I have given. It must be either a mistake of th printer, or of your astronomical correspondent. Woul any one say which is correct?—J. E. Manning.

[32522.]—**First B.A. Examination.**—Would an reader kindly specify the four epistles or moral essays by Pope, required for the 1st B.A. examination? I mean to whom the epistles are addressed.—H. Tucker.

[32523.]—**Double Star.**—Can some astronomical correspondent give me the name and data of a wide double I came across lately? It lies some 70s. to 80s. p. ζ Coronæ, about 20′ s. of it. The components seemed very equal in magnitude; they were (roughly) on the same parallel, and ± 30″ apart.—Mac.

[32524.]—**Pig Skins.**—Will any one inform me how to make, dress, and finish pigskin leather, suitable for saddles and purses?—C. J.

[32525.]—**Shafts in Wringing Machine Rollers.**—I have made a press to put shafts in wringing machine rollers, but now that it is finished I find that it will not answer my purpose, it being too much work to push the shaft in. I have a frame 4ft. 6in. long and 2ft. broad, made of hard wood, 6in. by 4in., placed on its edge, on a table 3ft. from the ground. I then got two 1in. bolts and bolted from end to end. I then got a bracket and bolted it to end of frame by two ½in. bolts after having it chased to my screw. I then placed at the end of my screw a wheel 2ft. diameter and put a handle on it; I then placed my wringing machine block at the opposite end to my screw, with a 1in. hole through; I then got my shaft 1¼in. square, now I want to know how to fix gearing to it to make it work easier.—M. T. O.

[32526.]—**First B. Sc. Examination.**—Will some candidate of last year kindly give an idea of the scope of the practical chemistry examination? How long is each individual candidate under examination, and what sort of tests are required of him? What is the practical examination in biology? Can the necessary skill in dissection be soon acquired? Is it such as can be mastered without a teacher? Also please name some good works, elementary and advanced, on this subject. They should not be anatomical books in the ordinary sense.—Skerryvore.

[32527.]—**Telephone.**—Will some kind reader inform me whether a battery current occasionally passing through the wires (to ring bell) connected with two telephones, thereby increasing the magnet power, is likely, in course of time, to be detrimental to the ferrotype plates? A "buckling" sound is heard on connecting and disconnecting battery, but at present, as far as I can judge, does not affect the speaking powers of instruments.—J. B. Poole.

[32528.]—**To Photographers.**—Can any of the numerous photographic amateurs who occasionally answer queries give me any information as to their experience of a new kind of apparatus I have come across at a friend's? It is called Dubroni's, and requires no dark room, but I do not quite understand the working of it. Any information will oblige—Faugasse.

[32529.]—**Steam Launch.**—Will some correspondent kindly give me instruction? I am now building steam launch for river work, and to take pleasure partie out for a short sea trip. What restrictions are we subjec to on the part of the Board of Trade? Can I put an kind of boiler in the boat, either vertical or horizontal tubular? I am about to put two small vertical boilers in working at 60lb. pressure, engine to be direct actio cylinder 10in. diameter by 10 stroke; the boat will b 50ft. long and 10ft. beam; displacement about 350ft. built of wood.—C. M.

[32530.]—**Hebrew.**—To "G. J. W."—I have latel commenced the study of Hebrew, and have books only f a guide; a few hints as to pronunciation would be ve useful to me. I have "Gesenius' Grammar," Bresla works (Weale's Series), and Prendergast's work (Maste Series); these all differ widely as to pronunciation, a having some conversation with a Polish Jew I w favoured with a fourth system. I have determined follow Gesenius, but find some difficulties, for instance. pages 35 and 36, words ending in Qames followed by w and yod are directed to be pronounced *âw* and *ây*, th and y to have their consonant sound. This I think I c manage in the case of ay, but am not certain about An example of an English word ending with the ri sound would, I think, settle this difficulty. Then ag Qames and Qames-chatuph being written with the sa vowel-point offer an obstacle, in some cases, to me ins mountable—for instance, from Qoph, Teth, Lame (qâṭâl), comes (Table C, page viii.) the form, in second person singular masculine of the infinitive, Qo Teth, Lamedh, Kaph, pointed with Qames, Shewa, Se Shewa, according to general rules the first two lett forming a closed syllable. This should be pronounced Q lᵊkh, being without metheg, and followed by shewa, in first per. plur. The third letter is accented, pointing the short o, yet the original having long a I cannot dec how this should be sounded.—W. G.

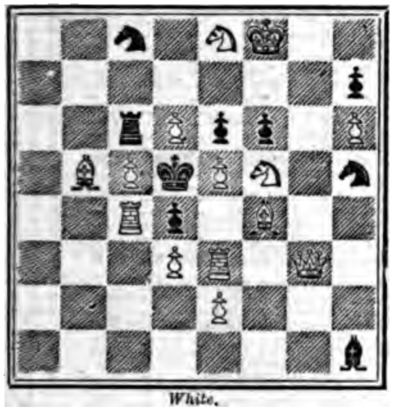
[32531.]—**Chemical Bath for Preservi Canned Meat.**—Will some fellow-reader favour w the following information?—1. What are the chemi used to raise the temperature of the water, and at w height is it generally used? 2. What quantity of che cals is required for, say, 100 gallons of water? 3. Are cans wholly, or only partly, covered while cooking? About what time does it take to cook, say, 6lb. cans Rhobt Cisteir.

CHESS.

ALL Communications intended for this department must be addressed to J. PIERCE, Copthill House, Bedford.

PROBLEM CCCCXVI.—BY J. N. BABSON.

Black.



White.

White to play and mate in two moves.

SOLUTION TO 414.

White.	*Black.*
1. K to K B 7.	1. B takes Kt. (a).
2. Q to Q B 6 (ch).	2. K takes Kt.
3. R takes P (ch).	3. Anything.
4. Q mates.	
	2. B takes Q.
3. Kt. to R 6 (ch).	3. K moves.
4. Mates.	
	(a) 1. B takes Q (b).
2. Q Kt to Q 6 (ch).	2. K moves.
3. Kt to K 7.	3. Anything.
4. Mates.	
	(b) 1. B to Q Kt 6.
2. Q to K 6, &c.	

NOTICES TO CORRESPONDENTS.

ARCANUM has pointed out a second solution to 413, thus:

1. $\frac{\text{R takes P}}{\text{P takes Kt.}}$ 2. $\frac{\text{B to Q Kt 5}}{\text{Aught.}}$ 3. Mates.

1. Q to Q B 6. 2. $\frac{\text{R takes Kt. (ch)}}{\text{Q to K 8.}}$ 3. Kt mates.

1. R takes P or Q to B 8. 2. $\frac{\text{R takes Kt (ch)}}{\text{Q takes R.}}$ 3. Kt mates.

ABBSON.—In 413 there is no mate your way if Black play 1. P takes Kt, becoming a Kt. In 411 if 1. P takes P. 2. $\frac{\text{Q to Q 4}}{\text{Aught.}}$ 3. Q to K B 6 mate.

F. C. C.—Thanks for the papers.

BRITISH CHESS PROBLEM ASSOCIATION.

RULES FOR THE TOURNEY AMONG THE MEMBERS OF THE ASSOCIATION.

All problems sent in must be original, and hitherto unpublished.

The publication of a problem in any paper (with the name of the composer attached) previous to the judges' award will cause such position and set to be disqualified.

One set only, consisting of three problems in from two to four moves, to be sent in by each competitor.

A single problem may be sent (to compete for the single problem prize), but not in addition to a set.

No competitor can take two prizes.

All competing sets must reach the secretary (Mr. J. P. Taylor, 63, Malvern-road, Dalston) by April 30, 1878, and each problem must have the composer's motto affixed.

A copy of each will be made and forwarded to the judges, and, if pronounced sound, it will shortly be printed in one of the following periodicals, the Chess Editors of which are members of the association:—*Illustrated London News, Land and Water, Illustrated Sporting and Dramatic News, Chess Player's Chronicle, Huddersfield College Magazine, Glasgow Evening News, Amateur World,* ENGLISH MECHANIC; and brief and all will be published also in the "West Papers."

The scale on which the judges (Messrs. Abbott, Andrews, and W. T. Pierce) have decided to estimate the merits of problems is as follows:—Beauty, 15; novelty, 10; difficulty, 10; construction, 10; variety, 5.

The prizes are:—For best set (including Press prize), £5; second set, £3; best four-mover, £2; best three-mover, £2; best two-mover, £2. The vice-president (Mr. Andrews) has also offered a copy of the forthcoming "Chess Gems," by J. A. Miles, for the third best set, and various minor prizes will also be given.

Cost of Education in Germany.—An interesting example of the comparative sums devoted in Germany to various educational purposes is to be seen in the recently-issued report of the Minister of Public Instruction for Saxony, a kingdom with 2,550,000 inhabitants. The whole number of educational establishments is 3,900; of scholars and students, 523,000; of instructors, 6,400. The salaries amount to 12,320,000 marks, and the total educational expenses are 18,000,000, of which 5,000,000 are contributed by the Government. The State devotes 785,000 marks to its 76 gymnasia and *Realschulen*, 1,364,000 to the general school system, and nearly as much—viz., 1,048,000 marks—to the University of Leipzig, with its 161 professors and 3,100 students, besides 298,000 marks for pensions. The total annual cost of the Leipzig University is 1,402,000 marks, or £70,100.

ANSWERS TO CORRESPONDENTS.

*** *All communications should be addressed to the* EDITOR *of the* ENGLISH MECHANIC, 31, *Tavistock-street, Covent Garden, W.C.*

HINTS TO CORRESPONDENTS.

1. Write on one side of the paper only, and put drawings for illustrations on separate pieces of paper. 2. Put titles to queries, and when answering queries put the numbers as well as the titles of the queries to which the replies refer. 3. No charge is made for inserting letters, queries, or replies. 4. Commercial letters, or queries, or replies are not inserted. 5. No question asking for education or scientific information is answered through the post. 6. Letters sent to correspondents, under cover to the Editor, are not forwarded; and the names of correspondents are not given to inquirers.

The following are the initials, &c., of letters to hand up to Tuesday evening, March 26, and unacknowledged elsewhere:—

H. WALLER.—H. Balchin.—F. W. Cooper.—Major O'Hara.—T. C. Burton.—J. Manford.—Acacia Wood.—T. S.—Ferrum.—J. H. Cooper.—W. C. P.—F. G.—Blue Gum.—L. L.—J. A. P.—G. A. S.—J. E. F.—A W. E.—S. D. J. R. Loco.—H. Brown.—Ignorance.—An Old Subscriber.—Canadian.—A. B. M.—J. Napier.—A Reader.—J. W. E.—A Poor Leaseholder.—York.—J. E. Vine.—J. Jopson.—W. L. Hall.—C. Watson.—Eos Cleddan Herculean.—W. D. M.—T. A.—J. Jewsbury.—G. Pinnington.—Shoemaker's Apprentice.—C. Knight.—Oscar Murray.—J. S. Sunderland.—J. L. B.—John Fortune.—J. Jones.—Todleben.—H.—Wideawake.—A Young Engineer.—E. J. Marshall.—B. C. C.—A. McNae.—Ringer.—Cottager.—Mongibello.—L. S. Y.—An Englishman Abroad.—C. E. G. H.—Coste.—T. J. O'Connor.—H. J. W.—T. Ryans.—C. S. Madan.—X. Y. Z.—Centurion.—C. Grover.—W. R. C.—H. L. S.—R. Frost.—J. T. V.—Colchester.—S. R.—Beta.—T. Morton.—B. Self.—Viridos.—Plaster.—F. T.—J. O.—T. Winchester.

BURLEIGH, D., Kilburn. (The dipleidoscope has long ago been described and commented on in our columns. See pp. 541 and 592, Vol. XVIII., and pp. 21, 37, 94, 25, and 128, Vol. XIX.)—E. W. (Any dealer will answer your questions about lenses, and no one else can do so satisfactorily; second query inserted.)—YOUNG HAND. (Both Lockwood and Co., and Cassell, Petter, and Galpin, publish handbooks on the subject.)—SIEP. (Stencil plates can be bought of any artists' colourman. See advertisement pages of the *Building News.*)—F. R. WAITE. (We have not received them.)—COTTON MILL. (Petroleum is the crude oil obtained from oil wells in America, Rangoon, the shores of the Caspian Sea, and other places. Paraffin is obtained from shale oil and petroleum. There is no danger likely to arise from keeping petroleum under proper precautions—an outhouse is the best place to keep it in. You can obtain it in large quantities of any Liverpool importer.)—W. E. BROWN. (Both numbers are out of print, but information on the subject is given in almost every other volume.)—G. T. BARTON. (Get "Miller's Elements of Chemistry," published by Longmans.)—MAC. (We do not know—you might obtain it through Williams and Norgate, or David Nutt, booksellers.)—C. J. BENTLEY. (Not received.)—W. H. HUMPHREYS. (E. W. Allen, Ave Maria-lane, E.C.)—RIDER. (You cannot repair them if much damaged; many recipes for cement have appeared in former Nos. Your second query is an advertisement.)—NEMO. (Nitric acid.)—T. MALLINSON. (Zanni and Bridger; see advertisement pages.)—B. J. (You can scarcely have read the number; the query was inserted on p. 48.)—INEXPERIENCE. (Books will help you, but by their study alone you cannot qualify yourself. You must enter an office and work in the regular way if you wish ever to become a practical member of the profession. Gwilt, Fergusson, the *Building News*, and the manuals published by Lockwood and Longmans will be the best books for you. Why not join the Architectural Association and use the Architectural Museum?)—VICTIM. (We do not think any blame attaches to the correspondent, seeing that you omitted to comply with the precautions laid down. "Sound Cork" said distinctly "It must be drawn through a champagne tap.")—A SCOTCHMAN. (At the Government Patent-office.)

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ELEVE.—Your letter on "Organon's" organ next week.

EQUITAS., W., Nemo.—See indices to back volumes.

HAMMER, Hawk.—Your communications are advertisements.)

BENJAMIN SNOOKS, A. Wright, J. B. Oliver, No. 3, and others have replied to queries already similarly answered.

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FRIDAY, APRIL 5, 1878.

ARTICLES.

ᴇE DIFFICULTIES IN THE ꜱTUDY OF CRYSTALS.

ʏ J. H. Collins, F.G.S.

) the *Mineralogical Society of Great Britain and Ireland*).

1. DECEPTIVE FORMS.

A). *Comparison of Forms.*

ounding planes of crystal forms
nsually referred to six distinct
" of axes, in which the axes vary
h, relative position, and number.
ntial characters of these systems
ed in all mineralogical text-books,
not be referred to here. The object
esent article is to call attention to
esemblances which exist between
d combinations belonging to dis-
tems, and to suggest certain obser-
on such "deceptive forms" which
nade by students who find them-
volved in difficulties.

Regular Octahedron (Fig. 1).—The
: forms closely resemble the regular
on, and may even be absolutely
uishable from it when the several
pen to be nearly equal, or when
al form happens to be somewhat
y developed or distorted :—
tetragonal pyramid 111.
tetragonal pyramid 101.
hemihedral form of the ditetra-
amid π h k l.
rhombic pyramid 111.
rhombic combination 101,011.
eculiar combination of a rhombo-
vith the basal plane sometimes
in *chalybite.*

gularly Developed Octahedrons.—
acute rhombohedron which may
l from fluor, by omitting one pair
f the octahedron, exactly resembles
rhombohedron sometimes seen in
d *chalybite.*
combination (Fig. 2) sometimes
spinel much resembles the acute
edron, with basal plane (Fig. 3)
in *calcite.*
irregularly developed octahedron
ten seen in *alum* exactly resembles
bic combination 102,011 (macro-
th brachydomes), which is some-
led the rhombic pyramid on square

Cube (Fig. 5).—The following
y closely resemble it :—

a. Tetragonal Forms.

square tetragonal prism of 1st
),001.
square tetragonal prism of 2nd
,001.
hemihedral form of the ditetra-
m, 1m0,001.

β. Rhombic Forms.

rectangular prism, 101,010,001.
prism, 110,001.
'macrodome," 0kl,100.
" brachydome," h01,010.
" brachy prism," 1k0,001.

γ. Hexagonal Form.

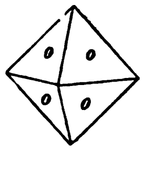
rhombohedron, when the angles
little from right angles.

4. *The rhombic dodecahedron* (Fig. 6) closely resembles the hexagonal combination of prism and rhombohedron (Fig. 7) sometimes seen in *calcite.*

5. *The tetrahedron* (Fig. 8) often closely resembles the tetragonal sphenoids which are the hemihedral developments of the tetragonal pyramids, 1*a* and 1*b*. Such sphenoids are often seen in the chalcoprite from the mines near Redruth.

6. The pentagonal dodecahedron (Fig. 9) very closely resembles the hexagonal combination of prism and rhombohedron (Fig. 10).

1



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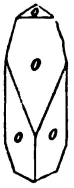

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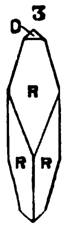

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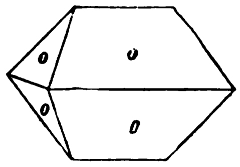

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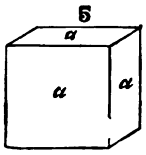

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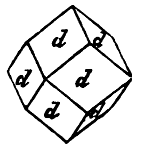

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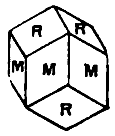

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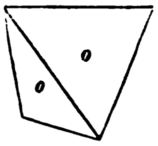

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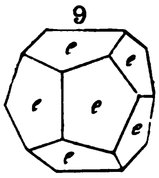

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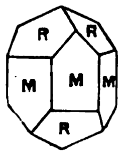

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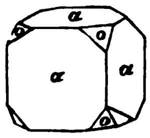

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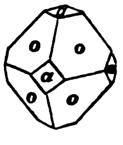

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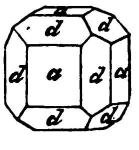

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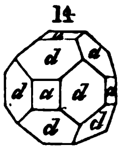

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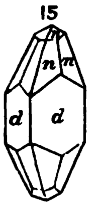

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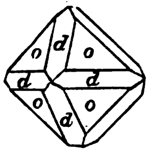

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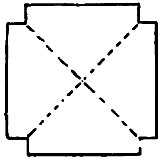

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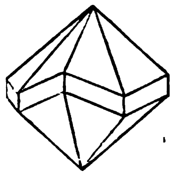

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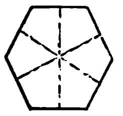

6. Combinations of the *cube* with the octahedron (Figs. 11 and 12) very closely resemble combinations of a tetragonal prism with a pyramid of a different order—either 110,001,101, or 100,001,111. Here, of course, the resemblance will be more close in proportion as the slope of the pyramid approaches that of the regular octahedron; and this, of course, depends upon the relative lengths of the principai and lateral axes.

7. Combinations of the cube with the rhombic dodecahedron (Figs. 13 and 14) may closely resemble the tetragonal combinations of two prisms and a pyramid—either 110,100,001,001, or 110,100,111,001.

8. The peculiarly and partially-developed combination of rhombic dodecahedron and deltohedron (Fig. 15), figured by **Dana** as occurring in *garnet*, might be easily mistaken for the tetragonal combination of prism, ditetragonal prism, and pyramid, 110,1nm,111.

9. The combination of octahedron and rhombic dodecahedron (Fig. 16) closely resembles the tetragonal combination—110, 111,101—sometimes found in *cassiterite.*

10. The rhombic macle of *Harmotome* (shown in cross section in Fig. 17) resembles very closely a tetragonal prism.

11. The tetragonal macle of *Rutile* (Fig. 18) closely resembles a hexagonal combination of scalenohedron and prism.

12. The rhombic macle of *Aragonite, Chalcocite,* and *Nitre* (Fig. 19) closely resembles the hexagonal prism, 110,001, or 120,001.

13. A great many cubical, tetragonal, rhombic forms and combinations are apt to resemble certain oblique and anorthic combinations when their axes are not highly inclined.

14. Cleaved fragments of tetragonal, rhombic, and oblique minerals may be mistaken for cubical forms.

(B). *Determination of the True Crystal System.*

14. Cleaved fragments may generally be at once distinguished from true crystals by the appearanee of the planes, but a crystal form cannot be satisfactorily determined by observations of its cleavages. If, however, there happen to be three sets of cleavages, all forming equal angles with each other, *and all equally perfect and easily obtained,* it will probably belong to the cubical system. Of course the cleavages may often be detected by careful examination—as flaws, &c.—without actually destroying the crystal.

15. Similar planes are usually marked similarly with roughnesses, striations, curvature, and the like irregularities. Hence, if in a crystal, for example, resembling Fig. 4, we find all the planes of equal brightness, or equally marked with striations, &c., we should be disposed to call it an irregularly developed octahedron; but if the larger planes differed from the smaller ones in these respects we should be probably right in setting it down as a rhombic combination.

In the cubical combinations Fig. 6 and 9 again all the planes will probably be similar in surface condition; whereas, in Figs. 7 and 10 the planes M will probably differ from the planes R.

16. Similar edges and angles are likely to be similarly modified or replaced by other planes. These secondary planes are sometimes very small, but they may often be found on careful examination. Thus, in such a form as Fig. 6 all the edges may be found replaced by small planes if it is truly a cubical form; while the hexagonal combination (Fig. 7) will be likely to exhibit replacements only on the edges between the planes M or the planes R.

It is seldom that a student will find all these indications fail him, but if he cannot get a clue to the real form either from replacements, striations and roughnesses or cleavages, he may have to examine portions of the crystal optically, in which case he will get very definite results, but generally only by destroying the crystal. The modus operandi may form the subject of another communication

THE STEAM JACKET.[*]

THE exact value of steam jacketing for cylinders has been a subject of controversy ever since Watt first introduced it to the notice of engineers. He saw clearly enough that to obtain the greatest economy it was necessary that the steam should not be cooled by coming in contact with a cold cylinder; and, accordingly, in the specification of his patent he stated that the steam vessel must be kept as hot as the steam which enters it during the whole time the engine is at work, and he proposed to effect this object by first surrounding the cylinder with steam, and secondly, clothing it with wood. During the century that has elapsed since Watt obtained his patent the steam-jacket has been the sport of many inventors, most of whom failed completely to understand the principle on which the utility of the jacket was based. The great mistake was the supposition that the jacket was intended to prevent loss of heat by conduction and radiation; and at one time it was a practice amongst some engineers to "jacket" with exhaust steam. Just as many nowadays fail to comprehend the theory of the compound engine, so they fail to understand the nature of the service performed by the steam-jacket. The function of the jacket is to prevent the condensation and liquefaction of the entering steam as it comes in contact with the surfaces of the cylinder. It will be understood that the jacket being in close connection with the boiler the steam contained within it is actually hotter than the steam entering the cylinder, because the latter has been slightly reduced in temperature by undergoing a little expansion in moving from the boiler to the cylinder. If the cylinder were not kept hot, the steam would be condensed by coming in contact with the cool surface of the metal, and it would be condensed still further by condensation during expansion; but, if the cylinder is surrounded by hotter steam, the slight condensation which theoretically takes place on expansion is compensated for by the heat of the steam in the jacket, which thus not only prevents an initial condensation, but also the liquefaction following on expansion, which is thus transferred from the steam in the cylinder to the steam in the jacket. The great advantage of the jacket is consequently found in the fact that, whereas condensation in the cylinder would be a serious loss of heat, the condensation in the jacket in no way represents a loss of fuel, for whatever heat is withdrawn from it is expended in maintaining the steam in the cylinder at its full power, and consequently the steam is used with the greatest degree of economy. The rationale of the action of the jacket is best seen perhaps by looking at the cycle of phenomena taking place in a simple unjacketed cylinder. When steam enters such a cylinder a portion of its heat is expended in bringing up the metal surfaces to an equal temperature with the steam, by which an appreciable quantity of steam is condensed into water, which passes through, not only without doing work, but actually reducing the temperature of the cylinder, the heat contained in which is abstracted by the water as it is reconverted into vapour at the end of the stroke. Without a means of keeping its contained steam hot, the cylinder may thus be said to act as a condenser at the beginning of the stroke, and as a boiler at the end, the result being a great waste of heat. There are other means of keeping the steam hot than by surrounding with a jacket open to the boiler—notably, hot-air supplied by the furnace gases, and superheating the steam. There are practical objections to the employment of either of those devices, and the only successful method of minimising the internal condensation of steam is the use of the jacket. Mr. Fletcher, in the useful and practical little manual, whose title we give below, tells us that there are still to be found some engineers who call in question the benefit to be derived from the use of the jacket, and by the aid of figures and "repaired" indicator diagrams prove to their own satisfaction the truth of their opinion; but, says Mr. Fletcher, very little dependence can be placed on the results arrived at by theoretical investigations, by which we suppose him to mean such "theoretical" investigations as he refers to, for it is certain that if the engineers he has in his mind's eye were better acquainted with the theory of the steam-engine they would cease their laboured attempts to prove by figures, and what they are pleased to term practical experiments, that the use of the jacket is a mistake—summing up their judgment in the erroneous conclusion "that the loss from radiation may just as well come from the steam in the cylinder as from the steam in the jacket." This view of the question is not by any means uncommon amongst "practical" men, who seem to be unaware that radiation has nothing whatever to do with the matter. Radiation is a loss that goes on with every boiler, as well as every cylinder, and no one would propose to steam-jacket a boiler, but we do take care to clothe them where possible, and prevent the loss as much as we can. And just as the engineer, well versed in the theory of the steam-engine, puts a jacket around his cylinder to prevent internal condensation, so he clothes the jacket to minimise radiation. But the loss from condensation of live steam and subsequent evaporation of the water is far greater than that from radiation, which can be materially reduced by very simple means. There is no doubt that much of the opposition to the steam-jacket found amongst practical men arises from the fact that their experience has been acquired under unfavourable conditions. Either the cylinder and its jacket have been badly designed, or the steam used has been abnormally wet. The many defects in construction are clearly pointed out by Mr. Fletcher, who promises us a treatise on steam-jacketing, which we are sure will be welcomed by engineers.

The leading principles of efficient steam-jacketing, though simple enough in themselves, require no little skill for their successful application, and a brief *résumé* of them may afford food for thought to many of our engineering readers. In the first place the jacket should completely encircle the cylinder from end to end; and, secondly, it should be constantly supplied with steam at the full boiler pressure. The arrangements should be such that the steam circulates freely around the cylinder, while at the same time accumulations of air or water should be rendered impossible. The working barrel of the cylinder should be made as thin as possible, and of the best conductor of heat—a point of no little importance, which, when properly attended to, is productive of considerable advantage; for the object is to impart the heat of the jacket steam to that in the cylinder, while by using thin metal, and that of the hardest kind, wear is reduced to a minimum. Mr. Fletcher proposes that phosphor bronze should be used for the purpose, as liners made of that alloy might be made as hard as desired and be furnished with an excellent surface to reduce friction to a minimum, while their thermal conductivity would be more than three times that of cast-iron. This suggestion is deserving the attention of makers of steam-engines, for a phosphor bronze liner would not add materially to the expense, while the extra cost would be covered by its durability and great conductivity. To obtain the greatest economy from the jacket it is imperative that the working steam should be as dry as possible, because all wet steam is evaporated in the cylinder by heat abstracted from the steam in the jacket; and, last but not least, all jackets and other receptacles for live steam should be carefully clothed and lagged to prevent radiation, for the loss of heat from this cause is sometimes very great. For instance, the great Corliss engine at the Philadelphia Exhibition had a layer of ¾in. of hair-felt and lagging of 1in., while over all, and separated by a half-inch air space, was a casing of polished iron, radiation being less from smooth and bright surfaces than from rough and dirty ones. Mr. Fletcher gives a couple of diagrams, showing how the steam-jacket should be arranged, and those who are interested in the subject would do well to read what he has to say in the little work which we hope is only the forerunner of a large and exhaustive treatise.

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[*] The Abuse of the Steam Jacket. By Wm. Fletcher, M.E. London: E. and F. N. Spon.

THE ORGAN: A COMPREHENSIVE TREATISE ON ITS MANUFACTURE, PROCURAL, AND LODGMENT.[*]

By John Watson Warman,

Associate of the College of Organists, London.

PART I.—GENERAL TREATMENT IN MANUFACTURE.

t. THE amount of the Drop should always be same in all Feeders forming a portion of one Bellows, although such feeders may, as already seen, easily differ in area. The reason is to simplify calculation in Blowing-action. The two feeders of a Cuckoo will, if of different area, have *naturally* each a different drop, but this is here allowed, because Blowing-action so simple.

It must be strictly borne in mind that throughout this entire description of the Bellows the keys are always assumed to be at the *Front*; that is, the most elaborately treated façade of the Instrument. When keys are otherwise placed such considerations as are involved in the position of the Player must be modified accordingly.

u. It will now be as well to give a little more information with respect to Double-action Feeders, as they are not, except the Vertical, much known in England.

v. The *Hinged Double-action* is simply an ordinary Hinged-feeder, with a second Feeder of same shape hinged to its under surface, both hinges being at same side, and, therefore, close to each other; the under Feeder must be smaller than the other—that is to say, it must not come so far at lug-edge as the upper Feeder, the latter thus overhang lower; the Lug is on upper feeder (same *board* as usual), the valves in the under Feeder are placed as usual (at top surface), those in the board to which Lug is attached are also on upper surface, as usual, but they must, of course, all be over the "set in" of the under Feeder, so to have no communication with latter; a Trunk must lead out from under lower Feeder (near hinge-end is most saving of space) to Receiver. The bottom edge of lower Feeder must always be in contact with something sufficiently strong to firmly resist downward stroke of Lug; and this contact should, by rights, be the entire width of Feeder, so to save Bracing latter, except at sides. The lower Feeder may, if desired, be hooked down; but note it will have a little traversing motion, and both Hooking (if present), and Trunk just spoken of, must accommodate this.

w. This is an excellent form of Feeder, for it not only does not *complicate* but positively *simplifies* Blowing-action; and little if any additional space is required. But it must be in all cases remembered that double-acting Feeders economise only *time* and *space*, and not *power*—at all events, to any great extent. These points in connection with Double-action have already been touched on (6, h. *ante*).

x. The *Whole Double-drop action* may, if choose, be made exactly like preceding, only bs now all parallel, and, therefore, no Another and more common way is to oth Feeders of same size, the lower one complete separate structure, with both and Top-board; the latter is firmly l to Bottom-board of the upper Feeder, rom ½in. to 1in. away from it—that is, that space between the two Boards; ere necessary to keep up the communi- ith the outward air, as one Feeder does overhang the other; the Suckers are at ide of Lower-board of upper Feeder, under side of Top-board of lower of course, Trunk from latter to :. The whole surface of Lowest-board resisted, hooked, if desired. This nent necessitates an extra Board; but ay be avoided by running one or more tunnels through Receiver (Trunk- pen to the air, the valves of Upper ll placed at the *part of Receiver board he Trunk*; the valves of lower Feeder be at upper face of Lower Board, course kept sufficiently clear of ground, low of free feeding. This last arrange- not recommended by Author, for it small an area for the feeding-valves of Receiver, and requires space beneath till, it may sometimes be of use when ery confined, and there yet exists a r the Lower Feeder to draw from.

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[*] All rights reserved.

Double-Action Vertical is, in working, ike preceding (first of the two forms) at the Feeders are all set up on edge; iver is now disconnected, and com- d with entirely by Trunk (often of ble length, as at Winchester l, *see* 7, x., and 20, r.) This kind of used chiefly with Water Motor, and is exceedingly well adapted; in such h Feeder has generally two folds, s more, and there are generally two even more placed together; thus, four Feeders—and these whole-movement e in action at once—that is to say, half stroke, and the remaining half with the troke, and, of course, a very large of wind is supplied; but the force is obviously in same ratio, and, there- n hand-power is used, care is necessary ve too many. Here is the great value gle powerful machine motor. When as two folds, one should be inverted.

enever the Feeder is double-acting, ver should be enlarged in proportion, it unsteadiness. As to do this laterally , in most cases, to lose the advantage om saved by the double-action Feeder, nerally best to have an additional Receiver the same size as the lower placed immediately over the latter, the ds of the two receivers conjoined by o insure exactly uniform ascent. The ivers are, of course, in communication other by the Trunk as well.

If a small Rise be all that is demanded , and these Receivers be large, each ve but one fold—one of the two , of course having Inverted rib. But rable Rise be wished, or if Bellows so at a wide rib materially diminishes acity, it will be best for each Receiver ts two folds—one inverted—as usual.

der separate from Receiver. Some- e Feeder is put at a distance from the ; the communication, of course, by The advantages are:—1. A saving of ide case; 2. A greater steadiness in as any jerk at the Feed is diminished and effect by the elasticity of the of air contained in the Trunk. Addi- ork is, of course, involved, as another required. The Trunk-band, or Box, wever, be often dispensed with.

is is obviously an excellent method se-room inside case is limited, or a sed (as Hydraulic Engine in some hich is at all jerky. With a Rotary e, or driving Shaft, furnished with Eccentrics, &c., there is, of course, of unsteadiness (*see* 17. 1.). *See* also N AND ARRANGEMENT (7, b, and on).

course Blowing-action is always *elabo- ith* parallel-ribbed Feeder, as single ver then sufficient.

TELL-TALE.—*See* own *Department.*

WEIGHTS.—*See* own *Div.* (16, n.)

e. ACTUAL CONSTRUCTION.—The complete Bellows comprehends the following—Boxing, Braces, Doors, Frames, Guards, Hinges, Leathering, Lugs, Panels, Regulators, Ribs, Spines, and Suckers, Ties, and Tie-rods; also Access, and Framing and General Workings. For all these *see* hereafter fully in *Part Detailed.*

CONNECTION OF DIFFERENT PRESSURES.—*See* in LOCATION AND ARRANGMENT (8, w., and on).

f. COMBINATION OR DOUBLE-PRESSURE BELLOWS.—For the Automatic Valve arrangement by which one Blowing-handle or other Actuator is enabled to supply two Receivers not alike in pressure, *see* in ARRANGEMENT (8, y.) and RESERVOIRS (14, j.). That treatment, of course, supposes two independent Structures; but it will be evident that a compact and not very large single Bellows, capable of giving two distinct pressures, will be in many cases very convenient. One such design will now be given.

g. Thit Bellows is made in the ordinary way—that is, with Trunk-band and two Feeders (the number of Feeders is not material), but the Receiver in two instead of in one. The Band also should be 1in. (or 2in. if possible) wider than usual; inside the band, and exactly beneath the division between the two Receivers, will be a Partition placed edgewise, in contact with Receivers, and extending nearly to bottom of box formed by the Trunk-band; from this Partition a Second bottom will extend the entire portion of the space beneath one Receiver, thus cutting off all communication with latter, except through the Partition or Second bottom; there must be sufficient space (½in. to 1in.) between Second bottom and Middle board proper, so as to allow free opening of Receiver suckers at that part. In second bottom, near partition, will be an opening or openings of sufficient size; and on these will be laid or otherwise applied the Automatic Valves, of course arranged to close when the upper board of Receiver has risen to sufficient height. It will be in this Bellows desirable to have (in addition to moveable Feeder and Receiver Panels) the Middle-board to screw to Trunk-band, screws passing through former into latter, heads thus beneath; Feeders "set in" the requisite amount: this decrease of relative area of Feeder surface will diminish defect to be now noticed. First, however, it is necessary to observe that the relative area of the two Receivers should be, if possible, such that the one forming the Reservoir is smaller than the other, so to still further diminish the said defect.

h. The foregoing is, as just said, very handy, but is defective simply because the steadiness is perilled when the lighter Receiver is not in use, for then the Feeder area with *each* stroke will approximate to Receiver area; and this, as already seen, makes, unless with good Blowing, the Receiver *dance*: still this need not be so, for the stroke may always be proportionally *slower*. The defect may be mitigated, first, by reducing size of Feeders (got rid of altogether, of course, if latter small enough, but then the Bellows become as extravagant in material as a complete independent Reservoir (*see* 14, j., and on); 2nd, by so apportioning the pressures that both are almost always in use (this, of course, is difficult, unless the heavier simply take the Treble of everything); 3rd, by having the lighter pressures only for a small portion (as the Choir Organ, taking Gt. Sw. and Ped. with the heavier—this is perfectly practicable and good); 4th, by so arranging that the lighter is always in use (as when heavier take only Ped.)

See all these arrangements fully in APPORTIONMENT (9, x., and on).

i. ONE BELLOWS (RECEIVER) INSIDE ANOTHER.—This has in some cases been done, as in the Organ by Hill, in the large hall at Belfast. It will, however, be obvious that in such case both must be Reservoirs; for the *inner* one must be such, as its rising or falling will inevitably affect and vary the density or pressure of the wind in the outer Bellows; and the *latter* could not rise and fall without interfering with the inner one unless the rise (of the outer) were made so considerable that the advantage of saving space would be neutralised, at all events to a great extent. Neither can the inner be the Reservoir *belonging* to the outer; for this, the outer, must have the heavier pressure, whereas whatever pressure is applie to the outer must be participated in by the inner.

j. Speaking generally, and leaving Reservoirs out of question, there can hardly be a greater mistake than the placing of one Receiver inside another; for even supposing a sufficient supply at the two pressures obtained, there *must* remain this important objection—viz., that while the outer Feeder is inevitably in its *cost* and *momentum* a Large one, it remains in its *supply* and *quick motion* a Small one; so that even if room actually saved, it is at the expense of price and steadiness: there are also the complications of *Tell-tale*, and difficulty of access to the inner Receiver. *See* further in RESERVOIRS (14, s.).

jj. EXHAUST BELLOWS.—These will often be required for Pneumatic Draw-action, &c. An Exhaust Bellows may be simply described as an ordinary one turned upside down; the Lugs of the Feeders thus at the highest instead of the lowest point. The Valves or Suckers must, of course, be suitably placed—those of the *Exhausters* (corresponding to the Feeders) will be at top (outside); those of the *Vacuum Chamber* (answering to the Receiver) at upper side of Middle-board. The Weights will now be attached to the *under* side of Bottom-board, or, better still, laid in on a shelf affixed to latter at a sufficient distance from it to admit them. The Bottom-board should, when quite down, rest on the floor or some other suitable construction; so to prevent the Weights dragging the Folds, &c., too far open, and thus straining them; or, if this be not practicable, the Bottom must be united to the Middle-board by a sufficient number of cords or Ties. Of course, no Waste-valve is required.

It will be seen that an ordinary Bellows can easily be converted into an Exhaust.

k. RESERVOIRS.—*See* own *Div.* (14, j.).

*** LOCATION AND ARRANGEMENT.

l. GENERAL LOCATION AND ARRANGEMENT.—A very excellent and safe rule with regard to the location of the Bellows will be simply this—*keep them outside* the Organ if possible; particularly is this to be desired when the Organ is large enough to allow (supposing Bellows absent) ingress of the entire person to the space immediately at the back of and beneath Claviers, assuming these placed as usual

m. Before, however, going more particularly into exact arrangements under the various circumstances, it will be as well to touch on one or two general points.

n. *Size of Bellows Necessary for Automatic Control of Engine.*—This is gone into under *Div.* of SIZE (15, r.).

o. *Feeder at Distance from Receiver.*—This has already been treated in DESIGN (4, c.); construe what is there said with what is directly given with reference to distance of Receiver from Sound-board.

Necessity and Treatment of Concussion Bellows.—*See* own *Department.*

p. *Distance of Bellows (Receiver) from Sound-board.*—This matter must be touched on carefully—1st, because it is one of great importance (and that in the first *lay* out); 2nd, because there is a great diversity of opinion respecting.

q. The general, though not invariable, belief in Germany, France, and England on this matter (so far as I have been able to ascertain) is, that a Receiver cannot safely be kept much farther from its Windchest than about 12ft., except with the assistance of an (intermediary) Reservoir. Professor Töpfer, of Weimar, has in particular been very strong on this point (observe, I am not giving Prof. Töpfer as an authority on Organ structure, having no exact evidence as to his real knowledge), and French and English builders have constantly worked on this assumption.

r. That this view is, however, partly erroneous is demonstrated by the usage of American builders who happen in this respect to have gone further than ourselves. With Messrs. Johnson, of Westfield, Mass., 30ft. distance *without* Reservoir is not at all an uncommon distance from Bellows (Receiver) to

Windchest; and the present writer can testify, from actual handling of one of their instruments, that it can be done with propriety. The Organ erected by this firm, in the North Congregational Church, Springfield, Mass., stands at some height on a gallery; the instrument itself is lofty, and its Bellows are on the *floor* of the Chamber beneath; there is no Reservoir, and yet the wind supply is remarkably even and firm.

s. It may, therefore, I think, be safely laid down that, except where cost of Reservoir can be easily borne latter may be done without up to length of 30ft. of Windtrunk. At same time I do not wish to speak too dogmatically on this point, and any fresh information will be quite welcome.

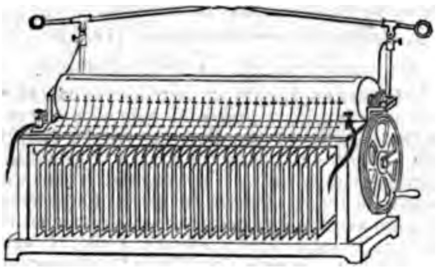
t. Of course, it is imperative that Trunks be larger and corners turned more easily as length increases. For want of this we have in England examples that are not altogether satisfactory. An instance occurs at the Parish Church, Sturry, Kent (by Wedlake), where the distance is rather long (probably about 20ft.), and the space not permitting of a Reservoir, and the Trunk not much, if any, larger than in ordinary cases, the wind supply is unsteady. It is only fair to say that the difficulties to be encountered in this Organ were considerable, and that it yet presents some excellent features.

For exact size, treatment, &c., of Windtrunk under all circumstances see that *Department*.

(*To be continued.*)

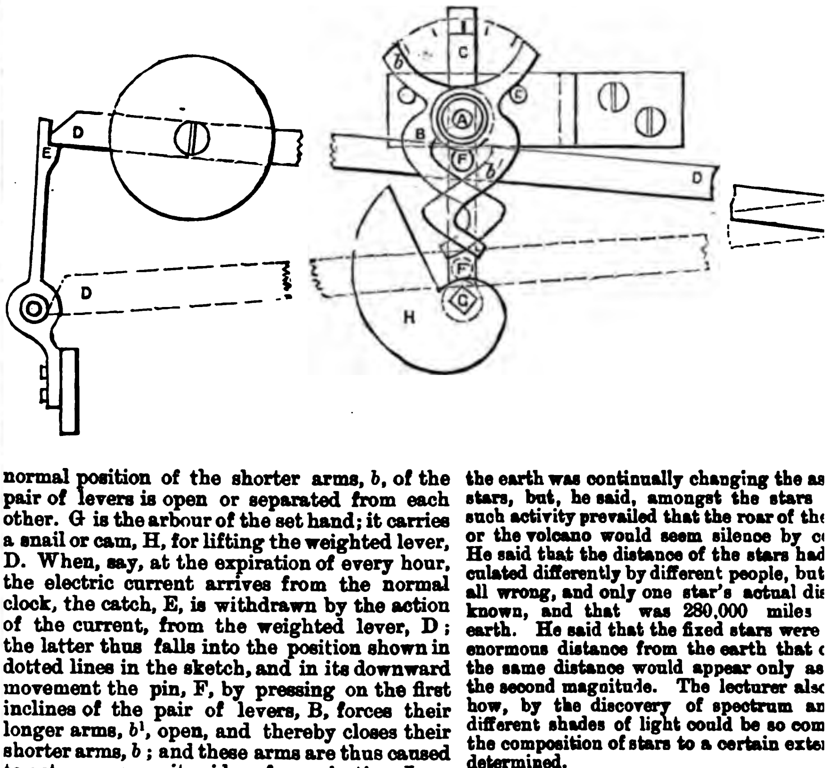
PLANTE'S RHEOSTATIC MACHINE.

A NEW rheostatic machine has been devised by M. Gaston Planté—the outcome of his researches into the static effects of voltaic electricity when studied by the aid of his secondary batteries. Having observed how easily an insulated plate condenser could be charged by means of a secondary battery of 800 couples, M. Planté connected a number of condensers, made up of thin plates of mica and tinfoil, which he disposed in a similar manner to the couples of the secondary battery itself, so as to be able to charge them in quantity and discharge them in tension. All the parts were carefully insulated, the commutator being composed of a long cylinder of ebonite, having longitudinal metallic bands, which united the condenser surfaces, and which were traversed by copper wires, bent at their extremities to facilitate coupling up. Spring-shaped wires were connected with the two armatures of each condenser, and fixed on an ebonite plate at each end of the cylinder, which is capable of being rotated. The following account of his results is given by M. Planté:—If the end conducting wires of the apparatus be brought into communication with the 800-couple secondary battery, even several days after the latter has been charged by two Bunsen elements, and if the commutator be rotated, there is obtained, between the arms at which the armatures of the extreme condensers end, a series of sparks quite similar to those given by electrical machines having condensers. By using an apparatus having but 30 condensers, each of 765 square inches of surface, I have obtained sparks 1·6in. in length. By using a battery of 200 couples I have produced sparks 0·32in. in length. The discharges of static electricity thus obtained are not alternately positive and negative, but are always in the same direction. Hence the loss of force resulting from transformation should be less than in induction apparatus, for, the voltaic circuit not being closed for an instant, there is no conversion of a part of the current into calorific effect. The machine may be kept in revolution for some time, and a considerable number of discharges obtained without apparent enfeeblement of the secondary battery.



SYNCHRONISING CLOCKS.

A METHOD of synchronising the public and other large clocks of a town has been recently invented and practically perfected by Mr. G. Lund, of the firm of Lund and Blockley, Pall-mall. The principal feature of the invention is the means adopted to hold or shift the minute hand of a clock when the apparatus is actuated by an electric current sent from a clock registering true time. The apparatus, as shown in the engraving, is intended primarily for use on turret and other large clocks, but by simple modifications it becomes applicable to clocks of any dimensions. The drawing shows the apparatus in elevation. Upon a horizontal stud or pin, A, is pivoted a pair of levers, B B, one arm, *b*, of each of which is made to act upon the set hand, C (or it may be upon a false minute hand, or upon the counterpoise of the minute hand), of the clock. This arm, *b*, of the lever may conveniently be, and is represented as, the shorter arm. The other or longer arm, b^1, of each lever, B, is of zig-zag form, or consists of two inclines, the inclines of the two levers crossing each other, as shown. A weighted lever, D, which is held up by a catch, E, carries a pin, F, the normal position of which is in the space between the two first zig-zags of the pair of levers, as seen in full lines in the sketch. The normal position of the shorter arms, *b*, of the pair of levers is open or separated from each other. G is the arbour of the set hand; it carries a snail or cam, H, for lifting the weighted lever, D. When, say, at the expiration of every hour, the electric current arrives from the normal clock, the catch, E, is withdrawn by the action of the current, from the weighted lever, D; the latter thus falls into the position shown in dotted lines in the sketch, and in its downward movement the pin, F, by pressing on the first inclines of the pair of levers, B, forces their longer arms, b^1, open, and thereby closes their shorter arms, *b*; and these arms are thus caused to act upon opposite sides of a projection, I, on the set hand, C, and move this hand, and consequently the minute hand, exactly tc zero, should it be either fast or slow; the shorter arms, *b*, again open and free the set hand, C, when the pin, F, on the weighted lever, during the continued descent of the same, by passing down the second inclines of the pair of levers, allows their long arms, b^1, again to close.



A slight dwell or rest may be given to the levers, B, in the closed position of their shorter arms by having a short vertical portion between the first and second inclines or zig-zags. The weighted lever, D, is gradually raised again to its normal position by means of the snail, H, which acts upon it or upon its pin during the next revolution of the set hand arbour, G. In its upward movement the lever, D, has again to open and close the pair of levers, B, to allow the pin, F, to pass, but by arranging the snail, H, so that it does not begin to act until, say, 5 minutes after the hour, the set hand, C, has got clear of the
upper arms, *b*, before they begin
The snail should lift the lever, D, hig
to be caught by the catch, E, say
before the completion of the hour.
to limit the play of the levers. It
that the pin on the weighted lever,
made to act in the reverse manne
described—that is to say, to open th
levers by an upward movement inste
downward one. In applying the arr
to ordinary or small clocks, where the
lever, D, and the snail, H, are unnece
pin (F) which acts upon the pair of
B, being worked directly by the el
rent, the second inclines of the pai
are dispensed with, and the first incl
long enough to prevent the pin (F
their ends. The action in this case i
pin (F), which may itself be the ar
the electro-magnet, is moved in one
by the electric current, and again re
a spring or counterweight. The p
the parts may be vertical or hori
thought best, and the short arms, *b*
levers or pins thereon may pass thro
in the dial so as to act upon the min
or they may act upon a false hand b
dial.

MR. PROCTOR ON THE STAR I

ON Tuesday week Mr. Proctor deliver
lecture in connection with the
School of Science. His subject was
Depths," and in the course of his rema
that, as we gazed up at the stars they a
to be perfectly still and quiet, and yet th
the earth was continually changing the as
stars, but, he said, amongst the stars
such activity prevailed that the roar of th
or the volcano would seem silence by c
He said that the distance of the stars had
culated differently by different people, but
all wrong, and only one star's actual di
known, and that was 280,000 miles
earth. He said that the fixed stars were
enormous distance from the earth that
the same distance would appear only as
the second magnitude. The lecturer als
how, by the discovery of spectrum an
different shades of light could be so com
the composition of stars to a certain exte
determined.

The lecturer exhibited some very beaut
graphs illustrating various views of th
and more especially of the milky way.
that our solar system had been developed
had been entirely upset by stellar investi
conclusion the lecturer said, that inste
nebulæ discovered by very powerful teles
part of another solar system, they wer
part of our own solar system, and we h
been able, even with the most powerfu
ever invented, to get to the outlying syst
doubtless existed beyond our own, and
that the profundity of the heavens was
and would never be fathomed.

ON RADIOMETER PHENOM
LIQUIDS.

(By M. Bergner, in *Annalen der*

MOVEMENTS similar to those in
occur in liquids. Thus, if a torsi
directed by a small magnet, and having
disc of mica, blackened on one side,
other, be hung in sulphide of carbon

r its great diathermancy ard mobility,
:kened side be exposed to the rays of a
ırce, say, a stearine candle, the disc is
:tly attracted, but after a short time
ɔ same occurs if the wall of the vessel
rith the hand. If, however, strong
directed on the disc, it is at once, or
y short attraction, strongly repelled.
torsion balance be hung in water that
l from air by boiling, and then cooled
temperature of the room, consequently
ıthermanous liquid, there occurs, with
n, an extremely slight attraction, but
exposed to strong solar rays, it is at
inctly attracted, and only after a long
pelled.

ıquids, exactly the same phenomenon
air. At atmospheric pressure, except
ısion of the disc, a much less intensity
required in the latter case than in the
adiometer may also be arranged in
·bon, if the vanes of the cross are pre-
vay above described, and its rotation
pretty rapid. In general, the sensi-
vable body in sulphide of carbon is so
s extremely difficult to bring a torsion
o the position of rest.

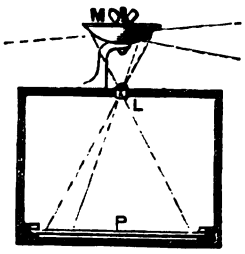
s in air, a rotary movement may be
ıquids by heating the rotary body on
vertical surfaces and ends from within.
longish rectangular case be made of
aving a double wall on one side in one
gth, and a double wall on the opposite
er half. Fill these wall intervals with
h a funnel to the middle of the case,
vhich it may float in water and may
ılso attach a weighted wire at the
ɔ the case in horizontal position, with
at a given depth under the water
case having been brought into cold
with hot water, and it immediately
ı about its middle point, the simple
ıted with ashes, and consequently pre-
ed outer surface, being attracted.

attraction and repulsion through heat
all kinds of non-solid matter, the idea
.t their cause is also everywhere the
ɔ foregoing communication may, per-
letermining the nature of the pheno-
eater certainty than has hitherto been

E OROHELIOGRAPH.

ıpanying illustration we give a diagram
ɔheliograph, which was thus described
oë in a communication to the Photo-
y of France:—"I have the honour to
tographic apparatus intended to pro-
ɔ plate and by a single exposure the
ıprising a nearly complete circle as
position or station from which it is
ıe only interruption in the image
e whole horizon is that which corre-
support of the mirror which forms
ature of this instrument; it thus
f two views be taken, observing that
ccupies a different place in each, a
ɔlutely complete may be secured. The
composed of an ordinary camera in-
ıngle of 90°, as if it were desired to
e sky; it is surmounted by a parabolic
aced at a certain distance above the
s of which is equal to its axis. The
is mirror is to reflect all the luminous
g from the divers points of the horizon,
rate them upon the lens, L, which they
ing upon the sensitive plate, P, under-
ge of the corresponding points. With
ı is obtained, in the form of a circle,
d image of the horizon. The hori-
come naturally curved, but the vertical
deformed; and the angles obtained
e of the circle to the different points
are exactly equal to those formed by
the station carried out to the corre-
s of the horizon and all visible objects
eby. This property makes the appa-
aluable for reconnaissances—for in-
ountainous countries; and it can be
by the aid of two or more panoramic
rom determined places, the operator can
n a map the exact positions of different
alculate their altitude. In this manner
ed, with little labour and expense, the
vas or skeleton of a reconnaissance,
ave any of the details completed by
ıs." It is for this object, in fact, that
has been planned, and called by its
eliograph." The problem was drawn
udent, captain in the engineers, and
Lieut.-Colonel Mangin, of the same
ıs calculated the form and size of the
studied the various optical conditions
necessary to satisfy.

shown to the society is rather primi-
devised to make the first essays. The
free from imperfections, and there is
a sort of astigmatism in the images. The vertical lines are sharper than the horizontal lines. The reflecting surface is badly silvered, and has been injured by want of care in handling; in addition to this the silvering of the exterior is an inconvenience which by another arrangement will disappear, and will permit of obtaining panoramic views without any interruption in their continuity. For all these reasons the print which has been obtained and exhibited does not possess all the perfection desirable, but it largely suffices to show that the final success is assured. The definite and revised apparatus is now in course of construction, and will most probably be made in such a way as to remedy an imperfection to which I have not yet drawn your attention. On the proof before the society it will be seen that the landscape is in a sense reversed; that is to say, the objects which in nature follow from right to left are produced on the print from left to right. If only artistic results were desired, the film could be transferred upon a pellicle and printed from the reversed side, and the inconvenience would then disappear. But for typographical use this manner of proceeding would have bad results in consequence of the varied contractions of the pellicular image, which would render the angles incorrect; this will necessite a modification, for which purpose there are several plans to choose from.



A NEW TOOL.*

A NEW and very useful tool has of late been introduced into the marine engine manufactories of Glasgow, Scotland, and it is likely to find an extended field of usefulness, because it is capable of performing a class of work which is somewhat troublesome to manipulate and usually requires a great deal of hand finishing. With this new tool, however, most, if not all the hand manipulation can be dispensed with.

FIG 1

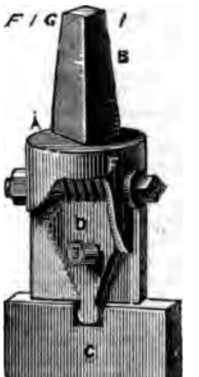
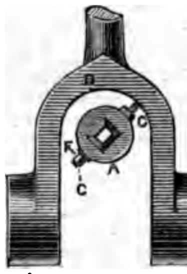


FIG. 2



In our engravings, Fig. 1 shows the construction of the tool, which consists of the stock, A A, with the shank, B, made tapering to fit the socket of a boring or drilling machine. Through the body of the stock is a keyway or slot, in which is placed the cutter, C, provided in the centre of the upper edge with a notch or recess. Into this slot fits the end of the piece, D, which is pivoted upon the pin, E. The radial edge of D has female worm teeth upon it. F is a worm screw in gear with the radial edge of D. Upon the outer end of F is a square projection to receive a handle, and it is obvious that by revolving the screw, F, the cutter, C, will be moved through the slot in the stock, and hence the size of the circle which the cutter will describe in a revolution of the stock, A, may be determined by operating the screw, F. Thus the tool is adjustable for different sizes of work, while it is rigidly held to any size without any tendency whatever either to slip or alter its form. The pin, G, is not an absolutely necessary part of the tool, but it is a valuable addition as it steadies the tool. This is necessary when the spindle of the machine in which it is used has play in the bearings, which is very often the case with boring and drilling machines. The use of G is to act as a guide fixed in the table upon which the work is held, to prevent the tool from springing away from the cut, and hence enabling it to do much smoother work. It is usual to make the width of the cutter, C, to suit some piece of work of which there is a large quantity to do, because when the cutter is in the centre of the stock both edges may perform cutting duty; in which case the tool can be fed to the cut twice as fast as when the cutter is used for an increased diameter, and one cutting edge only is operative. The tool may be put between the lathe centres and revolved, the work being fastened to the lathe saddle. In this way it is exceedingly useful in cutting out plain cores in half-core boxes.

In addition to its value as an adjustable boring tool this device may be used to cut out sweeps and curves, and is especially adapted to cutting those of double eyes. This operation is shown in Fig. 2, in which Ↄ is the double eye, A is the tool stock, F is the adjusting screw, and C is the cutter. The circular ends of connecting rod strips and other similar work also fall within the province of this tool, and in the case of such work upon rods too long to be revolved this is an important item, as such work has now to be relegated to that slowest and most unhandy of all machine tools, the slotting machine. The tool was invented by one of the engineers of the Transatlantic steamships, who unfortunately neglected to patent it.

DEATH OF THE "HARMONIOUS BLACKSMITH."

WE are sure all the old readers and correspondents of the ENGLISH MECHANIC will learn with regret that the "Harmonious Blacksmith" (Mr. Alfred Savage) died on the 8th ult., aged 69 years. His many contributions must be remembered by all except recent readers, and his absence from the pages of our later volumes has often been regretted by ourselves and others. His letters were always so full of information on the subjects to which he devoted his attention, and withal so humorous and interesting, that no one could help missing them. Other correspondents have to a certain extent occupied the ground he once held, but we always felt indebted to him for having in the earlier days of the existence of this journal so freely given so much valuable information on subjects concerning which his knowledge was probably unparalleled. The removal by death of one after another of the old correspondents of the ENGLISH MECHANIC reminds us every now and then of the fact that the journal itself is growing in years. We can all of us, as we succeed each other in our generation, whether as contributors or readers, in our efforts to maintain its usefulness and position intact, best insure the most fitting memorial of ourselves in the hearts and minds of those that follow us. None can hope more effectually to do this than did the "Harmonious Blacksmith," and those who gratefully remember his services will best manifest their appreciation thereof by emulating them.

PHOTOGRAPHY ON PORCELAIN.*

PHOTOGRAPHIC miniatures upon porcelain are the most exquisite pictures produced by the art. From practical test the following formula is recommended for obtaining, with uniform success, superior porcelain pictures, possessing strength, beauty of tone, and permanency.

Albumenising the Plate.

Dissolve three grains of chloride of strontium in four drachms of water, and add to the white of one egg, beat to a stiff froth, let settle, and filter through sponge. Clean the porcelain plate by laying in acid for several hours, wash thoroughly, and when dry wipe with flannel dipped in alcohol, and rub dry with clean flannel; remove particles of dust with camel's-hair brush, and flow on the albumen cold, drying it in over-heat. Plates thus prepared can be kept any length of time, and are ready for use.

Sensitising the Plate.

Dissolve one ounce of nitrate of silver in twelve drachms of water (by grinding the silver in a glass mortar and adding the water.) Take from this four drachms into a clean graduated or wide-mouth bottle, and add thereto, by drops, liquor of ammonia, which will brown the solution; continue adding until it is clear, then return to the eight drachms of plain silver, which will brown all the solution; add by drops the nitric acid C. P. until it is clear; then add the twelve drachms silver thus treated to twelve ounces of 95 per cent. alcohol, stirring while adding; filter, and it is ready for use. This solution will keep for any length of time, and when it requires replenishing make new, and mix with old, filter, and it is ready for use.

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* From the *Scientific American.*

* From *The Photographic Rays of Light.*

When wanted for use filter, pour into a clean bath-holder, warm the plate, and dip into the bath, let remain therein two minutes for polished plates, and three minutes for those with a ground surface; remove from bath, let it drain, then flow with 95 per cent. alcohol, pouring on the corner sufficient to cover the plate. A repetition of this upon a different corner of the plate may be required before the plate presents an even surface; when the plate is drained, and dried by heat, it is fumed from five to ten minutes. Should a vapour appear after fuming gently heat the plate, and it will disappear. Print a shade deeper than for paper.

Toning the Print.

When printed place in acid water in proportion of half an ounce acetic acid to sixteen ounces water, let remain therein for several minutes, or until the picture is changed to a uniform red tint, then wash in several changes of water or under a tap, and tone in a solution prepared the same as for paper prints; examine the progress of the toning by transmitted light; care must be taken not to overtone the print. When toned wash, and place in the fixing solution, prepared of one ounce hyposulphate of soda dissolved in ten ounces water; fix from five to ten minutes, then wash under a running stream from ten to fifteen minutes; dry over a gentle heat.

For prints to be plain or tinted, plates with a polished surface are used; for fine artistic finish in colours, plates with a ground surface produce the desired results. Photographic prints upon watch-dials can be made in the same manner. A few specimens made by this process, displayed in handsome velvet cases or frames, will result profitably to any establishment.

SOME RECENT IMPROVEMENTS IN THE METALLURGY OF NICKEL.*—III.

By Alfred H. Allen, F.C.S.

(*Vice-President of the Society of Public Analysts.*)

THE following are analyses of nickel obtained by Christofle from New Caledonian ore. No. 1 was melted nickel obtained by a wet process. No. 2 was manufactured by a combined wet and dry method:—

	No. 1. Per cent.	No. 2. Per cent.
Carbon	1·25	——
Silicon	·54	·13
Copper	——	·50
Manganese	·36	——
Iron	——	1·60
Nickel	97 75	98·00
	99·90	100·23

As in case of iron the presence of carbon or silicon greatly promotes the fustibility of nickel. Pure nickel is well known to require a very high temperature for its fusion, and when this difficulty is overcome, it is difficult to obtain the casting free of bubbles. Professor Winkler has recently achieved great success in this direction, and has obtained large and compact ingots of pure nickel and cobalt by insuring a sufficiently high temperature, suitable pots, taking precautions to keep out carbon and silicon, and casting in an atmosphere free from oxygen. For the fusion he employs a porcelain crucible embedded in a magnesia packing contained in a Hessian clay crucible, which last is inserted in a graphite crucible and imbedded in fire-clay. To obtain castings free from bubbles, it is found necessary to pour the metal into the mould through a flame of burning petroleum.

The casting of the nickel plates to serve as anodes for the electro-nickeling cells has recently become necessary. The melting is effected in ordinary steel pots with the addition of a little borax or other flux.

The following analyses of a nickel anode is due to Mr. W. E. Gard. They are interesting as showing the effect of the electro-chemical action. A is the original anode, and B the same anode after the loss of upwards of 50 per cent. of its weight by solution in the electro-nickelling vat:—

	A. Per cent.	B. Per cent.
Carbon	1·10	1·90
Silicon	·13	·26
Sulphur	·30	·10
Iron	·11	·31
Cobalt	trace	trace
Nickel	98·36	97·43
	100·00	100·00

A very useful addition to nickel to be cast into plates for anodes is a small proportion of tin. It adds considerably to the fusibility of the metal without causing any subsequent inconvenience.

The process of depositing nickel by the battery is one which is now very extensively carried on, and has been the subject of more than one lawsuit.

Practically, the only solution employed for the electro-deposition of nickel is that of the double sulphate of nickel and ammonium. It seems important to avoid the presence of fixed alkalies, and nitrates are also said to be prejudicial. In the patent granted to Brookes, elaborate precautions are taken to ensure the production of a pure nickel salt, and the company interested in working this process appear to have been disagreeably astonished to find that such precautions were unnecessary.

Besides patents for the deposition of nickel from solutions containing the cyanide of nickel and potassium, the tartrate of nickel and potassium, and the chloride of nickel and ammonium, several patents have been taken out for the use of the double sulphate of nickel and ammonium. In the course of an inquiry into the details of one of those processes, I observed a very curious fact, which I subsequently incorporated in a specification drawn up for the use of my clients, and which I see has formed the foundation of a recent patent described as the invention of a Mr. John Unwin.

Although the double sulphate of nickel and ammonium ($NiSO_4 + (NH_4)_2SO_4 + 6H_2O$) is readily soluble in water, even more so than the sulphate of nickel itself, it is almost insoluble in liquids containing much sulphate of ammonium. Hence, if a strong solution of ammonium sulphate be added to a liquid containing sulphate of nickel or sulphate of nickel and ammonium, a beautiful light blue crystalline precipitate of the double sulphate is thrown down, and the liquid becomes nearly colourless. So complete is the precipitation, that the method may be used to precipitate the nickel in old vat liquors.

Excess of sulphate of ammonium causes a similar precipitation in a solution containing sulphate of magnesium or ferrous sulphate, but not in a solution of ferric sulphate. The ferrous and magnesium sulphates are not precipitated with nearly the same ease as the nickel sulphate, but, in presence of the last salt, they are more or less dragged down with the nickel precipitate.

As iron in the ferric state is not precipitated, the impure solution of nickel sulphate obtained by the solution of metallic nickel in a mixture of nitric and sulphuric acids, can readily be treated with excess of ammonium sulphate, and the precipitated double sulphate of nickel and ammonium separated, washed with water containing sulphate of ammonium, and redissolved to prepare the nickel-plating bath.

The solution for depositing nickel should not have a higher density than about 1,030, and should be kept rather alkaline than acid. The current must be carefully regulated, or the deposit loses its lustre. A coating of any thickness may be deposited, and almost any metal may be covered. The deposit of nickel is especially suited for iron and steel articles. A number of specimens of nickel-plated articles are on the table. I am indebted to the Sheffield Nickel-plating Company for the loan of them. The deposit is but little liable to tarnish in a fairly dry atmosphere, but it is unable to withstand the influence of continued damp. For fire-irons, polished fenders, and other comparatively large articles of steel and iron, it is very well suited; and for coating surgical instruments, and similar articles of steel, its use is daily extending.

It has been proposed to employ a magneto-electric machine for separating metallic nickel from the crude solution of the ore, but I am not aware that the process has been actually carried into effect.

The discovery of the New Caledonian deposits will, no doubt, before long, cause a great extension in the application of nickel and its alloys, while, at the same time, from the neglect of the old ores and processes, cobalt compounds will become more expensive.

THE TECHNOLOGY OF PAPER-MAKING.—XII.*

The Various Classes of Paper; Characteristic Differences. The Determination of the Ash or Loading. Water Supply. General Arrangement and Construction of the Mill.

WE have now to consider the method of estimating the amount of ash or loading in paper. In all well-conducted establishments this operation is now very frequently conducted so as to control the use of loading matters in the mill. Paper-makers, as a rule, quite realise the importance of this, and we are convinced that in many other departments of the trade equal vigilance would be equally repaid. The following apparatus is necessary for the successful and rapid execution of the process:—A balance weighing two-tenths of a grain, a platinum capsule,
about 2¾in. in diameter by 1⅛in. deep, a t
pipe-clay support for the capsule, a pai
tongs to lift it with, a piece of platin
direct the hot air into the capsule, a piec
wire rounded at the ends, and a good ⅝in
burner. The operation in itself is ex
simple. Fifty grains of the sample torn i
pieces are weighed and placed in the capsu
venient way is to balance the capsule in t
and weigh the paper in it. The capsul
contents are then placed upon the suppor
burner, the flame of which must be con
that it will be quite smokeless. By ca
capsule a little, and placing the platina fo
so as to cause the flame and hot air to pla
the fragments, the carbon will be burned
more quickly than when it is left open.
sional stir with the end of the brass wire
fresh portions of the ash to the oxidising
the current. The burning should be t
effected in from ten to fifteen minutes.
capsule has been allowed to cool complet
be placed, with its contents, on the balan
weight of the residue ascertained; this,
by two, will give the percentage quantity c
matter. Allowance will, of course, be ma
normal ash of the paper. The ash, as a r
quite white; but, depending upon the co
of the paper, it may either be grey or r
good supply of gas should be provided for t
or the work will be tedious.

The character of the water supply of a
largely influences the character of the
duced. Of course, I do not refer to any
may be available for power, but to tha
essential for washing and diluting the pu
in every way suitable for the production o
classes of paper this water should be quite
colourless, free from all visible impurity
also from the dissolved chemical impuri
and iron. It is but rarely that we meet
possessing all these qualities in a high d
the supply is obtained from a stream it m
taminated with colouring matter derived
table sources, and at certain seasons it cer
be impure from mineral and other matte
into it by the rain. To insure a constant
known quality from such a source a res
filter will be necessary. The former
large enough to contain as many days'
the mill as experience has shown necess
over the periods during which the floo
seriously impure. If the normal condit
water supply is such as to involve const
tion, then the filters must be extensiv
arranged that a portion of the syster
cleaned out at any time, while the remain
at work. For every 1,000 gallons of
quired per 24 hours you must have a filt
of from one to one and a half square y
most suitable materials are sand and grave
in three or four layers, fine washed san
the upper stratum. Drain-tiles will, of
laid pretty thickly in the bottom; and i
tageous to have a few vertical air-pipes
cating with the drains; these are especi
able when running the water on to the fi
first time. But the water may be quite
colour and suspended matters, and still
suited for the purposes of the pa
It may be hard, or alkaline, from
sence of lime salts, which will r
the chemicals used at all the stages of t
detracting from their effect, and inv
use of larger proportions than would ot
necessary. Of course, the extent of this
be but slight, but, on the other hand,
serious, depending upon the proportion
the water, and the volume of it used in
operations. There is no good or readil
means of overcoming the difficulty.
agents may be used to remove a portion
and magnesia; but the use of them in
labour and expense, and it is question
cost will not in every case exceed the ga
the evil is really a serious one an effort
made to collect surface water, and apply
portions of the process where soft wat
desirable. If the water is contaminated
it will be quite unfit for pure white pa
iron is precipitable from its solution by a
when so precipated it cannot but affect
the paper. Of course, the quantity n
indeed, it usually is—almost infinitesima
case it may be disregarded; but, if it sho
to anything like a grain to the gallon, i
must be prejudicial. Hofmann, in his wor
says if water contains only one-fiftieth of
of iron it will be prejudicial. As there
grains in an imperial gallon, the quanti
to will be equal to about 14 grains per
such waters exist at all in the proximity
mills, give them a wide berth, as they
unsuited for any but medicinal purposes.
be the nature of the supply or its source,
desirable to have a couple of days' suppl
the mill, in case of accidents. This will
pumps, necessary when the source of su

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* A paper read before the Chemical Section of the Society of Arts.

* Being the substance of the Cantor Lectures delivered before the Society of Arts by Mr. W. Arnott, F.C.S.

uled from time to time. When the iped direct into small supply cisterns, f a pump becomes a serious matter. of water used per ton of fine printing ed should not exceed 40,000 gallons, rious precautions as to boiling, washing machine water, which I have indi- ime to time, be adopted, the quantity ian 30,000 gallons. Writings will take e lower qualities less.

er days of the paper trade, water for ses was considered indispensable, and, atively recently, the idea of building a ay from water-power would not have ed. The development of our coal-fields ystem, with the introduction of esparto s, have, however, completely changed s of success. No doubt water power an element of importance, but cheap for bringing the raw materials into the mill, and removing therefrom the ct, coupled with an abundant supply ug water, and a ready outlet for the o far to compensate for the absence of if it comes to be a choice between e or the other, and not both. The ary to keep a 100-inch machine mill 250 horse-power; and no doubt if any roportion of this could be got steadily it would be valuable. Water at the r, is very fluctuating in amount; and ll perhaps, above all other industrial s, requires a perfectly steady power. ecessary, independently of what may o furnish or supplement the driving siderable; and it will often be found er price of coal at one place com- other will be of more real importance stence or non-existence of so much

This leads me to say, in reference to of a site for a paper-mill that due re- e had to the following among other e possibility of obtaining a copious e soft water; proximity of railways, bility of getting a siding into the work; port for arrival of esparto; ready od coal at cheap rates; skilled labour l house accommodation for the same; efuse matters, both solid and liquid, isk of interdict as a nuisance; and, if lable water-power. In constructing a e plan should be well considered, so us operations, including the moving of m one place to another, may be with the smallest expenditure of labour. embered that the materials in process into paper continually descend as they the mill. They are first put in at the ler, then discharged from the bottom, to the breaking engine over the harged from the bottom into the the bottom of which they discharge raulic press. At this point there is ak in the gravitating process, hoists lift the pressed half-stuff to the level engine; from the latter it discharges chine chests, and thence on to the . If this hoisting can be avoided, so ter. It is seldom, however, that a site d where the whole process will go on lifting.

ngs should all be roomy, with high ell lit and ventilated. It is a mistake at work can be either well or cheaply , confined, ill-ventilated apartments. of workmen will grow up under the enne of cheerful surroundings, than sing atmosphere of a close, crowded, mill. The machine-house especially ventilated, and this must be arranged y that there will be no possibility of t, the effect of which would almost to precipitate blacks and dust of all e web, to its permanent detriment.

ount of vapour constantly arises from sing over the drying cylinder, and s speedily removed it will condense, m all parts of the roof, &c. Various been devised for the ventilation of es, and some of them have, no doubt, satisfactory. Boyle's ventilator, splendidly when there is a good de, does but little work when the outside is still. The Archimedean tor has been extensively adopted, and atisfaction, especially when driven by he mill shafting. This insures a con- , which would fail in calm weather—stoppage or slow motion of the screw n was dependent, as it is in the case such like, upon the power of the wind

Another system is to have a double haft rising from the roof, with the so arranged that soot and dust cannot ards.

boilers should be situated having a e easy access of fuel, and the points eam is most largely to be consumed. They should be of ample power, so that they will not require to be fired heavily. It is a great mistake, working with insufficient or indifferent boiler power, or with boilers that are not in first-class condition. Steady, careful firing in thin layers, in alternate furnaces, will give very economical results compared with heavy, reckless firing, conducted under the impression that, as the steam is difficult to keep up, the correct thing to do is to pitch on as many coals as possible. Let the quantity of smoke constantly issuing from the chimney-top speak to the absurdity of the practice, and also the blacks which a foggy day will inevitably bring down to pollute the product. Mechanical stokers are, no doubt, very good things, but they are only necessary when men and master are alike careless or ignorant of the principles involved in the combustion of fuel. The exposed portion of the steam boilers, as well as all the pipes leading the steam through the mill, should be coated with non-conducting materials. The sludge settling from machine and engine waters, mixed with a small proportion of rough fibre, makes a very good coating agent. The boilers should be blown down a few inches every shift, especially if the water is in any way hard; and they should all be insured, much more for the sake of the systematic inspection which that involves, than the securing of a few hundred pounds in the event of their blowing up.

USEFUL AND SCIENTIFIC NOTES.

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The Heat Value of Fuel.—With regard to the important question of the heat value of fuel it has been proved that conclusions from the results of elementary analysis are very uncertain, and also that little reliance can be placed on direct vaporisation experiments. In a recent paper to *Die Chemische Industrie*, Dr. Weyl points out the faults of these methods, and recommends, as preferable, decomposition of the fuel by dry distillation, and analytical determination of the solid, liquid, and gaseous products of decomposition. In this method the accident of too small a sample being used is avoided, as also too great pulverisation and drying at high temperature, and the decomposing action of atmospheric oxygen, which is therewith connected; and the whole of the coke is weighed, and its carbon, hydrogen, and mineral constituents determined. The water, tar, and gas that are formed are measured, and their heat of combustion ascertained with the aid of data that have been supplied by Favre and Silbermann, and Deville. The final result will, of course, exceed the true combustion value of the coal by the amount of heat equivalent to the work of decomposition into coke, tar, and gas. The decomposition of the coal should be done as quickly as possible and at a high temperature.

The Old Age of a Planet.—Mr. R. A. Proctor, on Monday week, gave a lecture at the London Institution on "The Old Age of a Planet," being a sequel to the lecture of the previous week on the youth of a planet. The duration of the various phases of a planet's existence depends, cæteris paribus, on its dimensions, and the planets smaller than the earth were referred to as representing various stages of planetary old age. Venus, which is nearer to the sun than the earth, and, therefore, probably of later birth, is also smaller than the earth, and is, theoretically, either in the same stage of planetary existence or even less developed than our planet. The evidence gained by telescopic observation accords with this view. It has recently been noticed that in certain phases we catch the illumination of what are regarded as the oceans of Venus, though some have, as Mr. Proctor considers, wildly interpreted the phenomena as indicating that Venus has a metallic surface inclosed in a glassy envelope. About Mercury we know too little to express any very confident opinion, but being near the sun and being probably therefore the last born of the planets, his small globe would pass quietly through the stages of planetary life. Of Mars we know more. Being much smaller than the earth, and also more remote from the sun, and therefore probably of earlier birth, this planet might be expected to have reached a much later stage of development, an inference which facts observed by the telescope support. Our moon, a still smaller planet, and certainly as a fully formed planet older than the earth from which it was thrown off, gives still better opportunities of telescopic observation, and is theoretically most likely to tell us of the old age of a planet. It seems to all intents dead, without air (or having air of extreme rarity) and without seas. There can be hardly a doubt that many of the features observable are the result of extinct craters, though some of the smaller of the circular markings, Mr. Proctor thinks, are the result of the falling into the moon's mass of meteoric bodies at a period prior to her attaining rigidity. Though we see some planets that have reached the death-like stage and others slowly tending towards it, yet when we look with still wider scope we see some of our own solar system, and some of other systems, perfecting towards the life period. The heat and light of one particular system is not lost, but go to keep up the eternal interchanges of cosmical vitality.

SCIENTIFIC SOCIETIES.

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IRON AND STEEL INSTITUTE.

THE spring meeting of this institute was held last week at the Hall of the Institution of Civil Engineers, Great George-street; Dr. C. W. Siemens, President, in the chair.

Report of the Council.

The Council, in presenting the ninth annu report, said they had much pleasure in being able to congratulate the members on the continued prosperity of the institute. The total number of members exceeds nine hundred. There continues to be a steady accession of new members, contributed both by this and foreign countries, forty-seven being proposed for election at the meeting. The council submitted to the meeting of members held at Newcastle in September last, a proposal for the establishment of a fund designed to recognise Mr. Jones's services, and to aid his widow and family. This proposal was unanimously approved of, and a committee was appointed to carry it into effect. The council have the pleasure of announcing to the members that the handsome sum of £2,318 has been raised in response to the appeal of the committee, including £117 contributed by the Newcastle Reception Committee. The deaths of the foreign and general secretaries created vacancies which have been filled—the former by the appointment of M Doby, of Brussels, the latter by the appointment of Mr. J. S. Deans, of Darlington. The reception of an invitation from M. Tresca, on behalf of the Société des Ingenieurs Civils, to visit Paris in the ensuing summer, and the concurrent holding of the International Exhibition in that city, have induced the council to recommend that the next autumnal meeting should be held in Paris.

The Bessemer Medal.

After the Secretary had read a letter from Professor Tunner, expressing regret at not being able to attend the meeting, the President said: Thanks to the liberal provision made by Mr. Bessemer, it was the pleasure and duty of their president, at the beginning of each year of office, to present the Bessemer gold medal to the gentleman who, in the opinion of the council, had distinguished himself in the branch of applied science which they themselves cultivated. The choice of the council had fallen this year upon a gentleman who (he thought) was pre-eminently entitled to the distinction. They all knew Professor Tunner from his works. Professor Tunner was at the head of a very ancient iron district. Styria had produced for centuries iron of very high merit. The cutler of Damascus had for centuries forged his blades of Styrian iron—at any rate Styrian iron had entered largely into the composition of his material; and he remembered that when, in 1851, the international jury made certain experiments upon the scythes sent from Styria, they were perfectly surprised to find that the keen edge of those implements would, without injury, cut off the head of a nail. That high class of material was not to be attributed simply to the skill of the operator. Nature had been very kind to the ironmaster of Styria in providing him with a spathose ore of extraordinary purity, and providing him with fuel in abundance of the highest quality in the form of enormous forests. Still, with all those advantages, results such as we hear of would not be realised without the skilful application of scientific knowledge. They were very proud of their achievements in blast-furnaces, but the Styrian furnace—although a different instrument from the blast-furnaces in this country—was one of peculiar merit, and the economical results which had been obtained were very surprising. He (the president) learned that a ton of iron was smelted with something like 13 cwt. of charcoal, which result was a remarkable one, although, of course, it had no connection whatever with the results obtained from the coke and inferior ironstone in this country. Professor Tunner might be said to be the leading spirit of that centre of industry. He need not here enlarge upon his works, which were well known to them, and which were largely quoted in their own excellent metallurgy by Percy; but Professor Tunner had for many years been active in calling into existence—or producing—young metallurgists, who had done good work in Austria, and who had also given to them indirectly some benefits. They were now receiving a large supply of ferro-manganese from the district of Styria—a material which they could not produce from materials of their own.

Mr. I. Lowthian Bell said, he accepted, with feelings of very great pleasure indeed, the duty which the president had imposed upon him—namely, that of conveying to his friend Professor Tunner the mark of high esteem in which the Iron and Steel Institute in this country held him.

The President stated that the first ordinary business on the agenda was a discussion of one of Dr. Percy's papers read at Newcastle—

The Protection from Oxidation of Metals by a Coating of their own Oxides.

The discussion was then commenced by Mr. Baker:—Dr. Percy, they would recollect, alluded to, and brought forward as an instance of that excellent coating, the fact of the Russian iron. Now, it would be in the knowledge of all gentlemen connected with iron and steel, that where the rails were wetted, as they usually were, and sheet steel was going through—say, for the making of pen-steel—they had a coating of very excellent character, and very much analogous to that produced by Professor Barff's process; they might bend that sheet steel about without detaching the beautifully perfect scale which was upon it. He might also call attention to the glazing of the furniture on guns, which is done by charcoal. There, again, he thought the same condition obtained, but it was curious that they did not get that very perfect resistance of oxidation that appeared to have been done by Mr. Barff, in carrying it out, he might say, perhaps in a more scientific way. With copper, he had also, as other chemists perhaps have done in the laboratory, had experience of the beautifully coloured oxide of copper which occurred very often on the surface of copper which had been wound round the combustion-tube submitted to gas. They got there a coating of the oxide which wonderfully resisted every action, but he must say he thought Dr. Percy had adduced one instance of the protection of metals by oxidation, which appeared to require more examination to show that it was an absolute fact.

Mr. Snelus asked if it would be possible to get some information from any of the members as to the practical method of carrying out the process? Mr. Barff's paper (which he had read through carefully) gave them no information at all as to how the process was carried out practically, and he dare say there were many other persons like himself who were anxious to make some experiments upon the matter, if they knew exactly the *modus operandi*, so that they might not go blundering about in the dark. At present there had been no description of a practical method of carrying out Mr. Barff's process on a practically large scale.

Mr. Nursey was understood to say that results of investigations he had made so far back as 1862, showed that the pipes of a boiler were coated internally with a protective lining of oxide, through the action of the superheated steam. It was stated by Professor Barff that the process could be applied to bridges and roofs and large pieces of iron. He doubted whether, except under very exceptional conditions, that application could be made, and if made, he (Mr. Nursey) thought it would be very undesirable to introduce a material so treated into constructions of any kind.

Mr. I. Lowthian Bell, M.P., said he very much questioned the truth of the last observation made by his friend Mr. Nursey—viz., that oxidising iron by superheated steam must necessarily weaken it, because they all knew the common mode of annealing boiler-sheets was by exposing them to a high temperature for a considerable time, and letting them cool gradually. With regard to the mode of carrying the operation into effect, he, with his friend Mr. Snelus, would like to know the industrial method followed by Mr. Barff; but there was no secret as to how the Russians carried out the process, because that was mentioned in a paper read by Dr. Percy himself. The steam which had to oxidise the iron was removed along with the iron, and he had no doubt the operation of converting the iron or the oxide was effected by the juice of the wood. With reference to the use of it, he himself had seen in the United States many locomotive engines covered with that material, *i.e.*—engines covered with material made in the Russian fashion, and it was impossible to conceive any substance that preserved its brightness, and absence of tarnish longer than did the iron described by Dr. Percy.

Mr. Baker also opened the discussion on Dr. Percy's other paper—

On the Cause of the Blisters on "Blister Steel."

Mr. Baker said he would just exhibit what was being done daily in Sheffield for the purpose of utilising, perhaps, some of the materials, but also for the purpose of producing a certain quality of steel. He had examined a large number of those re-conversions and failed to see any blisters, which was an additional proof, if it were required, of Dr. Percy's idea that they were formed entirely by the operation of oxide of iron being embedded and entangled in the mass.

The President said that, as no other gentleman wished to speak, he would close the discussion, adding his own testimony in favour of the views expressed by Dr. Percy. He himself had seen steel produced by fusion, subjected to heat, embedded in charcoal for a length of time, and had never seen the slightest trace of blister upon it, which, at any rate, was an indirect proof that where there was no oxide enclosed in the metal blisters were not formed.

Mr. I. Lowthian Bell, M.P., then read a paper on—

The Separation of Phosphorus from Pig-Iron.

This paper was a continuation of two preceding ones on the separation of carbon, silicon, sulphur, and phosphorus in the refining and the puddling furnace and the Bessemer converter, confined, however, to the behaviour of carbon and phosphorus when fluid cast iron is exposed to the action of the fused oxide or oxides of this metal. A marked changed is undoubtedly produced by this operation in cast iron. About 33 per cent. of the carbon and 60 per cent. of the silicon are thus removed; but the phosphorus is only slightly affected by the treatment, while the iron sometimes absorbs sulphur from the coke employed in the operation. The writer's claims to novelty are confined to his discovery of the influence of temperature in modifying the order of rapidity in which carbon and phosphorus leave pig-iron when exposed to the action of oxide of iron in a state of fusion. Many experiments and analyses were quoted to prove that at a temperature just sufficient to keep the substances liquid, the phosphorus was eliminated more readily than at a much higher temperature. As to the adaptability of the purified iron for steel, Mr. Bell feels bound to admit that if 0·1 per cent. has to be considered as the limit to which phosphorus can be tolerated in steel, he has still to look forward to the future for the realisation of his hopes. The main result of his experiment was, that 8 tons of iron, containing on an average above 1·5 per cent. of phosphorus, had this impurity diminished to 0·229 per cent. The uniformity of results in working this process appears to be rather a question of mechanical arrangement than one of chemical difficulty. Some experiments on the conversion of this purified iron into steel were carried out at Woolwich by Mr. Price, and the results were quoted, and samples shown.

Professor Williamson said he rose to congratulate the institute on having received so extremely valuable a report upon that subject. The additional knowledge with which Mr. Bell had favoured them beyond that which was communicated at Newcastle was, in several respects, as members had no doubt noticed, of considerable importance. He would not presume, after the account with which Mr. Bell had favoured them, to go into any analysis or particulars of his experiments, because, of course, that would claim very great attention, and depend upon the particulars in each case, in order to obtain the results recorded; but many of his results appeared already to be of considerable importance, and especially those which showed the importance of regulating the position of what he might call the washing materials, oxide of iron, rendered fluid partly by silicon and partly by other materials, by which the removal of the silicon and phosphorus had been effected. Of course members were perfectly well aware that in the operation the oxide of iron had to do two things, as, in fact, Mr. Bell so clearly pointed out. One part of it had to supply oxygen to the phosphorus, which had to be removed, of course, thereby being reduced to the metallic state of iron; whilst another part had to lay hold of, and to keep hold of, the phosphoric acid which had been formed. Now, he noticed among the earlier statements of Mr. Bell's paper, a summary of the average of oxide of iron, which, according to the particular proportion, would be required to remove the phosphorus from a ton of pig. The quantity was considerable—ten cwt. to the ton. Now he had no doubt whatever that it had occurred to Mr. Bell to diminish the amount of oxide of iron which was used by replacing that part of it which had not got to give up oxygen, but which had merely to act as a base—either lime or some other base—which was of comparatively little value. Of course any base which was strong enough at the temperature at which the operation was performed would do instead of oxide of iron to keep hold of phosphoric acid when it was formed, and it was of course well known to all members that if instead of having chiefly one base present in their cinder or slag, if they had several—perhaps with one or the other bases in addition to oxide of iron—that they would thereby favour one condition which was apparently of great importance in this operation—namely, the fluidity of the mass. Of course salts of silica containing a good many bases were, as a rule, more fusible, and required a lower temperature in order to be made liquid, than silicates of one base, or of few bases, and he had very little doubt that Mr. Bell, who was so keenly alive to all the conditions which bore on that great problem which he had worked out, had already had occasion to replace some of the oxide of iron which had been present in these experiments by another base, or other bases, for the purpose of doing that part of the work which oxide of iron was intended to do.

Mr. Snelus said Professor Williamson had spoken about what he considered of the utmost importance, and it so happened that he had hit upon the nail which he (Mr. Snelus) had been trying to drive home for a considerable time. Six years ago he took out a patent for using lime for the lining of puddling and other furnaces. That patent was still valid, and he had refrained from saying anything about it at these meetings, because he knew the value of the essence of the thing, and for the last six years he had been trying to devise some mechanical means for applying it in practice. He believed he had succeeded now in doing so, and he should not have risen on the present occasion, nor, indeed, until it had been perfected in practice, had it not been that Professor Williamson had raised the question as to the effect of using another oxide in order to do the duty which Mr. Bell made the oxide of iron do in double proportion. Professor Williamson had mentioned the oxide of iron in Mr. Bell's process as doing a double duty. It had done that of supplying oxygen to the phosphorus in his molten metal; the oxide of iron had also done the duty of combining with the phosphoric acid so produced, and many years ago the same idea occurred to him (Mr. Snelus). He put it into practice, and he had told casually a good many members of the institute six years ago that he had succeeded in reducing phosphorus in Cleveland pig-iron down to under 0·1 per cent., using limestone as the lining of his furnace, and the president would remember, no doubt, that he attempted to use the same material in his revolving furnace. He (Mr. Snelus) went to see it at work at Birmingham, and there was a difficulty in using it. It occurred to him what the difficulty was. He thought still, as he thought then, that it was simply one of temperature. The revolving furnace was not an instrument in which so far Mr. Siemens had been able to get up a very high temperature—certainly not as high as he had been able to get in the fixed melting furnace—and the consequence was, that, in the experiments which were tried at Birmingham, the lining material of lime did not get sufficiently heated to get hardened, and that involved the lime peeling off, and mixing with the ball of iron, and there was considerable difficulty in dealing with the material under those circumstances. Previous to that he had himself lined a Bessemer converter with limestone, and he might mention that the result he got there from 3 or 4 tons of iron so treated, perfectly corroborated the fact that he had ascertained in dealing with a hundred-weight and a half of iron—that the phosphorus was almost perfectly eliminated under those circumstances. In the Bessemer process he thought there were practical difficulties in applying the lime in a Bessemer vessel—there were practical difficulties in applying it in Mr. Siemens' rotating furnace; and those difficulties he had been beating his brains about for several years past in order to overcome, and he hoped soon to have the opportunity of putting the thing into practical operation.

Mr. Riley said it was most important that engineers and metallurgists should come to some definite opinion as to the maximum amount of phosphorus which it was possible to have in a steel rail. Some years since he had several rails taken up on the Great Northern line. Mr. Price Williams read a paper on the "Life of Steel Rails," and he (Mr. Riley) found in several of these steel rails there was as much as ·274 of phosphorus in them. These rails were steel, and he believed he was correct in saying that they were now down on the Great Northern Line, and if so, they had been down six years. He thought it would come to a question as to what amount of phosphorus they could do with in steel rails; his impression was that they could do with considerably more than 3-10ths per cent.

After some conversational remarks from several members, Mr. Sidney Thomas said he had no intention of saying anything to-day, but as the subject of the Bessemer converter had been opened, it might be of interest to members to know that he had been enabled by the assistance of Mr. Martin, of Blaenavon, to remove phosphorus almost entirely by the Bessemer converter. Of course that statement would meet with a smile of incredulity; gentlemen would scarcely believe it, but he had the results in his pocket of some hundred and odd analyses by Mr. Gilchrist, who had had almost the entire conduct of the experiments, varying from the very small quantity of six pounds up to ten hundredweight, and the results all carried out the theory with which he originally started, and showed that in their worst results 20 per cent. of phosphorus was removed, and in their best he must say that 99·9 was removed, and they hoped that they had overcome the practical difficulties that had hitherto stood in the way. He hoped to lay the results before them at a future time.

The President said Mr. Bell had contributed some valuable facts which interested a great many of them. He found that he could, by treating Cleveland pig metal in a rotary furnace, such as they saw at the Clarence Works, reduce the phosphorus to the extent of from 3-10ths to 4-10ths per cent. But other results had been given, showing that the phosphorus had been reduced below 1-10th per cent. The slag produced gave 6-10ths and a fraction per cent. of phosphoric acid, he supposed, whereas the phosphorus in the metal in that case had been reduced to 1-7th per cent. Now, as regards these two figures, they agree very much with the results which he found in treating the same subject in another way. At Towcester, in the rotative furnace the slag generally was found to contain about 6-10ths to 7-10ths, sometimes 8-10ths of phosphoric acid; but the metal produced in that process had

m brought to a very low percentage indeed. So
, then, they might consider it as an accomplished
t, that, whether they dealt with pig-metal, or
ether they dealt with ores containing a large per-
tage of phosphorus, that phosphorus could be
ninated to such an extent as to make that metal
fectly applicable for the production of steel. The
stion of the relative merit of the two modes of
ng it was one of expense, and on that subject
y were still without sufficient information. Mr.
ll gave them certain data, commencing with
veland pig-metal. He subjected that metal to a
ining process, and in that operation he used
cwt. of oxide per ton of iron. Now, without
hing in any way to discourage Mr. Bell and his
nds, he thought that he would have to modify
t process before he could tempt steel manufac-
ers to use it practically. The employment of
wt. of rich oxide of iron would form an item of
ense altogether out of proportion to what was
v practically admissible. 10cwt. of rich oxide
ld not be valued at less than probably 10s., and
ling to that the cost of the operation itself, the
l used, he thought there could be no margin in
our of using the cheaper Cleveland metal as
pared to the dearer Cumberland metal; but, as
. Williamson had said, other bases might be
nd to take the place of oxide of iron; and Mr.
lus had brought before them a scheme
ich he had been working out—the substitution
lime for lining. Certainly he (the Presi-
t) looked with much favour upon that pro-
al and made an experiment at his experi-
ntal works at Birmingham with a lining of that
cription. The difficulty they encountered was
t the lining itself was not sufficiently hard to
st the action of the charges. It might be that
y did not get sufficient heat to consolidate it, but
the limestone which they used contained mag-
ia to some extent, which he thought made it
ble, so that they did not obtain satisfactory
ults. As regards the question of phosphorus in
steel, he might state with some confidence—
ving made a great many experiments, and seen
results upon a large scale in a process of making
l for materials containing a considerable amount
phosphorus. There was no difficulty, for in-
nce, in converting old iron rails (which might be,
a great extent at least, Cleveland rails) into steel
ls of such quality as might satisfy all the mecha-
al tests which engineers insisted upon. The limit
ich he should assign to phosphorus in such
terial was ¼ per cent.; increasing the amount of
sphorus in steel beyond ¼ per cent. there was
at danger of making the steel brittle—that is to
y, of making it fail under the test of a falling
ight. That difficulty increased very much with
e reduction of temperature. On a hot summer's
y such a rail might resist the test, but on a cold
nter's day it would no longer do so. Another
ry essential condition was that the steel rail, con-
ning ¼ per cent. of phosphorus, should contain
rtainly less than 2-10ths per cent. of carbon, and
siderably less to withstand the falling weight
t, and therefore it must contain a considerable
percentage—exceeding 7-10ths per cent. certainly—of manganese. Such metal would stand almost any ordinary mechanical test that might be applied to it, but should never be used for producing forgings. It might be said that manganese was to a steelmaker what charity was in religion—it covered a multitude of sins, and those things were of a lucifer kind—phosphorus and sulphur. If they gave him the worst classes of iron, and wished him to make steel of it that would stand the Admiralty test, he would undertake to do it, but such steel should nevertheless not be used in such applications as were now contemplated of mild steel. No boiler should be made of it, no forgings should be made of it, and, he thought also, no shaft should be made of it.

Mr. I. Lowthian Bell, M.P., said he recognised to the fullest the very correct view which had been laid down by Professor Williamson, with regard to the double duty played by the oxide of iron, and that the double duty was actually performed was obvious from the analysis which was given in the paper he had read, and by which it would be seen that the quantity of peroxide of iron existed to a much greater extent in the oxide before it was used than afterwards, indicating, of course, that the excess of oxygen had been given up from oxidising the phosphorus. With regard to the quantity of oxide, which would at the same time answer what the president had said on the matter, he would call attention to the fact that he had merely assumed 10cwt. as a hypothetical quantity. He might instance that in the event of their considering 6 per cent. of phosphoric acid to be the extent to which that substance would be permitted to exist in the resulting cinder, then they must expect to have to use 10 cwt. of oxide of iron. If he were to tell them not one-half had been used to the ton of iron, he would still be within the mark. The experiments in connection with lime were not in a sufficiently advanced condition to enable him to deal with the matter at present. As soon as he had examined the question narrowly he should have much pleasure, in the event of the institute wishing it, to communicate to them the results of those investigations. Now, with regard to the use of lime in a puddling furnace, of course he had not had the privilege of seeing the experiment referred to by his friend Mr. Snelus; but he might say this, that the Walker Iron Works in the year 1850, which was therefore twenty-seven years ago, and at that time—and he thought his friend Mr. Wales would bear him out in what he said—the plentiful application of iron ore as a material for fettling was a thing that they never heard of before, and almost the only foreign material that they ever were permitted to introduce into their puddling furnaces was limestone. The entire fettling of the puddling furnace at Walker for at least five years anterior to the year 1850, were performed exclusively with ironstone. With regard to the phosphorus, and separating the phosphorus from the residual or residuary product, that, undoubtedly, was a question of very great importance. He made a calculation upon one occasion as to the loss that the presence of phosphorus in Cleveland pig-iron entailed upon the world. He made out in the first place, that it did other pig-iron a world of harm, and in the second place it would have done the whole world a world of good if they could have placed it under other circumstances. He might tell Mr. Fox that they had already been following that branch of the subject; but he was too intent at present on getting their iron free from phosphorus to pay much attention to the use of phosphorus when so got. Now, to go back to the question of the quantity of oxide required, of course, as they very properly put it, the whole value of the thing was what it was good for. If he proposed, for instance, to use a quantity of gold, or any very expensive material in the operation in question, and that quantity of gold or expensive material amounted, per cent., to more than the value of the improvement, then, of course, he must make his bow and go; but he did not think he had arrived at that; he thought they might do with a very much less quantity than he had mentioned himself.

Mr. J. Ireland then read a paper on some recent improvements in the manufacture of

Iron Sponge

by the Blair process. The author described the ordinary method of constructing the furnaces for the production of iron sponge, and afterwards explained the improvements he had recently affected in their details. He stated that in the autumn of last year he was requested by the Indian Government to reduce some of the iron ore, of which there are large deposits some 50 miles distant from the Warora coalfields, the condition being that the ore must be reduced with Warora coal, a quantity of each having been sent over here from India. The ore is magnetic, very rich and pure, containing over 70 per cent. of metallic iron. The coal, on the other hand, is very poor, being a black lignite, containing about 15 per cent. of ash and 10 per cent. of water, besides a great number of sulphur pyrites, and it will not coke. Mr. Ireland operated on some 20 tons of the Indian ore, and iron sponge of uniform and excellent quality was produced, part of which had been since made into first-class tool steel, and some of it melted in a cupola into pig-metal. The Indian Government are so satisfied with the experiment that the question of erecting works on this principle for the manufacture of iron and steel in India is now under consideration by the council.

Mr. Michael Scott read a paper on

Steel-Casting Apparatus,

in which he described an arrangement which had been successfully applied to the Siemens open-hearth steel-melting furnace in order to facilitate the casting of ingots. It consists of an iron trough lined with tiles, closed at both ends, and mounted upon a small crane hinged to an iron column, upon which rests the ladle which primarily receives the metal from the furnace. The spout and crane revolve on the vertical axis of the latter in a horizontal plane, and the moulds being arranged circularly around the column, the outer end of the spout is brought successively over the moulds, when the small stoppers being raised by levers, metal flowing from the ladle passes into the moulds. The small stoppers are then lowered, so as to close the orifices in the nozzles and stop the flow of metal through them, and the spout is turned until it is over another pair of moulds, which are filled in a similar manner, and so on until all the metal is run. Mr. Scott suggested the use of this apparatus in a modified form in Bessemer pits

Mr. Bessemer pointed out several practical objections to the use of such an apparatus in connection with the Bessemer process, however well it might answer when applied to the Siemens process.

Mr. Charles Wood read a paper on the

Production and Depreciation of Rails,

and the application of iron and steel to the permanent way of railways. Mr. Wood observed that the total mileage of the railways of the world was 206,000 miles. Deducting 17,000 miles for the United Kingdom gave 189,000, while, adding to the latter figure 25 per cent. for sidings, stations, and double lines, brought the total mileage outside the United Kingdom to 238,000 miles. Taking these 238,000 miles at 108 tons per mile gives 25,704,000 tons as the tonnage outside the United Kingdom, while it is 4,500,000 within the kingdom, making a gross weight of 30,204,000 tons of rails in use in the world. It was explained that the 17,000 miles of railway in the United Kingdom were taken as being double, as although some were single, yet stations, sidings, and private lines gave a considerable addition. The average life of a rail being calculated at ten years theoretically brought the annual requirements of the world to 4,110,400 tons. The total annual make, however, was only 2,745,000 tons, so that there was a deficiency in demand of 1,365,000 tons per annum. To this extent, therefore, Mr. Wood argued that orders were being kept back in consequence of the depression of the times, but that ultimately there must be a powerful reaction and good times for the railmakers. He suggested that railway companies should avail themselves of the present low prices for purchasing stocks of rails. Mr. Wood then pointed out the defects and disadvantages of timber-laid permanent way, and after describing various forms of iron permanent-way in use on the Continent and in India, he introduced to notice a system of iron-way designed by himself. This system consists of a wrought-iron inverted trough cross sleeper with a special arrangement of clip-jaw in which the rail is held by means of a wooden key. The sleeper, with its two clip chairs and two wooden railway keys, five pieces in all, forms a very simple arrangement.

Mr. Price Williams, referring to the life of a rail, observed that that was a very difficult question to determine, owing to the great varieties of traffic on different railways, and to the fact that both iron and steel rails were still used. When the use of iron rails had been discontinued and steel rails alone were used—which in course of time they would be—then only could the life of a rail be definitively calculated. The life of a rail, moreover, had to be estimated by the amount of traffic passing over it, combined with the speed at which that traffic moved.

Mr. C. B. Holland read a paper, in which he described the manufacture of Bessemer steel and steel rails at the works of Messrs. Brown, Bayley, and Dixon, at Sheffield.

Dr. Percy, F.R.S., placed before the meeting some particulars as to the manufacture of Japanese copper. Bars of this metal present a beautiful rose-coloured tint on their surface, which is due to an extremely thin and pertinaciously adherent film of red oxide of copper or cuprous oxide. This tint is not in the least degree affected by free exposure to the atmosphere. Dr. Percy placed before the meeting bars which he had possessed for 30 years, and which had undergone no change, although freely exposed to the atmosphere. The secret of this result lies in casting the copper under water, the metal being very highly heated and the water being also made hot. Dr. Percy stated that he had succeeded in casting copper in this way, and had produced similar results to those shown in the Japanese metal.

The concluding paper was read by Mr. C. H. Halcomb, in which he described a new form of joint for rails, which is being tried on the Midland and other railways. It is known as the Acaster joint, and embodies the application of the principle of the wedge. It is made of steel, is about 18in. long, and may be described as a kind of clip, held up to its work by wedge pieces with serrated edges to prevent it slipping. So far as it has been tried it is stated to have answered well as a means of joining the ends of rails.

THE INSTITUTION OF CIVIL ENGINEERS.

At the meeting on March 26, Mr. Bateman, President, in the chair, the paper read was on

Direct Acting or Non-Rotative Pumping Engines and Pumps,

by Mr. Henry Davey, Assoc. Inst. C.E. The author discussed some new forms of direct acting pumping engines and pumps, as a question of relative cost and efficiency, illustrating his arguments by practical examples. The direct acting engine had a wider sphere of application in mining operations than elsewhere, and experience had proved it to be the best type for deep mine and heavy pumping. Until lately, the Cornish had been the only direct acting expansive engine. It was a very economical machine under favourable circumstances, but its range of expansive working was limited. Compound rotative engines had been made to do a higher duty than Cornish engines. In the early days of pumping, Hornblower, Trevithick, Woolf, and Sims experimented with compound Cornish engines in Cornwall; but these attemps had failed because the engines were single acting, and the distribution of steam was such as to lead to great thermal loss from the cooling influence of the condenser. From these and other practical defects the engines fell into disuse. To work direct acting engines expansively, certain conditions were necessary. An inert mass must be provided, which, by

its inertia at the beginning and momentum towards the end of the stroke, should compensate for the diminishing pressure of the expanding steam employed in overcoming the almost uniform resistance of the pump. In single cylinder engines this involved heavy initial strains, considerable piston speeds, and a large inert mass to render a high degree of expansion possible. These obstacles were removed in the direct double acting compound engine. This part of the subject was graphically illustrated by indicator and velocity diagrams, taken from compound and Cornish engines under various conditions of working, the results being tabulated. The relative cost of compound and of Cornish engines was next compared, and it was shown that the cost of the engine and buildings was less for the compound than for the Cornish engine. The author then described certain improvements in valve gears, and discussed the construction of pumps and pump valves, advocating much heavier lifts than those commonly used. As examples, a 200-H P. compound engine, employed underground, in forcing against a column 1,100ft. in height, and a 600-H.P. compound engine, actuating two 20-inch plungers by spears, against a column of 700ft., were referred to. An improved form of pump work was adopted to render such heavy lifts practicable and safe. Twenty varieties of pump valves were illustrated, and diagrams of the lift of pump valves, and others showing the shocks produced in the opening and closing of valves, were exhibited. In an addendum the author touched briefly on three questions of special interest in connection with the subject of the paper. These related to the economical use of steam, in regard to the degree of expansion, as to how greater economy might be secured, and as to the condition of maximum efficiency.

SOCIETY OF ENGINEERS.

At a meeting of the Society of Engineers, held on Monday evening, April 1st, in the Society's Hall, Victoria-street, Westminster, Mr. J. Bernays, Vice-President, in the chair, a paper was read by Mr. W. Schönheyder on "Equalising the Wear in Horizontal Steam Cylinders." The author, after noticing the large extent to which the horizontal engine was used at the present time, in preference to the older type, the beam engine, explained that one objection to its use was the great and unequal wear of the cylinder, which was due to the weight of the piston continually rubbing backwards and forwards on it, and to the difficulty found in lubricating it sufficiently, especially when the cylinder was kept hot by the now universal steam jacket. After enumerating the evils resulting from the unequal wear of cylinders and pistons, the most important expedients for preventing it were described, and the author's reasons given why they could not fulfil their purpose in practice. The author then gave a description of his method of remedying the evil. This was stated to consist in making the piston-rod with a camber or upward bend, in such a manner as that, when loaded with the weight of the piston and placed in the cylinder, it assumed a straight line, and transferred the weight to outside guides. Special tools are used, which render the production of these rods easy and certain.

THE METEOROLOGICAL SOCIETY.

The usual monthly meeting of this society was held on Wednesday, the 20th ult., at the Institution of Civil Engineers; Mr. C. Greaves, President, in the chair. Mr. B. L. Smith was elected a Fellow. The discussion on Dr. Tripe's paper "On the Winter Climate of Some English Seaside Health Resorts," was resumed and concluded, after which the following papers were read:—"Notes on a Waterspout" by Captain W. Watson, F.M.S.; "Notes on the Occurrence of Globular Lightning and of Waterspouts in County Donegal, Ireland," by M. Fitzgerald; and "Observations of Rainfall at Sea," by W. J. Black.

The discussion on the subjects of waterspouts and globular lightning was adjourned till the next meeting on April 17th.

A Pocket Counter.—Mr. Browning has introduced a useful little instrument, patented by Mr. A. Sainte, which is admirably adapted for indicating the number of revolutions of shafts and pulleys. The counter is sold in a case suitable for the pocket, and is accompanied by accessories for attaching to different parts of moving machinery. Its chief merit is that by means of a spring clamp the wheels can be set back to zero instantly, and as they have sets of figures for forward and backward motions, the speed can be read off at a glance. The instrument is well adapted for all purposes of revolution counting, and is especially applicable to those cases in which a periodical examination of the relative speeds of different shafts and spindles is necessary to secure good work. The labour of going round a mill and taking the speeds will be much reduced by means of this handy counter.

SCIENTIFIC NEWS.

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We announced last week the death of Dr. R. J. Mayer, who died at Heilbronn, on the 20th of March, aged 63. This distinguished German physician devoted his leisure to the investigation of abstruse questions in physical science, and so long ago as 1842 he published a paper in which the relations subsisting between heat and work were defined, and a calculation of the mechanical equivalent of heat was given. That the calculation afterwards proved to be erroneous in no way detracts from the merits of Mayer, for certain data required for the accurate computation of the mechanical equivalent were then unavailable, or available only in a defective form, and the calculation was found to agree fairly with Joule's when based on the more accurate knowledge subsequently gained. Mayer's work, it must be remembered, was not of an experimental nature: he had not the means to check his hypotheses by practical tests, but worked out his theories in his study. In 1845 he published a remarkable paper on "Organic Motion and Nutrition," and in 1848 appeared his famous essay on "Celestial Dynamics," in which he propounded the hypothesis that the sun's heat is maintained by meteoric matter drawn into its furnaces. His paper on the mechanical equivalent of heat was published in 1851, and proved to be his last, for his mind became unhinged by the severe labours he had undergone and the absence of appreciation, not to say rebuffs, he met with amongst his scientific contemporaries. Dr. Robert Julius Mayer was one of those gigantic intellects which make themselves felt under any circumstances. Under more favourable conditions he would have taken without dispute that prominent place in the ranks of scientific men which cannot be denied him now by those who at one time depreciated his work.

On the same day Prof. A. Lamy died at Paris, where for many years he had occupied the chair of Industrial Chemistry at the Ecole Centrale. He is chiefly memorable for his isolation and examination of the properties of thallium, the discovery of which was at one time claimed for him in opposition to Crookes. That claim could not, however, be maintained, but M. Lamy speedily took the lead in working out the new metal and its properties. In 1869 he invented the pyrometers known by his name, and he was also the first to obtain induction currents from terrestrial magnetism.

The annual meeting of the Chemical Society was held last Saturday; Dr. Gladstone, president, in the chair. In his report the president referred to the past year as an eventful one in the history of the society, its precise position and the value of its fellowship having been set at rest. The fund for the encouragement of research had come into operation, and the society was now a purely learned body, the Institute of Chemistry having been founded to support the professional interests of chemists. The society has nearly 1,000 fellows on its list, and is in a flourishing condition.

The small planet discovered by Herr Palisa on the 28th of February (No. 184) has been named Deiopeia.

The Selenographical Society, of which some mention has already been made in our columns, has been established to promote the advance of selenography by aiding those engaged in the study of the surface of the moon, by affording them information, and by giving them opportunities of consulting the work of fellow-labourers. Mr. W. R. Birt is the president, the Rev. W. J. B. Richards, treasurer, and Mr. Herbert Sadler, 32, Manor-street, Clapham, is the secretary. The Rev. T. W. Webb and Messrs. G. Knott, A. A. Common, N. E. Green, E. G. Loder, J. W. Durrad, and E. Neison are amongst those who have already joined. The annual subscription is half a guinea.

The Patent Reform Bill, introduced by Mr. G. Anderson, M.P. for Glasgow, is understood to have been drafted under the auspices of a committee, of which Sir W. Thomson is president. The bill, we need scarcely say, proposes to reduce the fees, and is generally adapted to promote and encourage invention. It has, however, little chance of becoming a
session, unless the House suddenly
to do something.

Some important experiments wer
week at the works of the Leeds Forg
in testing the comparative strength
boiler flue, and one of similar dim
Fox's patent corrugated principle.
yielded under an hydraulic pressur
whereas the corrugated flues—of
similar quality of metal and of the
ness—could not be bulged until a
450lb. was reached. This result
unsatisfactory, and on examination
covered that at the point of collaps
a defect in the weld. Previous tests
lished the fact that the corrugate
withstand a pressure of 1,000lb. to
inch.

At the general meeting of the In
Mechanical Engineers, on the 11
scientific investigation of the cos
different descriptions of railway tra
ried on will be brought before th
The meeting is expected to be large
by members and those interested
matters.

It is stated that Prof. Emerson R
discovered a new explosive, com
two substances which can be kept
out risk, and can be mixed as requi
a valuable blasting and explosive a
powder is a mixture of 75 parts of
potassium with 25 parts of sulphu
discovered by Prof. Reynolds some
which can be obtained in quant
waste product of gas manufacture
explosive is a white powder, wh
ignited at a lower temperature than
and leaves less solid residue.

The *Journal of Horticulture* say
Thomas Jackson, gardener to Col
died lately at the age of 106, retai
faculties to the last. He came of
stock, for his father is said to have
age of 115 years.

The preparations for M. Giffard's g
tive balloon, to be located behind th
are progressing. The work of stitchi
was commenced last week, 100 w
employed. Its dimensions are 55 m
or 180ft. by 118ft. The car will
persons, and the cable will be 600

A new process adopted by M.
engineer and chemist in Paris, for p
reproduction, in blue lines on whi
industrial drawings, plans, maps,
cently been brought before the Fr
d'Encouragement. It is based on t
of perchloride of iron of being red
tochloride by light. The latter
changed by a solution of prussiate
while the former is immediately co
The copying paper is sensitised by
in a bath formed of 100 of water,
perchloride of iron, and 5 of oxa
other vegetable acid). The drawin
parent paper, is placed on a dry
copying paper, which is called "cy
exposed to the light under glass
seconds to the sun in summer, a
seconds in winter; in shade the exp
from 2 to 40 minutes, according
The electric light may be used. Af
the sheet is placed in a bath of
potash (15 to 18 per cent. of w
immediately colours blue all the
the perchloride has remained inta
not affect the parts where the salt
duced by the light. Then the
washed with water, and passed int
8 to 10 per cent. of hydrochloric aci
moves the salt of protoxide of iro
washed again and dried. The d
appears in deep blue tints on a
ground, and has the aspect of a dr
by hand with blue ink.

A telephone on quite a new p
been invented by M. Bregnet. It
cation of the electrical phenome
by M. Lippmann in capillary tubes
strument (according to one ar
consists of a cylindrical vessel cont
mercury with acidulated water abo

liquid, but not reaching the mercury, a vertical tube drawn to a point also containing mercury. The mer- e tubes of the two instruments is by means of a wire issuing at the the mercury of the two vessels is onnected. The vibrations produced :e in the air above the mercury in re translated into variations of elec- force in the mercury, and cor- : vibrations are produced in the air quid metal in the other tube. (M. paper on the subject will be found in ndus).

rtain ancient texts it appears (ac- M. Muller), that the Incas knew l of protecting crops from the action ' means of smoke, rendering the air arent. Severe laws rendered this practice obligatory. After the nquest it fell into desuetude, and made impossible numerous kinds of that had before been very produc-

researches by Boll, Kühne, and ke it very probable that a photo- process takes place in the retina in f vision, and that the material sensi- ght is provisionally accumulated; regenerated after each act of vision. s has also observed that if the eye l to a gradually increasing impres- ment comes when nothing can be t can then be demonstrated with the scope that the vessels of the retina of blood; which would indicate that material passes directly from the the retina, and is replaced from the me experiments in support of this been recently made by M. Exner. these the field of vision was divided ite and a black half, and a white brought into the black half. This st covered, however. The eye was on the boundary of the two halves white appeared nearly black. The the white circle was now removed. appeared distinctly white, and only iteness gradually. This is explained ing that the supply of visual mate- retina, which with the defective cir- as not made good, was consumed in alf of the field of vision, but in the k half could still serve for perception ite circle.

ntillation of stars continues to occupy gny's attention, and in a recent paper lgian Academy he discusses a series ations which seem fully to demon- at stars whose spectra are charac- dark bands and black lines scintillate stars with fine and numerous ines, and much less than those whose resent only a few of the principal lines. gard to the colours in scintillation— principally red, orange, yellow, green, e, blue, and violet—he mentions, inter blue seems generally to predominate other colours in rainy weather. Red ost constant type; green and violet rare, yellow is rarely absent, and s very frequently predominant.

stated by Dr. Cones, of the U.S. that a breed cf solid-hoofed pigs has tly been established in Texas. The l phalanges of the toes are united to single broad phalanx; above this, how- e other two phalanges of each of the ncipal digits remain perfectly distinct. f is perfectly solid, and on its sole there d angular elevation of horny substance, s curiously like the frog of the horse's The breed is so firmly established that ency to revert to the original and nor- m is observable. It is further stated the cross of a solid-hoofed boar with a the ordinary type a majority of the litter e peculiarity of the male parent.

e was cast at Creusot the other day an f steel weighing 90,000 kilogrammes. peration succeeded perfectly, and M. ler was encouraged to go still further. preparing to cast an ingot of 125,000 mmes, or two and-a-half times the weight argest piece which has ever been pro- the Krupp works.

LETTERS TO THE EDITOR.

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[We do not hold ourselves responsible for the opinions of our correspondents. The Editor respectfully requests that all communications should be drawn up as briefly as possible.]

All communications should be addressed to the Editor of the ENGLISH MECHANIC, 31, *Tavistock-street, Covent-garden W.C.*

All Cheques and Post-office Orders to be made Payable to J. PASSMORE EDWARDS.

*** *In order to facilitate reference, Correspondents, when speaking of any Letter previously inserted, will oblige by mentioning the number of the Letter, as well as the page on which it appears.*

"I would have everyone write what he knows, and as much as he knows, but no more; and that not in this only, but in all other subjects: For such a person may have some particular knowledge and experience of the nature of such a person or such a fountain, that as to other things, knows no more than what everybody does, and yet, to keep a clutter with this little pittance of his, will undertake to write the whole body of physicks: a vice from whence great inconveniences derive their original." —*Montaigne's Essays.*

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"ORGANON'S" ORGAN AND OTHER THINGS.

[14165.]—WHERE is "Saul Rymea?" Could not he have slipped in a note when he saw "Organon's" pen make a slip—not that it has slipped very often; —still such things will happen in the best written letters, as well as the "regulated families" who come under that superlative description.

The first slip is a very small one. In the first letter (p. 69, Vol. XXVI.) he says: "Get out the key frame bearers 9⅞in. × 2⅛in.;" they ought to be 2⅛in. at the front end, and 2⅞in. at the back, so that the keys are level when raised on top of pitman rod. Immediately below this he says, "the half-row board on top is ¾in. thick, so that a piece of ⅞in. pine must be glued on top of tube board at bass end to give a level surface for guide board to rest on." The "piece of pine" must be at least ⅜ths higher than the half-row tube board, so as to allow the stop valve on the half row to open, and it must be put along the back as well as on the front of bass half. A curious mistake occurs at the very commencement of the second letter (p. 117), relative to the fitting of the stop valves or mutes. He puts it thus: "Glue the stop valves on the skin. . . . Take one of the valves, and applying it to the place it is to occupy, notice how it lies." The instructions are all right, but they are misplaced. You take the valve and fit it to the place it is to occupy, and then you glue the skin to it, and I may remark that the fitting must be very carefully done or you will have no end of trouble at the treble end of the instrument. You must not trust much to the leather; see that the mute fits up neatly against the tubes all the way along, and then fit it down to the reeds just as neatly. Of course you will understand that you plane off the inside of the mute to make it fit the edge of tube board, and off the outside to make it fit the reeds. In bending the mute springs I always turn the two ends at right angles to each other—not both in the same direction as shown by "Organon." I never saw them done that way, and should think that unless the wire was very stiff you would hardly get strength enough.

A little lower down in the same letter the cart gets once again before the horse (I need not quote). The reed valves are glued on a strip of felt, and when dry are cut apart, then you find out the exact spot where the pitman rod comes down, and proceed as "Organon" says. You will find the tool used by shoemakers for cutting eyelet holes the very thing to cut out both the felt and wood to fill the hole.

I ought to have pointed out in passing that just before he tells how to do the stop-valves he shows how to put on the spring rail. In doing so he omits to mention that the rail must be glued to the soundboard, as well as screwed. Nobody would be likely to be misled by that, though; but he makes a mistake in giving the distance of spring-rail from front of sound-chest. The way to get the distance is to place one of the springs to be used in a piece of board, just as it will be in the rail, and measure the distance from coil to bend at point. That will be the distance of centre of spring-rail from pitman rod—that is to say, the point of the spring must rest just behind the pitman rod and the rail, for the springs must be put on to suit that. While I am at the springs, anyway, I may point out that they must not be driven into the rail. You must drill a hole just tight for the wire, so that you can push them in to place with a pair of small pliers, ground to the shape shown in Fig. 1. The object in view, in shaping the pliers so is to avoid touching the coil in any way. If you squeeze or press the coil at all, in pressing the tail into the spring-rail, you weaken the spring, and the key is then lighter than the rest; and if you spoil a spring here and there, you will find that you have ruined the "touch" of your instrument.

Now about the guide pins, which have to be driven for the reed valves. They must be driven exactly in line with the centre of the slot. They must all be driven the same distance into the soundboard, and, if you have an eye to the eternal fitness of things, they must be driven in perfectly straight lines from end to end of the instrument. The tool to do this with will cost you five minutes' work to begin with, and give you a job worth looking at when you are finished. Take a piece of wood long enough to reach from inside edge of spring-rail to ⅛in. beyond opposite end of valve slot, wide enough to reach from edge of one slot to edge of second next one—that is, it covers one slot entirely, and its edges run parallel with the inside edges of the neighbouring one on either side. If your pins are 1in. long, make your gauge ⅞in. deep, to begin with. Off this ⅞ths you will "rabbit" ⅛th on the lower side, until the section shows as it is in Fig. 2. The spur or tongue shown on under side fits into the slot in the soundboard. You mark the places for your pins, and drill holes for them. Of course, you make sure to drill the holes exactly true, and in the centre. The drill will be a shade larger than the spring wire, so that your gauge slips easy off the pins when driven. Fig. 3 will show how to apply the article, I think.

Of course you will understand that to use this pin gauge all the valves must be the same length. If you buy them, you are sure to get them so; if you make them, you had better make them all the same length. Of course you will graduate the felt and leather to suit the varying lengths of valve slots; but the valves themselves are more easily handled if they are the same length throughout. Had I been at "Organon's" elbow when he was making the drawing which accompanies letter II. (p. 117) I would have suggested two alterations in it. The first one would have been to make the point of the spring-rest behind the pitman rod instead of in front, as he shows it; and second, the insertion of a strip of felt (same thickness as is used on the valves) under the rear end of the valve, just behind the guide pin. I suggest this on the assumption that the melodia set is in front. The object in view is to give the large reeds the best chance—*i.e.*, the largest opening. If you look at the drawing you will see that, as at present arranged, when you push down the key, the valve would hug the board in front, and all the opening, or the larger opening, would be in rear, just where it is not particularly wanted. The drawing shows the depth of the wind-chest all right. I should judge it about ⅜ of a rim on the upper board, and ¼in. on the lower; but he varies the business in the third letter by leaving the ¼in. on the underboard, after making his upper rim 1¼in. deep. I do not take this to be a slip of the pen. It looks like a clear case of heterophemy. The wind-chests are got up both ways—sometimes with 1¼in. rim on the upper board and none on the lower, and sometimes the rim is divided in the middle, as shown in the Fig. "Organon" was writing of the one, and thinking of the other. The wind-chest does not require to be more than 1⅛in. or 1¼in. inside. The bass reeds object to it being smaller, the treble do not seem to relish it any larger. If any fellow wants to do the thing "up to the knocker," though, he can make the middle board of his bellows on the bevel, so that he requires 1⅜in. of wind-chest at the bass end to bring his soundboard level. The bass reeds will acknowledge his kindness in doing the little bit of extra work by giving him a fine rolling mellow tone in exchange therefor. In offering these criticisms, Sir, you will permit me to say in addition, that "Organon" deserves credit for the clear and masterly way in which he handles his subject. You will be pleased to observe that nearly all the points in which I have felt obliged to supplement him are what your predecessor used to designate "dodges;" but they are points which must be seen to, especially the fitting of the stop valves, the driving of the guide pins, and the putting on of the valve springs.

If "Boehm" (page 273) wants a portable American organ of four octaves, why does he not try some of the agents for Mason and Hamlin? I know the firm make these instruments. I do not know if they export them to England, but if he fails to get one there, why not apply to the gentleman who advertises himself on your front page as an agent for American organs and organ material? Surely, if he has not one in stock, the matter of a few weeks will let him get one.

"Clyde," same page, is a little indefinite in his query. Has his present instrument one or two sets of reeds? If only one set, then he should sell the tube board and get one with 2½ sets, as he proposes. If it has two sets it would be a very easy matter to add the stops and the celeste. He can get a celeste set in a board by itself and plant it on the back part of the present soundboard. The connections would be very easily made, especially by a practised wood-worker. If his present board only contains one set of reeds, I should be a little doubtful about his bellows being equal to the wind required for 2½ sets, but I will tell him how to find out. Take off the back of the case and measure the reservoir. If it is, say, 32in. long by 16in. broad, and opens out 5in., and holds 2½ times the full of one feeder, then it is good for 2½ sets. It is very easy to find that out, and when found out write again and get more explicit instructions as to how to do the work.

If W. H. Gaikrod (query 31332, p. 274) carries out his idea of planting the sub-bass underneath the bottom board, he will require to get a stout malleable iron hook screwed into one of the joists in the ceiling of the room where the instrument is to stand, and a stout cord depending therefrom, so that when tuning is required he can hitch himself up by the heels. A little practice will be required to get a good job, but "patience and perseverance," &c. He can satisfy himself in five minutes as to how the reeds will work, but he really need not give himself the trouble. If he gets a good tube board and good reeds, he will get good tone. There is one thing he can try very easily. He can partition off the space required by the sub bass board so as to keep the wind away from the rest of the chest. Some makers do this and some do not—it depends entirely on their style of board. Estey, of Brattelboro, Vt., has the best sub-bass of any of the makers I know. I should qualify that a little by saying that it speaks readier than the others. Some of the other makers have "cribbed" from Estey which goes to show that a good thing is appreciated (not appropriated) in this wicked world. The instrument he refers to as having 1½ set of reeds, the ½ set being of powerful tone and named "clarinet," is a very common form and pretty cheap. The very best way to do with that ½ set of unvoiced reeds can be seen on one of Geo. Woods and Co.'s organs. If "W. H. G." cannot see one of them I will tell him how to do with it. "Aeoline" (the genuine article) is produced by a very light narrow reed, mounted in tube-board to match, and is a very pretty solo stop. "Vox humana" is sometimes—indeed usually—a half set of 16ft. reeds, with small channels and little voicing—rather, I should say, little twisting.

I am fairly baffled to find the name and number of a query put some time ago concerning a tremolo for an American organ, but I shall answer the query all the same, and trust the gentleman who put it may run his eye over this. The ordinary American tremolo consists simply of a small box 4¼in. long, 2in. wide, and about 3in. deep, inside of which is a piece of thin wood faced with soft leather and weighted with a piece of lead on the end of a wire fixed on the upper surface of the aforesaid piece of thin wood, alias the "clapper." Fig. 4 shows the arrangement of the thing. Fig. 5 is another form of tremolo valve in which the hinged clapper of wood gives place to a light metal casting attached to and kept down by a brass spring; it has only been about two years or so in use, but I would use it in preference to the old one, there being less "thump" to it than the common one. If any of your readers, who are manufacturers, think of adopting it, they had better look through the patents issued in England during the last three years before doing so; because, although it was invented or, at least, patented in this country by a Mr. Arne, I have seen it on some of Mason and Hamlin's organs, and, reasoning from that, conclude that they must have acquired the patent right. If they have done so, it is not unlikely they have got protection in England also. Fig. 6 is still another form of tremolo, and I believe it to be the best of the lot. It is the invention of Mr. W. Ewell, of the Munroe Reed Company, Worcester. The company hold the patent and manufacture the article—the drawing is half the size of longitudinal section. A A are the ends of outside box, B the top of same, which must be air-tight, C, a slantindicular partition with wind opening in it 1¼in. in diameter, in position as shown; D is another small division with small hole in it, through which the wire, E, passes; F is a rubber ball about 1⅜in. in diameter, suspended by a stout linen thread, G, from the bent wire, E. The beauty of the thing is that you can regulate the length of the wave by drawing out or pushing in the wire, E. Awfully simple, is it not? Now to apply them, or some of them, you have to put a valve over all the wind openings leading from the wind-chest to the bellows. The tremolo stop must close this valve, because all the wind must pass through the tremolo when it is in use. Then you must cut two openings in the soundboard to match those in the bottom of the tremolo box (see Figs. 4 and 7). One of these openings must be isolated from the rest of the wind-chest by having divisions put round it, same thickness as rim of wind-chest, and leather put on it the same also. Then you bore two ¾in. holes down through the middle board into the bellows. Then, if you have done your work properly, you can have all the trembling you want. I suppose I need hardly mention that Figs. 4 and 5 ought to have boxes to cover them in, the same as is shown in Fig. 6, only there is no partition in them. I would have given you the boxes, but Congress clipped ten cents off the dollar last week, and I positively could not afford to do it. In case the inquirer should require to inquire further, I send off with this letter a tremolo box addressed to "Organon." Fig. 7 is the plan of bottom board for Figs. 4 and 5, and openings made in soundboard for Fig. 6.

Eleve.

FIG. 2.

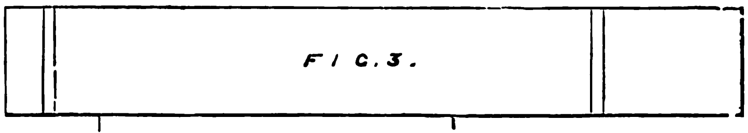


FIG. 3.

FIG. 4.

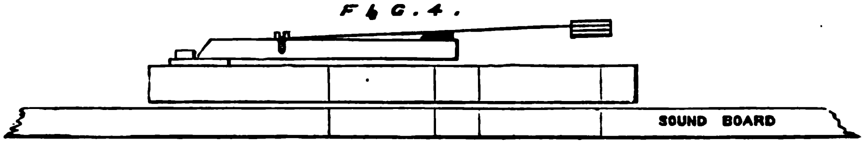


FIG. 5.

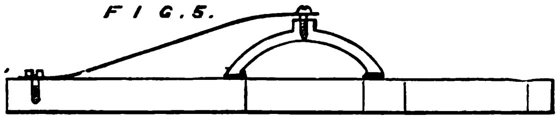


FIG. 1.

FIG. 6.

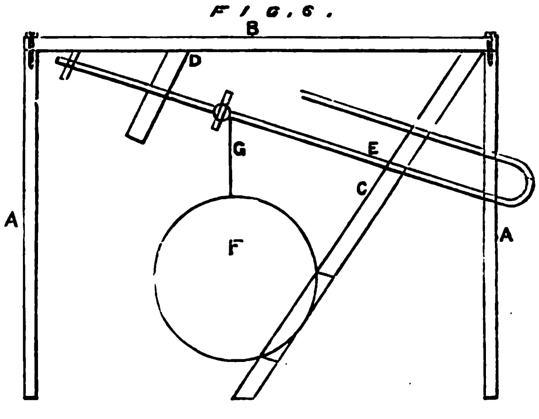
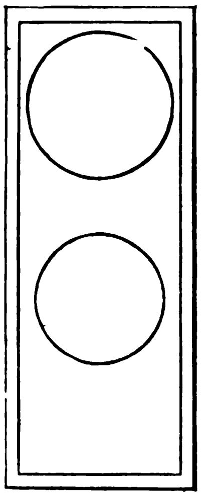
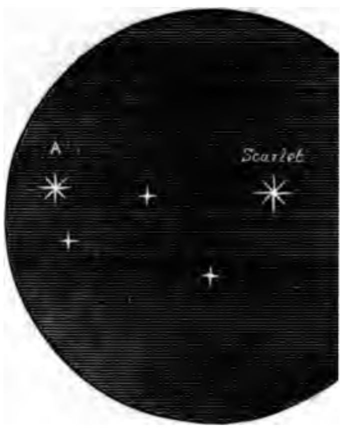


FIG. 7.



HIND'S SCARLET STAR.

[14166.]—In reply to "Brickwall" (let. 14110) I may tell him that there is no star of about the same size following the crimson star in Lepus. There is, however, a star of about the same magnitude a few minutes preceding this star, which is commonly known as Hind's scarlet star, the positio R.A. 4h. 53m., declination 15° 1′ south. think "Brickwall" could have ob scarlet star at all, or he could not have fa noticed its intense colour which is, as Hi it, "of the most intense crimson, resemb drop on the black ground of the sky."



On the evening of March 10th, 18 observed with the 6$\frac{3}{16}$in. Merz achroma in the observatory of W. G. Lettsom, E the guidance of "Brickwall" or any gazers who may wish to see a really beau I give a diagram of the field with a mod Once found there will be no mistake in t it is by far the most intense-coloured ever observed. The star, A, is nearly the scarlet star and white, therefore striking contrast. The star, B, is also The others are small.

C.

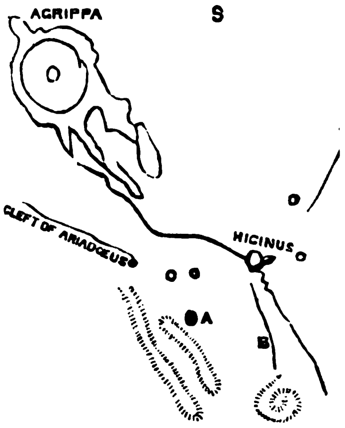
STAR p RIGEL.

[14167.]—Last night I looked at last panion to the brightest star *p* Rigel, Espin named some time back. The been so extremely unfavourable that I unable to look for it before. Thoug was particularly good I did not get a v tory view, for Rigel was low, and oft for a time by smoke from a railway. B I saw a faint star *n*, and perhaps a littl wards I fancied there was another *s f*, one more distant exactly *f*. This las very doubtful. Indeed, I lay no wei observation at all from the causes above and should not be surprised if Mr. Esp were all three incorrect. The first I fel of, as I thought I saw it both with The best time for me to observe Orio tember or October, when it souths e morning. I have never at any other t many faint stars as then.

B

NEW CRATER N.W. OF HY

[14168.]—Some of your readers may interested in the announcement, in th *schrift für Astronomie* for 27th of Mar a totally new crater N.W. of Hyginus, E. of Mädler's grey spot, which was di

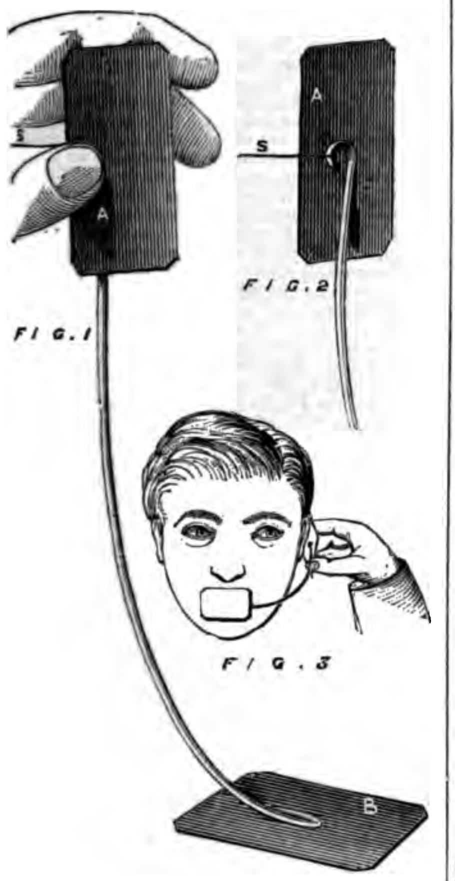


Dr. Klein, of Cologne, on May 19th, 187 on Schr., Lohrmann, B. and M., Neison, and though Dr. Klein has had twelve y ence of lunar observation he had never of such an object there before. It has b Schmidt since its discovery by Dr. describes it at its discovery as a black c shadow, and without a wall, about 4,000 metres diameter, or two-thirds of Hyginus itself. The crater is marked A on the rough sketch (a copy of Dr. Klein's), and there is a rille or valley, B, near it, which is probably also new. Mr. Neison assures me, from his own observations of the spot, that the crater seen by Klein was certainly not in existence from 1870 to 1875, and I have myself frequently examined the region in 1874 and 1875, but certainly saw nothing resembling the object discovered by the German astronomer. It should be looked for on the 0th of the present month. **Herbert Sadler.**

N.B.—The crater should be observed on or near the terminator, as Dr. Klein finds it disappear under the increasing illumination.

STRING TELEPHONE.

[14169.]—I find by experiment that a small disc of thin metal plate, about 1½in. square, having a string or wire passed through a central hole, may be substituted with advantage for the tubular mouthpiece and diaphragm. This disc is held between the thumb and fingers by its edges, Fig. 1; and, for listening, applied in close contact with the ear; for speaking, held near the mouth, so as just not to interfere with the action of the lips. The sounds transmitted are quite as loud and clearer than when the tubular mouthpiece is used. If a pair of these discs are connected by a short string (say, about 18in. long), and this string be passed through a hook attached to the end of the main line, one disc may be applied permanently to the ear, and the other to the mouth, so as to obviate in conversation the inconvenience of change of position for speaking or listening. For, as the string connecting the pair slides through the hook, it is easy to make its tension equal for both the discs.



Another plan, which answers equally well (see Figs. 1 and 2), is to solder a wire, of which the end is hooked, W, Fig. 2, for the attachment of the string, S, to the centre of the ear-disc, A. This wire is of such length that its other end, B, Fig. 1, being soldered to the centre of the mouth-disc, and being suitably bent, this disc is by it held just in front of the lips, Fig. 3. The other disc, A, being pressed to the ear, and held as before, by its edges, leaves to the wire and its mouth-disc perfect freedom of vibration. This arrangement answers perfectly; but, as the apparatus thus constructed is not of convenient form for the pocket, it may be altered so as to fold flat by making a simple joint in the wire, hinge fashion. This hinge being tightened by its pivot, which is furnished with a screw thread and small nut, the necessary vibration remains uninterrupted. This modification is also perfectly successful. I believe that for ordinary purposes and moderate distances the string or wire telephone will practically be found more useful than the electric. The volume of sound is much greater, and it needs no separate call bell, for a thin wire may be permanently strained by moderate weights over pulleys at its termini, so that when pulled at either end the weight may be made to strike a resonant plate or bell at the opposite terminus. To this permanent wire, either at its termini, or at any intermediate point, a telephonic disc, with its string and hook, may be attached, so that conversation may be carried on, not only between the terminal parties, but at the same time, with any others situated near the course of the wire. I see no reason to doubt but that, if a wire was thus strained along the length of a street, branch strings might lead to each house, and enable all the residents to join in general conversation.

Stow Easton. **J. Hippesley.**

STRONG TELEPHONE.

[14170.]—Since our last correspondence on this subject I have tried a few more experiments, and have been very successful. When calling attention my voice can now be heard twenty-five yards from the receiving telephone, almost as loud as at the transmitting end. This is more than three times the distance I could hear when last I wrote on the subject. The sound best heard at that distance is "Cuckoo," and my call bell is quite unnecessary. **John Fortune.**

CANOES AND CANOEING.

[14171.]—Having read the article in the English Mechanic on "Canoes and Canoeing," I venture to suggest a light and convenient arrangement for the sail to be raised and lowered in case of a squall. Would you kindly let me know through your journal whether it would be practicable?

FIG. 1

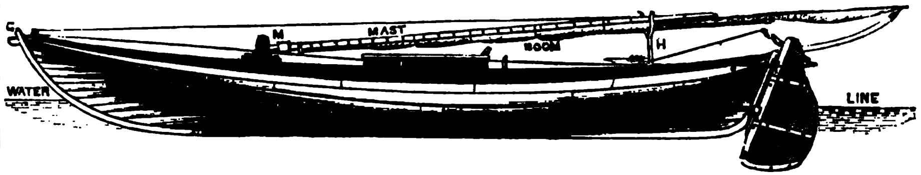


FIG. 2

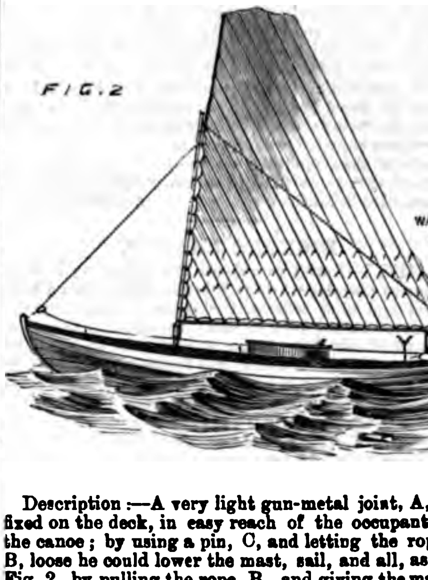
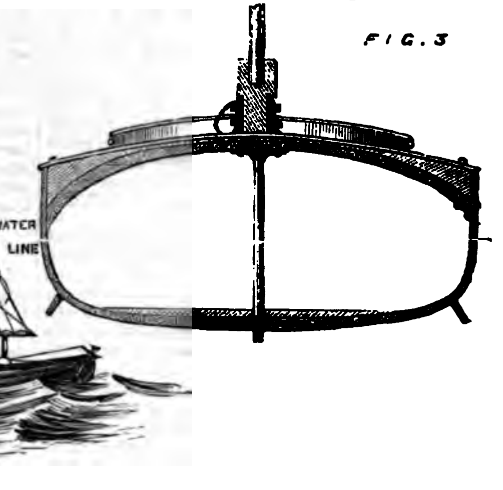


FIG. 3



Description:—A very light gun-metal joint, A, is fixed on the deck, in easy reach of the occupant of the canoe; by using a pin, C, and letting the rope, B, loose he could lower the mast, sail, and all, as in Fig. 2, by pulling the rope, B, and giving the mast a start with his hand he would have his sail set in less than a minute. Fig. 1 shows mast down; Fig. 2, mast fixed for sailing; Fig. 3, midship section of canoe. **D. Ferrier.**

THE TELEPHONE.

[14172.]—I have made two pairs of telephones, one pair having reels of hard wood, wound with No. 36 silk-covered copper wire, the other pair having reels of cardboard, wound with No. 28 silk-covered wire. Both pairs of telephones have their cases made of wooden boxes obtained from a chemist, and the parts inclosing the magnet are made of cardboard, rolled into a tube to fit the magnet, and glued on to the boxes. Both pairs transmit any sound, including the sound of the piano, and all the letters of the alphabet, but the pair with the cardboard reels, and No. 28 wire, are far superior to the others, speaking with remarkable clearness, and carrying even a whisper distinctly. I mention this with the view of helping those who cannot get brass reels easily, or who are troubled by the extreme liability to break of the No. 36 wire. It also shows that turned wood cases are not absolutely necessary for useful instruments, thereby reducing the cost of making them considerably.

X. Y. Z.

THE HORSESHOE MAGNET TELEPHONE.

[14173.]—I am glad to see some discussion on the horseshoe magnet telephone in the English Mechanic. I must confess that I was disappointed on reading Prof. A. E. Dolbear's little book, "The Telephone, and How to Make It," and which, although most ably written, may be an excellent textbook on the phenomena of electricity, magnetism, and sound, is not what it professes to be—viz., a handbook on the telephone, as out of 130 pages only 28 are devoted to this instrument, and his directions "how to make it" are compressed into barely 8. It would have been interesting to all readers to have had also a full description, with woodcuts, of Prof. Bell's telephone, instead of a few lines, in which Prof. Bell's merits as an inventor of this instrument are barely recognised; and his discoveries in the problem of transmitting speech are alluded to so briefly that the general reader might imagine that his instrument is not the most practical one.

In the directions that the author (Prof. Dolbear) gives for making his telephone it would have been more satisfactory, I think, if he had entered more into detail, and explained more clearly how the wires should be wound on the bobbins and connected. To non-electricians it is important to know if two line wires are required, or whether one is sufficient, the other connection being made by earth.

Your correspondent, "W. P." (letter 14011), has given a good description of what appears to me to be a simple form of telephone, and I should be glad if he would kindly enlighten me upon the following points:—

1. Which direction should the wire be wound upon the bobbin, and if it is indifferent whether that placed upon N. pole be wound right-handed or left
2. Whether the ends of the wires are connected by soldering, or if merely twisted together be sufficient?
3. The distance the extremities of the bent pieces should be kept apart, and if the soft iron poles projected slightly beyond the bobbins, as in Prof. Dolbear's telephone, would it not do as well, and be simpler than fixing on a bent piece; also, if it would be any detriment to solder on the soft iron pole pieces to the magnet?
4. How such instruments can be regulated, and whether it would not be an improvement to have an adjusting screw at back of tail-piece to enable the magnet to be brought backwards and forwards as required?
5. The size of the magnets?
6. What advantage is found in filling the telephone with paraffin (I presume only the tail-piece), and whether white wax melted would not answer the same purpose?

I should be glad to know how the wires should be connected with the line wires, whether by merely twisting or by soldering, and if any kind of wire can be used for lines. **Mongibello.**

PSYCHO.

[14174.]—Some one seems to have discovered the secret of Psycho, as there is now being exhibited in Birmingham, in connection with Herr Dobler's performance, a similar automaton. Numbers of individuals have propounded at va great variety of very ingenious solutions of the mystery, nearly the whole of which ideas would be impossible to carry out with success practically, and I am surprised that no one seems to have thought of a simple and practical method of forming an invisible communication between the operator's assistants and the figure itself. The fact of the automatom resting on a hollow glass cylinder is a proof that the communication comes through that cylinder, otherwise a solid rod or glass slab would be used. The puenmatic theory is untenable, the various motions could not be obtained by the alternate compression and exhaustion of air; but what is to prevent a second smaller glass cylinder being pushed up from underneath, and being raised, depressed, or revolved to any extent, and yet be invisible to those standing round; or a slip of glass (or half a dozen of them), might be worked inside the cylinder close against it, and be equally invisible, and the machinery of the figure not only set in motion, but guided to a nicety. I have seen the automatons, and am convinced that they are both worked on this principle. Some time ago I contemplated making a talking head to be fixed on a solid rod of glass, all parts being open to examination, but have never had time to carry the idea out, and merely mention it to show that, in my opinion, it is possible to produce something even more remarkable than Psycho. I hope you will give your readers the opportunity of expressing their opinion upon my theory. **W. C. P.**

BRAKES.

[14175.]—In reading the very interesting letter of "C. E. S.," p. 39, on brakes, I see remarks on the vacuum brake on the Cheshire lines, which I can hardly reconcile with what I have observed. "C. E. S." seems to say that the Midland have been forced into the use of the vacuum brake because the Cheshire lines' engines and carriages have been fitted with it. I fail to see how the fitting of their trains could affect the Midland trains from Liverpool to London. I have seen the 9, 10.45 a.m., 12 noon, 2.35, and 4 p.m. trains from Liverpool to London and the corresponding down trains scores of times, and they have always been composed of Midland carriages, and drawn by engines of the 890, 1070, 1280, and 1310 classes. They seemed quite complete in themselves, and independent of every other company. It hardly seems likely that the Midland Company would fit their most important expresses with a notoriously bad brake so as not to clash with the Cheshire lines, whose line is barely one-fifth of the whole distance to London from Liverpool. If the Midland have adopted the vacuum so as not to clash with the Cheshire lines, one could hardly have a more striking example of the pernicious effects of different companies adopting different brakes. I should be very glad if "C. E. S." would set me right on this point.

A statement that has surprised me has been that the L.N.W. Railway Company only allow the chain brake to be used in cases of emergency. On the Buxton line, and some of the local trains between Manchester and Stockport the brake is used on the least pretext, and in a most unpleasant manner—the sudden shock with which it is applied throwing the passengers forward. Even the L. and Y. seem to be making a trial of the different brakes. They have some trains fitted with Smith's vacuum brake, and lately have had an engine (Odin, 601) and eight coaches fitted with the Westinghouse brake. This certainly is a step in the right direction, and it is to be hoped this company will think fit to adopt the air brake, for if any railroad was ever in need of a powerful continuous brake the L. and Y. is that railroad.

It seems a pity that "C. E. S." should be contradicted after he has been to the trouble of making the inquiries about the tank-engine. It may straighten matters a bit if I say that No. 11 had a plate on, with Avonside Engine Company, Bristol, No. 1185, 1877. Would "Egeria" be kind enough to give a table of the engines working the day and night expresses from Euston to Carlisle? **L. L.**

A CURIOUS PHENOMENON.

[14176.]—It will no doubt be remembered by your readers that at the Philadelphia Exhibition a curious phenomenon was observed in connection with the Westinghouse Brake Company's apparatus. It has nothing whatever to do with the action of the automatic brake, but it is attracting great attention at the present time, and I think the following cutting from the *Times* will be interesting to your readers:—

"A Curious Phenomenon.—The Westinghouse Automatic Brake Company are exhibiting at their office in St. Stephen's Palace Chambers, Westminster, a working apparatus which displays the action of the brake upon a train. The apparatus consists of the platform of a single carriage, with the brake levers fitted to the wheels; and upon the platform are the brake cylinders of the other carriages of a long train, placed side by side, but yet separated by the same lengths of tubing which would intervene between them in a train. The whole action of the brake, the means of putting it on and off, and of graduating its force, may thus be conveniently studied, and the instantaneous character of its working is beautifully shown. Appended to the brake gear is a nozzle, arranged for the exhibition of a curious phenomenon which was first observed at Philadelphia. By turning a tap a jet of air, released from great compression, issues from the nozzle; and this jet will support two or three balls, as balls are often supported by a fountain. The peculiarity of the effect, however, is that the jet need not be vertical, but that it will support the balls when the course of the air is at an angle of 45° with the horizon. If the force of the jet, in these circumstances, is diminished, the balls do not fall vertically, but backwards along the oblique line of the stream of air, so as to come nearer to the nozzle. The balls may be of any material, as glass, wood, or indiarubber; but a hollow indiarubber ball, which is of equal thickness throughout, displays some curious phenomena of rotation. When placed in the jet it soon begins to spin; and as the speed of its rotation increases its shape gradually changes, and it becomes first an oblate spheroid and ultimately an almost flattened disc. As it flattens its axis of rotation gradually turns round; and when this axis comes to be at right angles to its original position, the speed of the rotation diminishes, and the ball ultimately comes to rest. For a moment it remains motionless, supported by the jet, and then it begins to spin again upon an axis, and repeats the former changes of position and of speed ad infinitum. At the International Exhibition at Philadelphia these rotating balls attracted great attention, and some of the most eminent mathematicians in the United States were occupied in formulating the laws which governed their movements."—*Times*, March 9.

March 27. **C. E. S.**

G.E.R. LOCOMOTIVES.

[14177.]—In my last letter the fitting of the axle-boxes to the framing was described, after which they are placed on the journals, having been turned to the required fit, and on them the framing is mounted, which has, of course, in the meantime had all necessary stays adjusted.

The cylinders, after having first been bored by one of Craven's vertical boring machines, and otherwise fitted and finished, are then bolted to the framing. The connecting rods are fitted to the cross head of the piston rod, and also to the crank pin of driving wheel. This finishes the construction of the engine. The boiler is 12ft. long × 4ft. broad, and is riveted by an hydraulic riveting machine, not long established in these works. The fire-box and casing, when the barrels of the boiler and tubes of the same have been adjusted, are riveted to the tube-plate. The whole is then mounted on the framing, the steam and exhaust pipes fitted, the boiler lagged, and the locomotive is finished. **Ambidexter.**

BICYCLE BRAKES.

[14178.]—I beg to submit the following idea of mine to bicyclists. It is a brake that acts on both front and hind wheels, the latter actuated by the former. In the fork or some convenient place over the front wheel is pivoted a lever, the shorter arm of which carries a roller, the longer arm is brought close up to the handles, and may be actuated either by pushing, as in the thumb brake, or by twisting the handles. The latter may be effected by having a short chain attached to the lever which is wound up, or by a cam or projection between the handles, which pushes the lever out when the handles are turned. The hind wheel brake is applied as follows:—The front wheel is braked by a roller, not a spoon as in most front wheel brakes; this roller is fixed on a spindle and is suspended in a fork. The spindle projects through the fork on one side, and carries a small pulley, to which the cord of the hind wheel brake is attached. Thus when the roller is brought in contact with the front wheel it revolves and winds up the cord of the hind wheel brake, which is thereby applied. Both wheels can therefore be braked at once. I cannot say whether this is practicable or not, as I have not tried it, not being the possessor of a bicycle. I give the idea for what it is worth, and should like to hear what F. L. Striffler or some other bicycle authority thinks about it.

Abergavenny, March 25th. **W. R. D.**

THE BRITISH WORKMAN.

[14179.]—The facts recorded by "F. R. A. S.," 14134, p. 62, are unhappily only a too common experience. Any one who has to call in workmen to make casual repairs will be very apt to have occasion for similar complaints. But is it quite fair, nevertheless, to make such matters *typical of the British workman?* The preceding column of "F. R. A. S.'s" letter relates to what he (and a good many others) calls "a barefaced and most impudent job." That, also, is unhappily not a solitary instance. Physicians do not mind at times making a good long matter of charges over very simple ailments, and generally it is more easy to get a doctor into your house than to get him away from it. We have heard also of lawyers' bills, and even of counsel of high standing who accept large fees, and make no appearance in support of their clients, and of many who do this with a tolerable certainty that they will be unable to render the services paid for. Would it be strictly fair to treat these matters as typical of the "British gentleman?" As to the case of the man who gets Union assistance, to which he is not forced by absolute necessity, it is bad and dishonourable conduct; but is it much worse than the course adopted by much higher and more educated classes with the Bluecoat School, and a good many other funds, which, originally intended for one (and a necessitous) class, have been gradually absorbed by another and well-to-do class? The fact is, these things are not matters of class at all—they are inherent in human nature. They may even be traced to a fallacious teaching of political economy, by which "Buy in the cheapest market and sell in the dearest" is converted into, "Do as little as you can and get as much as you can for it." Really, too, if we look at those propositions side by side, it is very hard to say where is the difference, and why one is right and the other wrong.

There is, in truth, a serious problem of social and political economy underlying all these matters, which the coming age will have to settle peaceably and gradually, or violently. No complaints about the British workman will aid the settlements which ignore the causes at work. The same complaints have long existed—they are only getting stronger and more defined, because the time is fast approaching when the causes themselves must be examined and remedied. The current complaints about servants are only another form of the same thing. They are quite true and reasonable; yet, paradoxical at it seems, they are utterly unjust and unreasonable. People expect from their servants an amount of steady industry, genial good temper, self-denial, and self-control, which they do not expect, and if they did would certainly not get, from their own daughters. The increase of riches and luxury, the growing disinclination of the employing classes to that honourable domestic occupation which they stigmatise as menial labour, have created a demand beyond the national supply. Precisely the same causes, operating like a contagion, render the service-supplying classes averse to the restraints of domestic life. If the evil (and it is a great one) is to be remedied, the cure must come from, and be applied to, the employing classes first. Until they recognise the "Dignity of Labour," those of whom they claim to be the leaders can only be expected to desire to escape the "Servility of Labour."

The fact is, and it is in vain to shut our eyes to it, that hitherto the world has been worked upon the system of enslaving the many in order to contribute to the luxury of the few. That system has been slowly changing through some centuries; and now, by a law of nature which accelerates the motion produced by a constantly acting force, the steps of the change are becoming more rapid. It is vain to complain of the change, useless to merely deplore even the mistakes and consequent evils which attend it. Probably the poor British workmen, whose dilatoriness our friend records, did not hold a discussion knowingly on political economy during their smoking interval, but something of this kind possibly did pass:—"Jolly sort of place this chap has got, Bill, hasn't he?" "Ah! and he grumbles about a little drop of water getting in; I wish he had to sleep in my place." "What's the next job, Bill?" "Don't know, the governor says do this properly, don't be in a hurry about it, you're not wanted anywhere." If it just did occur to some of these British workmen that this offered an unpromising look-out for the Saturday, and that our friend could better afford to spare the money than they and their families the wages, is it to be very greatly wondered at? It is wrong; I am not defending the actual course then and so often adopted; but what I do wish to do is to point out that it is but a rough and practical form of the coming question, "Why should labour and bare necessaries be the lot of one class, idleness and luxury the privileges of another class?" The answer to that will never again be the one-sided one of the past and still present social system. Those who claim the superior position and higher advantages will have to prove that they are entitled to them by their own contributions to the well-being of all. The self-constituted leaders of the social system will do well to ask whether the conduct of the British workman is not a natural result of the examples set him, and the conditions maintained by themselves. **Sigma.**

HEALING OF WOUNDS.

[14180.]—On p. 61 you quote the opinion of the celebrated traveller D'Abbadie, "that wounds to be healed should be exposed to the air." Experience and observation have given me a contrary opinion, and I have no hesitation in saying that a wound which is kept as much as possible from actual contact with the air will heal in half the time that an exposed wound would. In the cases of burns, and especially, I have noticed that when the ed skin is removed a large open sore is left, takes weeks and sometimes months to heal; other hand, if the blister is pricked to remove iid, and the skin allowed to collapse on the l and carefully covered, it will heal in a few The old skin dries up, adheres to the wound, mes off nearly in one piece, when the healing s is complete, and leaves hardly any scar. and unctuous applications should be avoided, e part should not be even moistened. The es not last long, and soon abates without any ition. I have also seen great benefit derived vering incised wounds with collodion at the hey were bleeding. D'Abbadie's bandaged s may have been improperly or too tightly ed. Most wounds, if properly treated at the will heal by first intention, but are retarded tinual washing, dressing, and exposure, by the coagulum or other incrustation provided ure is softened and removed. In proof of what just stated, I may mention a system of vacn ately introduced. A small blister is raised ans of a cantharidine application. The serum wed to escape and the lymph is introduced h the skin; but this, of course, is too much for poor people who have to be vaccinated hing. **Os.**

—I think cases of blood-poisoning chiefly arise ents of full habit of body, who consume large ties of alcohol, and who make full meals of nwholesome food. In these cases the blood to be already charged with noxious matter. perhaps, decomposes or germinates on contact e air. With such people the slightest injury lises their lives. In fact it has been said of s' draymen, that if they once go into hospital s injury they seldom come out.

SCREWMANIA.

31.]—I AM glad to see that your able corre-nt, "J. L.," has taken up the subject of cutting in the lathe. It is a pursuit in which some interest, and I suppose there are few r turners who have not felt the necessity of some simple attachment to the lathe which at a correct screw with ease and despatch. to remember having seen in the MECHANIC years ago a description of screw-cutting tus by a Mr. Taylor, which, I think, from .'s" description, was nearly the same as machine. A sort of box was fastened on he bed, and the T-rest was fastened to the le lid. A long lever was pivoted in the box the lid. To the other end was fixed a cord passing over a pulley, was wound on the l. A short lever was attached to the lid, other end could be clamped on the long a any desired position, thus varying the pitch sure.

e never made such an apparatus, but on my he I have an arrangement which I find very It is an extension of the plan given in columns some time ago by Mr. Wenham. ly my readers will remember that Mr. Wen-arrangement could not very well be applied to lathes in which the slide-rest had a longi-slide at the bottom. My slide-rest is not so cted—hence an extension of the plan is neces-I may state that the back gear axle is placed he mandrel spindle and not behind, as in the y plan. The lathe band goes direct to a pulley on this axle, and a small pinion gears e large wheel on the mandrel spindle. In f the ordinary back gear shaft there is a spindle made of ¾ gas tube, and motion is itted to it from the mandrel by means of three heels, the middle one of which can be thrown ear when the apparatus is not required. This ment causes the spindle to rotate in the rection, and at the same rate as the mandrel. ly necessary that the wheels on the spindles have an equal number of teeth, the inter-wheel may have any convenient number. e hollow projecting end of the back spindle d a number of pattern screws of different The pattern screws are about 3in. long, re, of course, a nut fitted on each, and are d in the shaft by means of the set-screw. Each be fastened in the jaws of a long fork con-rod which passes along the lathe bed in a h the back spindle. So far this is Mr. Wen-arrangement. By throwing the wheels into cause this rod to move at a rate correspond-h the pitch of the screw we are using, and rangement is now necessary to transmit this to the top carriage of the slide-rest. I lish this in the following way:—An axle n bearings transversely across the foot plate liding poppet. On each side of this axle two levers are fitted. The one on the back side is in ith the back spindle, and the fork connecting fastened in a movable hinge which can be l upon any part of the lever. Upon the ver a similar hinge is fixed, and a rod passes is to the top carriage of the slide-rest, and to t is pivoted. The screw of the top slide must, of course, be removed, and the carriage will then be free to move when motion is transmitted to the rod. Now, it is evident that if the hinges through which the levers move be clamped at equal distances from the axis of motion, the front lever will move at an equal rate with the back lever, and a screw can be traced corresponding to the pattern screw we are using. By altering the ratio of the distances of these hinges from the centre of motion we can vary the pitch at pleasure, so that one pattern screw will serve for various numbers of threads. The error arising from the obliquity of the connecting rods is very trifling. The slide-rest is very convenient, though not at all essential to the complete working of the apparatus. If the V-tool be rigidly connected to the front rod, it may be held steadily on the top of the T-rest. I have a small simple slide-rest which fits in the socket of the ordinary hand-rest; it is very convenient for use with this apparatus, as the screw is easily removable, it can be readily adjusted, and takes up very little room.

Orderic Vital.

TELESCOPIC APERTURES AND TIME OF EARTH FALLING TO SUN.

[14182.]—"8¼IN. O.G." seems to be under some misapprehension as to what is meant by the magnifying power of a telescope being so much to the inch of aperture. He seems to suppose that it is superficial measure, whereas it is not superficial, but linear. Thus, when we say that the power is 100 to the inch, it is not meant that it is 100 to every round inch or square inch in the O.G., but to every inch in the diameter.

Finding that the result given in my letter, p. 44, differs so widely from that given by "F.R.A.S.," p. 61, I have very carefully revised it, but can come to no other conclusion than that there given. Perhaps "F.R.A.S." or "W. C. E.," if this should meet their eye, will point out where it is wrong, if it is so. I have only employed equations which are recognised, to wit—

$$T = \frac{2\pi\, a^{\frac{3}{2}}}{\sqrt{\mu}}$$

$$t = \frac{\pi\, a^{\frac{3}{2}}}{2\sqrt{2}}$$

Kepler's law and the law of falling bodies, for which see "Pratt's Mechanical Philosophy," if necessary; a and μ represent the same quantities in each of them by hypothesis; and if the correctness of them is not disputed it is easy to see that t is to T in a constant ratio—*i.e.*, as 1 is to $4\sqrt{2}$. Mr. G. Pinnington is correct in saying that the law of falling bodies is, that "the squares of the times vary as the cubes of the distances." The law is equally true for bodies falling to a centre, and for bodies revolving about one.

W. G. P.

THE MANUFACTURE OF SALTPETRE.

[14183.]—THERE is an idea frequently current among unscientific people that saltpetre, being a native product, cannot be manufactured artificially. Very often, also, I have observed that when the manufacture of saltpetre was spoken of it was understood as meaning the refining or recrystallising of the native article. As saltpetre is known to every one I think a description of its manufacture will be interesting to many. Although there are several methods of manufacturing it I will only attempt to describe that which is carried on in this country—viz., the double decomposition of chloride of potassium and nitrate of soda. The theory of this process is about the simplest there is, but it is one which requires to be regulated by careful chemical analysis. If the chloride of potassium and nitrate of soda were obtained pure, then the proportions of each would always remain the same; but, as these are obtained in various states of purity, different proportions are used for every fresh lot, calculated from the analysis.

Muriate of potash is the commercial name for chloride of potassium the percentage of which ranges from 70 to 85 in German and from 84 to 90 in kelp muriates. These muriates also contain sulphate of potash, but in saltpetre-making this sulphate is calculated to chloride and added to the chloride already existing, as the quantity usually present (from ½ to 6 per cent.) is decomposed also. In nitrate of soda the refraction (impurities) ranges from 3 to 8 per cent. Suppose we have muriate the total potash in which equals 90 per cent. chloride of potassium, and we have nitrate of soda with 6 per cent. refraction, we find out our proportions as follows: The equivalent weight of pure nitrate of soda being 85, that of our impure article will be 90·4 by the simple calculation—

Percentage of nit. soda.				Eq. of pure nit soda.		
94	:	100	::	85	=	90·4

Having got the equivalent of our nitrate of soda we find the quantity wanted for the muriate thus—

Eq. of chlor. potm.		Eq. of nit. soda.		Per cent. of chlor. in muriate.		Per cent. of nit. soda required.
74·6	:	90·4	::	90	=	109

or 100 parts of our commercial muriate will require 109 parts of our nitrate of soda; but in some works the muriate is weighed out in cwts., making the quantity of nitrate of soda 122lb. for each cwt. of muriate.

Before detailing the process I may mention that German muriates contain chloride of magnesium and sulphate of lime, which require to be rendered insoluble, or the former salt would accumulate in the liquors, and ultimately crystallise with the saltpetre. It is therefore essential that these ingredients be estimated, and sufficient soda-ash used to precipitate them from the liquors. The liquors, however, should be tested periodically for magnesium and lime salts (a solution of carbonate of soda will do), and, if present, precipitated by adding the necessary quantity of soda-ash. Kelp muriate, on the contrary, usually contains alkali, which is generally taken up by the lime and magnesium salts in the nitrate of soda and the water used. When using kelp muriate I have seen the alkali in excess, but never in any quantity to be checked. If it should, however, have increased too much, I would, if possible, have changed on to German muriate for a time.

The charges of "muriate" and nitrate of soda having been weighed out, the first operation is to boil them together, which is done in large circular iron pans, heated either with close steam or fire. The mother liquors, washings, &c., from previous workings are pumped into these pans, into which the "muriate" and "nitrate" are dissolved. If soda-ash is required it is now dissolved in a little hot water and put in also. The whole is heated up, kept well agitated, and allowed to boil for about two hours, according to the strength. The chemical action which goes on is

Muriate. Nit. soda. Common salt. Saltpetre.

$$KCl + NaNO_3 = NaCl + KNO_3$$

As is well known, saltpetre (nitrate of potash) is much more soluble in hot water than in cold, whilst the solubility of common salt differs very little in hot and cold water. Our boiling liquor, then, being saturated with saltpetre, and the mother liquors, &c., when we started, being saturated with salt, it is evident that, although all the saltpetre formed has gone into solution, the greatest part of the salt cannot, being less soluble in hot liquors than saltpetre; therefore it precipitates in fine crystals throughout the solution.

The fires are now drawn, or the steam shut off, as the case may be, and the liquor allowed to settle, when the salt and insoluble matters sink to the bottom. These are fished out by the workmen with perforated iron shovels into drainers. After further settling the clear liquid is drawn off into coolers to crystallise. It is becoming more general to run the liquor off by a pipe at the bottom of the pans, without settling or fishing, through filters consisting of an iron box with a perforated false bottom, on which are laid a few clean nitrate of soda bags and a layer of salt. This way, of course, saves time and labour. When the saltpetre is crystallising the liquor is usually agitated either by hand or machinery, to produce small crystals. When sufficiently cool the mother liquor is run off to be used over again, and we have left the impure saltpetre, containing, when dried, about 15 per cent. of salt.

The products we have now got are saltpetre contaminated with salt, and salt (in the filter) containing saltpetre from a small portion of the mother liquor still remaining. These we have to purify. On looking back at the solubilities of saltpetre and salt in hot and cold water we find how we can do this. If we put cold water on the saltpetre we will dissolve the salt, and comparatively little of the saltpetre. That little, however, in dissolving lowers the temperature of the water to such an extent that a thin film of ice forms on the top. This reduction in temperature renders the saltpetre all the less soluble, and does not affect the solubility of the salt to any extent. Again, when we put boiling water on the salt, we dissolve out the saltpetre and comparatively little of the salt.

To wash the salt the hole in the bottom of filter or drainer is plugged up, and boiling weak liquor from a previous working run on until the salt is completely covered. After standing fifteen or twenty minutes the plug is withdrawn and the salt allowed to drain. Another wash is put on, and so on, finishing with boiling water, and until the strength of the last three washes remains constant when tested with a hydrometer. This is sufficient to wash out almost the whole of the saltpetre. I seldom found more than ·1 per cent. left in the salt. Of course the last washings are used as first washes for the next lot of salt, the first or strong washes going into the pans with mother liquor to dissolve fresh quantities of "muriate," &c. The salt is then turned out and sold as a by-product.

The saltpetre crystals are lifted from the coolers, put into a box with a perforated false bottom, and washed in a similar way to the salt, only cold water is used. The washings are not tested with a hydrometer; the saltpetre usually gets a certain number of washes, the number regulated by previous testings, according to the purity of the saltpetre required. In this, also, the last washings serve as first washes for a subsequent lot. The crystals are then allowed to drain, or they are at once put into a centrifugal machine and dried.

The great use of saltpetre is in the manufacture of gunpowder, in which there is 65 per cent. in low qualities, up to 75 in good qualities. Gunpowder-makers, however, seldom use any kind of saltpetre without being refined in their neighbourhood, because in the carriage it may gather gritty matters, making it dangerous to mill. The saltpetre, therefore, is dissolved over again in boiling-water and weak liquors, and crystallised, the solution cooled quickly by being thoroughly agitated, and having a circulation of cold water round the sides and bottom of the cooler, to obtain the crystals as fine as possible. As the saltpetre crystallises it may be fished out, put into a washing-box and washed several times, first with cold weak washings from a previous lot, then with water, and allowed to drain. It should not now contain more than ·05 per cent. of common salt. To obtain the saltpetre in a high state of purity it is essential that the water used for washing should be as free as possible from floating matter, chlorides, sulphates, &c. In refining for gunpowder-making all iron and steel implements are to be avoided—a piece breaking off the corner of a steel shovel unnoticed, and going among the saltpetre into the mill, would be extremely dangerous. The coolers are usually made of copper, the washing-boxes of wood, and the shovels of wood or yellow metal.

At one time only native (Indian) saltpetre was used for gunpowder. When artificial or "British" saltpetre was introduced gunpowder-makers were rather shy of it, and some of them would not use it on any account. Even in our Government specifications it was stipulated that Indian saltpetre was to be used in making gunpowder, but this, I believe, is now considerably modified. A few gunpowder-makers say there is a difference between Indian and British saltpetre, but where the difference is, chemically or mechanically, I could never find out. I was connected with a gunpowder works where British saltpetre was made, the powder-maker of which either was of the above opinion or was prejudiced. On one occasion I got a quantity of Indian saltpetre to refine for a particular kind of powder, and which was kept separated from the British. To prove whether there was really any difference in the working, and whether that difference could be detected, I substituted British for Indian, and vice versa, and no complaints were heard. I learnt, also, that the results of the powder were perfectly satisfactory, especially when the British was used, on account of a little extra care having been given to that containing the supposed Indian.

J. Napier.

LOSS OF THE EURYDICE—DANGER OF OPEN PORT-HOLES.

[14184.]—Though no one can assert that the Eurydice would have not foundered if her port-holes had been closed, it is certain that open port-holes are a serious cause of danger when a ship is forced to heave over, and that, if they were so arranged as to close whenever the ship is in such a position, a great danger would be avoided. As they are not so arranged, we must conclude that it would be difficult so to arrange them, but it must not, therefore, be concluded to be impossible; and probably some of your correspondents can tell us how to manage. Would this plan answer? Let a number of levers be fixed amidship, with weights on their lower ends, and rods at top fixed to the port-hole doors of each side. When the ship is inclined to either side the weighted end of the lever will be nearer to that side, and the other end more distant, and the port-hole door would be drawn to whenever the inclination is considerable before it is enough to allow any water to enter. The same end could be accomplished by attaching a float to each port-hole door, by which it would be closed whenever the ship is so much inclined as to dip the float in the water.

Philo.

INOFFENSIVE URINALS.

[14185.]—There can be few railway travellers who have not often been annoyed by the bad smell of urinals which are rarely so constructed as not to be offensive. It is true that some trouble is taken and expense incurred to prevent this. For some an ample supply of water is provided—for others chemical deodorants are used with some effect, but generally the result is not satisfactory, and for a very simple reason, because a needlessly large surface gets wetted with urine which, by decomposition, forms ammonia, both offensive to smell itself, and the carrier of offensive particles with it. It is very common for the surface exposed to be wetted to be many square feet in area, some of it nearly level, and all of it made of rough flag, which continues wet a long time, and is scarcely ever quite dry nor yet so thoroughly wet that the urine is completely diluted. Now, this evil might be quite removed without any or scarcely any more cost than is now incurred for removing it very imperfectly. Instead of the flags or the large basins now commonly provided, there should be upright pipes 3 or 4in. in diameter, and about a yard high, with the front cut away for about a foot to accommodate persons of various heights, terminating below in an inverted siphon which would let the liquid run off when about an inch in depth, and prevent any foul air arising except from the liquid in the pipe. If to this a small run of water containing a little carbolic acid were added, not enough to be smelt, there would be no offensive effluvium. If the sides of the upright pipes were glazed, scarcely any urine would adhere. I have been told that none would adhere if the surface were covered with a film of wax or paraffin.

Philo.

NATURAL HYGROSCOPES.

[14186.]—A few notes on simple natural hygroscopes may be of interest to your readers, although probably many of them are well acquainted with those I am about to introduce to your notice. Perhaps the most accurate apparatus for determining the degree of dampness in the air is the screw-shaped appendage of the seed of the Pelargonium, this natural hygroscope approaching in the accuracy of its indications the best hygrometers. The mode of constructing the pelargonium hygroscope is shown in Fig. 1. E is the support of the spiral appendage of the seed, F, which is inserted in a block of wood. G S is a light wooden needle or piece of straw fixed by collodion to the extremity of the spiral. The end, S, turns over a dial, C D, divided as shown in the plan view. On this circle, zero corresponds to the greatest humidity, and 100° to the greatest dryness. Between these extremes are traced five spiral turns, as the helix does not usually unwind on itself more than four times. Each turn marked is considered as beginning on the diameter, 0 to 100. Thus, for example, if the helix makes two twists and a half, the indicated degree is read on the third turn of the spiral marked on the dial where the needle points to 50°. As the helix is quite fragile, a few copper wires may be arched over it to protect it from chance injury. Fig. 2 shows the indications of the pelargonium hygroscope (in dotted line) as compared with a Mason hygrometer of fine construction. The accordance of the indications is quite remarkable. There are two other hygroscopes which are even more simple, though far less useful as hygrometers, than the foregoing. The first is merely a cork in which a needle is inserted as a pointer, suspended from a nail by a catgut cord. The catgut cord contains more or less twist in proportion to the quantity of moisture in the air. The needle, therefore, as the cord turns, swings in one or the other direction; and by a little experimenting a dial can easily be made upon which its indications may be read to scale. The simplest hygroscope of all is a ginger-bread cake, placed on a ledge. This kind of cake (especially some makes) is very sensitive to variations of humidity in the air; and when dampness is present it bends over the ledge. During dry weather it returns to its horizontal position. A straw may be fastened to it as an index, and a dial, as above noted, be constructed by experiment.

J. T. M.

FIG. 1

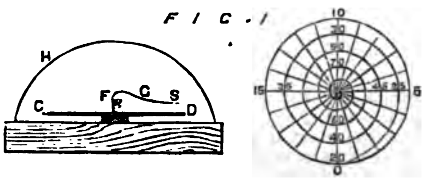
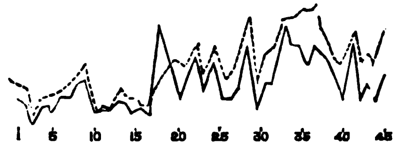


FIG. 2



KENTISH RAGSTONE AND CRYSTALS.

[14187.]—I do not know the place indicated by Harrietshaw in Mr. C.'s original letter (13824, p. 428), but in the neighbourhood of Maidstone I have obtained crystals which are probably the same sort as his. They adhere in thin layers to exposed surfaces of the "rag," probably the sides of fissures through which water, charged with the constituents of the crystals, has percolated. My analysis of these coincides with Mr. C.'s. Taking colourless crystals, complete solution in HCl was obtained with effervescence of CO_2. The solution gave every ordinary reaction for Ca, and also a *greenish* precipitate with H_4NHO, a *light blue* with K_4FeCy_6, a *deep blue* with K_3FeCy_6, and *no colour* with KCyS, indicating a ferrous salt (probably $FeCO_3$), in addition to the calcium. As to the *shape* of the crystals I speak with greater hesitation. Crystallography is to me a considerable m "mess," as A. Ward would say), and in of calcite, with, according to Mr. C., its 60 dary forms, one may be pardoned for think somewhat too short to study them. The are small, and adhere closely together and "rag," so that it is difficult for a novice out the true form. But I can plainly see pentagonal faces to each crystal, in the many that are better placed for observation incline to say "pentagonal dodecahedron place the matter beyond doubt, I have se specimens to a well-known mineralogist, H. Collins (letter 14078, p. 629), with a ho he will communicate to these columns the of his observations on them. If they are new form of calcite (or ferro-calcite to coin probably "G. J. H." would like a specimen

Dagh

ORGANIC CHEMISTRY.

[14188.]—"Jup. Rex." says, in letter "On the subsequent liquefaction and solidi of the mass of the earth, no mineral metal bonates could have been formed." How is t the metallic carbonates are decomposed at a they can take up the carbon dioxide on again. Carbonate of lime, for instance, is posed at a red heat, but as soon as it cools up carbon dioxide on cooling. I quite agr him in regard to the new definition of that of chemistry which has so long been misund Of organic chemistry I hope we shall now more, for in these days of scientific advance is very strange if the name of the science is a misnomer.

Fer

THE KETONES.

[14189.]—Ketones are substances deriv the acetic or fatty series of acids by the subs of a monad positive radical, instead of the h of the acid, thus: acetic acid CH_3COHO CH_3COMe by the substitution of the radic or Me, in the place of the HO of t CH_3COMe is termed acetone, and may be $COMe_2$, which is a compound of carbonic ox the monad positive radical methyl. The therefore, are compounds of carbonic oxide radicals of the series $CnH_2n + 1$. The keto a marked resemblance to the aldehydes, CH_3COH is acetic aldehyde, and CH_3C acetone, the acetic ketone, in which the rad supplants the H of the aldehyde; when the other dead salt of a volatile monobasic acid mitted to dry distillation, a ketone is one products formed, thus: $(CH_3)_2(CO)_2CaO''$ converted into $COCaO''$ and $COMe_2$. Mos ketones, like the aldehydes, combine w alkaline hydric sulphates thus: CH_3CO $SOKOHO = SOKOHO, CH_3COMe$. But the aldehydes, they do not reduce ammonia tions of argentic oxide, and do not oxidise sure to the atmosphere. Nascent hydrogen the ketones into secondary alcohols thus: C $H_2 = CH_3CMeHHO$, and the aldehyde CH_3 $H_2 = CH_3CH_2HO$, the normal alcohol. The ing are the most important ketones—viz., CC $COCH_3C_2H_5, COCH_3C_3H_7, CO(C_2H_5)_2, COC_2$ $CO(C_3H_7)_2$, $COCH_3C_4H_9$, $COCH_3C_6H_5$, CO $(COEt)_2C_6H_4$, &c. These ketones may be by distilling salts of the fatty acids thus: 2 C $1\,COKO = COKO_2 + CO(CnH_2n + 1)_2$. oxide acting on a sodic compound forms thus: $2Na(CnH_2n + 1) + CO = CO(CnH_2n$ Na_2. The zinc compounds of the monad radicals act on the chloracids of the same forming ketones thus: $Zn(CnH_2n$ + $2COCnH_2n + 1\,Cl = ZnCl_2 + 2CO(CnH_2$ Ketones containing two different radicals obtained by distilling two fatty acids, $CH_3COKO + C_3H_7COKO = COKO_2 + COC$ And zinc eltride acting on the chlorides from the dibasic acids forms ketones h diadradical thus: $(C_2H_4)^{11}$ $(COCl)_2$ + Z $(C_2H_4)^{11}$ $(COEt)_2$. Acetone, CO $(CH_3)_2$, known of the ketones, is obtained by d calcic acetate or plumbic acetate with weight of quicklime, or by passing the va acetic acid through a porcelain tube heate ness. Sodic acetate, on ignition, yields thus: $2CH_3CONaO = CONaO_2 + C$ Acetone is a colourless liquid, specific gra having a pleasant odour, and boils at 56° other ketones boil at temperatures that inc the number of carbon atoms in the radical i Acetone burns with a clear white flame, a heated gives off an inflammable vapour.

Hugh Clen

Kentish Ragstone and Crystals.—
—The words, "As an undoubted and und fact," which are made to commence the la graph of letter 14155, p. 76, should conc paragraph before, and have the full stop a not before them.—G. J. H.

EPLIES TO QUERIES.

s their answers, Correspondents are re- ly requested to mention, in each instance, and number of the query asked.

.]—**Engines on the Somerset and Dorset Railway.**—Your correspondent "The New page 43, No. 31878, again disputes my upon pages 536 of the last, and 19 of the volume, with regard to the existence of the built by the Midland and London and South Railway Companies for the Joint Line. ending the answers referred to I did "make cquainted with the facts," as I not only was informed of their existence, but I saw some ngines myself. I am well aware that the e Engine Company have lately built some for the Joint Line, but these have nothing r to do with those built by the leasing com- I have to-day, March 27, made further in- and the fact of the engines having been built ll known that I am quite at a loss to under- ow "The New Clock" can contradict my ats in page 19.—C. E. S.

.]—**Bogie Tanks on S. and D. Joint y.**—I have for many years been a reader of er, but my duties as a locomotive official . and D. J. R. prevent me giving the time g to the ENGLISH MECHANIC so often as I ish. But I see on page 43 the "New Clock" the wrong for once. We have five engines, Derby, and five by the South Western in 1877. I went to Nine Elms with others to oilers tested, and also to Derby, and if the lock" knows anything of the L. and S. W. must have heard of these engines. I saw vings when they were designed, I saw the under construction, I have been upon them, e them every day; so what is the use of say- do not exist? They are a fact, sir, and not t, but they do their work as well as possi- e of them, built 1877, on Beattie's patent, es 9lb. of water per 1lb. of coal. I am at Midland works to-day, seeing a new tank r the Joint line, and I go on Monday to the Western works, London, to see another of gines.—S. D. J. R. LOCO.

]—**Shoemaker's Ink.**—If "Exon" will ive the quantities of each article required he ge—SHOEMAKER'S APPRENTICE.

.]—**Time of Fall of Earth to Sun.**—I "A Fellow of the Royal Astronomical " that the reason I gave one-fourth of the periodic time for the time of falling to the this. On going through the calculations. my using an incorrect mass of the sun, I about 90 days, so I assumed it must be a the time of revolution. I now no longer would take one-fourth of its periodic time, thing nearer 65 days. It is very certain it e less than 82·2 days—a result we get by the sun's effect on the earth to be uniform beginning to the end of the fall. But by the earth has completed one-half of its the sun's effect will be increased fourfold, ll cause the earth to fall with much greater than it would were the force of gravity Now, which would be the best method of ng the effect this increase of force would n the time of fall? I only know of one, and ld be extremely long.—J. G. VINE.

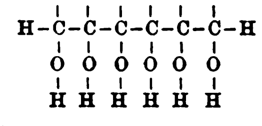
]—**Compound v. Ordinary Condensing s.**—On page 44 F. H. Wenham says, "the advantages of these engines must depend primary pressure employed in the boiler." turn to my letter, March 15, page 19, he that, with equal initial and terminal pres- l ratio of expansion, there is no advantage ompound system. Why F. H. Wenham lvance the above statement I do not com- as I fail to see the connection between a d engine working at one initial pressure, rdinary condensing engine at another. If o compare two classes of engine fairly, each of each class must be taken as working nditions similar to the rest. I certainly do t the statement that at a pressure of 200lb. und engine becomes a matter of necessity, igher the initial pressure is the less the area required, and therefore the shock to the ot felt. If we have a cylinder of a given king at a given pressure it will be necessary the area by one-half if we wish to double ing pressure—in order to expand—and still same amount of weight, so that, although ure is doubled, the shock on the recipro- arts remains the same, because the area m is reduced to half what it previously was. loss from re-evaporation, &c., in expand- gle cylinders, it can be so far overcome by ketting, high speed, proper arrangement of c., that I am still convinced that the most al engine will yet be constructed on the linder system.—JOHN S. SUNDERLAND, Bridge, near Huddersfield.

]—**Compound v. Ordinary Condensing s.**—F. H. Wenham says he knew a manu- who passed exhaust steam from an auxiliary boiler of condensing engine to be used over again in condensing engine, and effected a saving of half feed water and fuel. Of course it must be a saving in water and fuel, but to get exhaust steam into boiler is the job. It has been tried a long time by Marchant and others with no saving. Of course it could be done, but it would take a lot of the power from the auxiliary engine in pumping exhaust steam into boiler, so the question is, does it pay to use power that way, or use the full power of the auxiliary engine, as usual with condensing engine?—A YOUNG ENGINEER.

[32036.]—**Wheel-Making.**—In the few lines I wrote, p. 608, No. 675, I merely endeavoured to impart information which, on Mr. Shearing's own confession, he seemed to lack. As he considers my explanation "the most unique he ever heard of," I beg to refer him to "Mechanics and Mechanism," by Robert Scott Burn (a name good enough, surely) page 35, where he will find that I am not altogether alone in uniqueness. I am perfectly aware that axles are "bent downwards," but I have yet to learn that this process is adopted, "so that the bottom spokes of the wheel would be perpendicular on level ground." It may be my ignorance, but I was under the impression that one reason was to prevent the nave of the wheel from binding too much against the shoulder of the axle; another, that the circumference of the wheel might be thrown further from the body of the vehicle.—J. L. B.

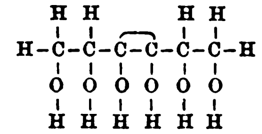
[32042.]—**Alum Analysis (U.Q.).**—The sample must be pulverised finely. Sulphate of alumina: One gramme must be dissolved in hydrochloric acid. The insoluble must be washed with boiling water, dried, ignited, and weighed. Weight × 100 = Silica percentage. Precipitate the solution with ammonia, filter, wash, dry, ignite, and weigh. Result equals alumina. Calculate the amount of acid taken up to form the sulphate, and add it on to the alumina. Result equals sulphate of alumina × 100 for percentage. Free sulphuric acid: One gramme of the sample is dissolved in acid and filtered. The solution is precipitated with pure barium nitrate or chloride, filtered, washed, dried, and weighed. Result equals barium sulphate. Calculate this to sulphuric acid, and deduct from this the amount of sulphuric acid taken up by the alumina. The difference equals free sulphuric acid × 100 for percentage. Moisture: One gramme is dried at 212° Fah., until no farther loss of weight is observable × 100 for percentage. Impurities: Add up the calculated results, and deduct from 100·00. The impurities probably consist of iron and lime.—FERRUM.

[32103.]—**Organic Chemistry.**—There does not seem much for me to reply to in the first part of Mr. Clements's communication (page 19), but I may say a few words concerning the last three graphic formulæ. No. 1 is clearly inadmissible, and the remaining two seem somewhat intricate. Mannite, which may be taken as the starting point of this group, is a hexahydric alcohol, having the formula—



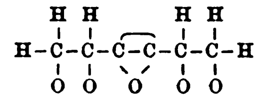
$$\begin{array}{cccccccc} & H & H & H & H & H & H & \\ & | & | & | & | & | & | & \\ H- & C- & C- & C- & C- & C- & C & -H \\ & | & | & | & | & | & | & \\ & O & O & O & O & O & O & \\ & | & | & | & | & | & | & \\ & H & H & H & H & H & H & \end{array}$$

Glucose differs from this, in having only twelve atoms of hydrogen, and its formula may probably be—



$$\begin{array}{cccccccc} & H & H & & & H & H & \\ & | & | & & & | & | & \\ H- & C- & C- & C- & C- & C- & C & -H \\ & | & | & | & | & | & | & \\ & O & O & O & O & O & O & \\ & | & | & | & | & | & | & \\ & H & H & H & H & H & H & \end{array}$$

The class of compounds at present represented by the formula $C_6H_{10}O_5$ differ from glucose in having one molecule less water, and the simplest formula which can be assigned them is—



$$\begin{array}{cccccccc} & H & H & & & H & H & \\ & | & | & & & | & | & \\ H- & C- & C- & C- & C- & C- & C & -H \\ & | & | & \diagdown & \diagup & | & | & \\ & O & O & \multicolumn{2}{c}{O} & O & O & \\ & | & | & & & | & | & \\ & H & H & & & H & H & \end{array}$$

It would not be difficult to construct isomers, preserving this general plan, which would account for the various compounds having the above formula; but it must be remembered that we really do not know for certain the molecular weight of these substances. The molecule of cellulose, for instance, must contain at least $C_6H_{10}O_5$; but it may contain $C_{12}H_{20}O_{10}$ or $C_{18}H_{30}O_{15}$, and until the problem as to what it does contain is settled, speculations regarding its graphic formula are of but little use. The isomerism of mucic and saccharic acid is a further indication that the four bonds of carbon are not of equal value.—WILLIAM JOHN GREY.

[32120.]—**Definition.**—The 3¼in. Wray would have a focus of 45in. And, assuming that you can read the correspondence columns at 30in., you would require an astro eyepiece composed of an eye lens ⅓in. focus, and field lens 1in. focus, mounted ⅔in. apart. The lenses should be both plano's, and as large as you can get them. You must also have a diaphragm midway between the two lenses, and having the same diameter as eye lens. The eyepieces, A, B, C, belonging to microscope, will do very well on the moon, and on some of the stars, but not being achromatic are inferior to the Huyghenian form. I would recommend you to have 4 eyepieces, about 45, 90, 200, and 300.—W. J. LANCASTER.

[32129.]—**What is It?**—"J. H. C.," I think, must be mistaken. Either "J. H. C." or I do not know what "Patlander" means. Certainly frog-spawn does not resemble boiled starch. Very few frogs spawn in February; and certainly every one knows what frog spawn is like. I am sure "J. H. C." is wrong—*i.e.*, if he thinks the jelly-like substance is any other than what I said in my communication which was published on March 8.—JOS. ATKINSON.

[32129.]—**What Is It?**—The jelly-like substance found in fields, &c., which "J. H. C." thinks is frog-spawn is possibly an alga (*Tremella Nostoc*). I have not seen the query which "J. H. C." answers by his suggestion of frog-spawn, and consequently cannot judge which solution is the more probable, but the alga above referred to so puzzled country people that they gave it the name of "star slough," supposing it to be the remains of a meteor or falling star. It is usually of an olive tint, and is lobed and waved, becoming skinny, dark brown, and brittle when dry. I have found it in quantities on the chalk downs about Winchester. The gelatinous matter when smeared on the hands is said to emit a phosphorescent light. Withering, in his "British Plants," when describing this alga, says that after very severe frost he frequently found a gelatinous substance which at first sight might pass for a Tremella, but which proved to be the remains of frozen frogs. This substance, he says, does not shrivel up in dry weather as the Tremella does, nor is it plaited or waved, and generally some of the bones of the frog may be found in it.—S. H. G.

[32143.]—**Hydrocarbons.**—Gasoline is the best hydrocarbon, amongst the cheap constituents of petroleum, for carburetting gas.—J. T. M.

[32145.]—**Burning Compound.**—Has H. Farmer tried ordinary gunpowder mixed with the wax? His conditions are too strict, I am afraid. Gun-cotton, dynamite, and other compounds, will burn fiercely without explosion, but it is doubtful if they will do so when mixed with wax.—PYROS.

[32153.]—**Bell Hanging.**—If Mr. Taylor would ask a specific question, he would probably obtain an answer, but no one cares about writing a treatise in answer to a query.—S. M.

[32165.]—**Pianoforte and Harmonium.**—The request of "J. H. U." is certainly modest. He requires details for making a combined pianoforte and harmonium, apparently overlooking the fact that a useful method of combining those instruments would be certainly patented. He should search the indexes published at the Patent-office, which may, I believe, be seen in all large towns—those (called abridgments) with brief descriptions of the inventions, are the best—and then purchase the complete specifications with drawings. I believe he may make an instrument for his own use as an experiment without fear of infringing the rights of the inventor. I had occasion some time ago to make a collection of patents relating to pianofortes, and found every facility at the Patent-office Library. In my list I find that B. Johnson and W. Clarke patented in 1863 methods of combining pianos and harmoniums, so also did E. Lea in 1864, and B. Johnson in 1866; but neither of those impressed me with any great idea of its merits. Possibly, within the last two or three years, something else may have been patented, but my list does not extend so far, and being interested only in pianoforte improvements I have not looked into those which seek to combine the organ and harmonium with it.—STRINGPLATE.

[32166.].—**Power of Springs.**—"J., Leeds," should refer to page 413, Vol. XXIV., for means of ascertaining strength of spiral springs.—J. G. P.

[32180.]—**Throstle Bobbin.**—I cannot comprehend what "Overlooker" and one who signs himself "30 Years' Experience," mean when they state that a full bobbin runs quicker than an empty one; "Overlooker" concluding afterwards if a bobbin full of yarn ran quicker, the yarn would snarl or go slack, "30 Years' Experience" agreeing with him. Now, it is a fact that a full bobbin always runs quicker than one less full of thread. Snarling arises from the drag not being sufficient to keep the tension of the thread for winding on the bobbin. I have seen bobbins made to run faster than the spindle without snarling, but the drag must be sufficient to keep the thread the proper tension, and prevent it becoming too slack. Also, a bobbin may run the same speed as the spindle; for instance, in ring spinning. In this case the tension or drag is produced by a small piece of metal, pulled by the thread round a ring after the bobbin, the latter giving twist to the thread. The drag of a bobbin, no doubt, is increased by the addition of weight of thread, but this is compensated for by the increased leverage the thread acquires by the increased size of the barrel of the bobbin.—J. JONES.

[32189.]—**Steam Vessels in the Navy.**—Does E. Phillips mean men-of-war or what? A complete list from 1873 would be difficult to get.—J. T. M.

[32198.]—**American Organ.**—The best octave coupler I know of was figured on p. 120, Vol. XXIII. In any moderate-sized bellows there is no difficulty with the different pressures exerted by the springs.

When you want to play soft you blow gently, and when you want it loud you blow hard. Except at the two extremes the pressure is fairly equal. "Amateur" seems to have hit on one of the great defects of American organs blown by hand. The American organ is an essentially expressive instrument, and to blow by hand with "measured beat and slow" is to destroy the music. It is all very well of course for practice with pedals.—Organon.

[32202.]—**Colliery Steam Pump.**—Will "A. B." make his questions clearer? I cannot see what he wants to know.—J. G. P.

[32219.]—**L. C. and D. R. Engines.**—In my reply to the above query on page 21 a printer's error occurs—Oxford junction, which should read Otford junction.—G. L. P.

[32224.]—**Ruby Pin of Lever Watch.**—This pin gets out of the "fork" in consequence of the "guard-pin" not being sufficiently near to the edge of the roller, and hence it passes at times by the act of setting the hands back, and at other times by the act of winding; especially when the watch has no maintaining power, or the "going-fusee" does not act properly. Sometimes this defect may be remedied by bending the "guard-pin" nearer to the roller.—Seconds' Practical Watchmaker.

[32242.]—**Watch Query.**—"One Open to Learn" should make a file suited to the requirement by making a "smooth verge file" red-hot, and when cooled file the end of it narrow, shaping it to the form of dovetail required, leaving the rough edge of the file to form the base of it, so that when the file is formed the edge should be sloped sufficiently to cut the dovetail any required angle. The files as sold are usually unfit for the job. Before using it make it quite hard by fire and water.—Seconds' Practical Watchmaker.

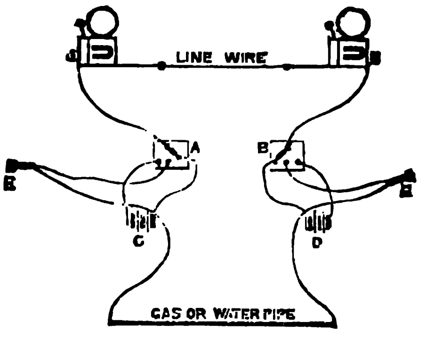
[32248.]—**Repolishing Marble Clock.**—Sometimes I have improved the glass by polishing with a rubber formed of clean cotton-wool charged with putty powder, mixed with oil to the consistency of cream; and when smoothed, use the fleshy part of the hand (clean) and the same powder slightly damped with milk, finishing off with dry powder and the hand.—Seconds' Practical Watchmaker.

[32268.]—**Great Eastern Engines.**—We have about 30 of 87 class; they were designed by Mr. Sinclair in about 1860, and have been doing the express work. Four of them have vacuum brakes—namely, 51, 60, 291, and 300. Two are stationed at Norwich, and 2 at Ipswich. They have 7ft. drivers, and 16in. cylinders, with raised fire-box. They have been making at Stratford works several 4-wheel coupled engines, with 6ft. wheels and bogie truck. Five are fitted with the Westinghouse brake, and 4 with vacuum brakes. There were 2 4-wheeled coupled engines built at Stratford, in 1874, of Mr. Johnson's design, with 6ft. 6in. coupled wheels, with inside cylinders. I have known them to run the 7.3 p.m. up Cambridge train to Tottenham, a distance of 50 miles, in 55min., with 16 coaches on.—G. E. R.

[32302.]—**Midland Carriages.**—The Midland Railway Company last week commenced running the carriages to which, I suppose, "Mathematicus" refers, on the Manchester expresses from St. Pancras. Externally the carriages are exactly similar to the Pullman cars, running on two 4-wheel bogies, and having a balcony at each end. Internally there is a gangway down one side from which compartments open, each of which contains 6 seats. There is a separate portion reserved for smokers, and in the 3rd class cars a commodious luggage compartment. The guard is thus enabled to walk from one end of a train composed of these carriages to the other, and the passengers to communicate with the guard. The carriages I have already seen have been numbered from 1 to 8, and one set of four was run last week on the 5 p.m. Manchester express, in combination with a Pullman car and a few composites and brake-vans. They are fitted with Smith's vacuum brakes, and, so far as I have yet experienced, run very steadily and smoothly (though not so smoothly as the ordinary 6-wheel bogie carriages). Although much appreciated by the passengers they have not been found by the M. R. Co. to be wholly satisfactory, and have been withdrawn in favour of the ordinary rolling stock which was previously run on the Manchester expresses. Perhaps "C. E. S." could inform us why they were withdrawn, and whether it is likely that they will again be put on the rails.—H. L. S.

[32308.]—**Jamin Magnet.**—I should be obliged if "Glatton" would say how many layers of copper wire give the best result: in the engraving, there appears to be only one layer.—J. M. E.

[32312.]—**Electric Bells.**—The following method of connecting bells and telephones with one wire has not yet been mentioned. I think, and seeing that the telephones are by this arrangement thrown out of the circuit, while the bells are ringing, and thus not subjected to the battery current, perhaps it is to be preferred. A and B are two switch arrangements having a movable arm fixed to the top button, and capable of sliding over the lower three, and making contact with either. C and D are the batteries, E and F the telephones, and G and H the bells. In the diagram the switches are shown in the position in which they are always left after using. Then, by turning either of them on to the end button, both bells ring, thus letting the ringers know that the circuit is complete. The switch is then moved back for the answer. When that has been received, both switches are moved to the middle button, which brings the telephones into circuit, and conversation may be carried on. It is necessary to remember to move the switches back after the conversation is finished. A friend and I use this arrangement over 300 yards of wire. It may interest some of "ours" to know that we use uninsulated copper wire, which is carried over the roofs of several houses, and across three streets without any insulation whatever, and the gas-pipe is used for the return circuit. We use three Leclanché cells of 1 pint capacity, and find them just sufficient for our purpose. Two were not powerful enough. This has now been in use for several weeks, and the weather does not seem to have any bad effect on bells or telephones. I have written this since. I dare say many of "ours" would not think of using naked wire for bells. A wrinkle I have found out connected with the telephone is, that the strength of the magnet makes more difference than some might suppose. A pair which were working miserably I took to pieces, and had the magnets re-magnetised, and they now work splendidly. Many thanks to Mr. Lancaster for answering my query of some weeks ago. Since writing it, I have made two or three pairs in different ways, and have found out for myself most of the questions I asked then. My experience as to iron cores is that they don't make any perceptible difference for ordinary purposes, and I also find ¾oz. of wire work perhaps rather better than ¼oz., but there is very little difference.—S. Y.



[32345.]—**Grain of Violin Wood.**—I am glad "Fiddler" has propounded this query, and heartily endorse it, hoping it may induce amateurs to explore the hitherto much-neglected study of resonant bodies. It was only the other day that a popular lecturer expressed to me his surprise that so interesting a subject should be so neglected. It is one, moreover, in which, for many reasons, an amateur would be more likely of success than a professional. Certain facts are known in relation to sympathetic and mechanical vibration, but the causes are yet a mystery. It is, for example, not surprising to find a thick-weighted bass string reproduce higher notes than its fundamental up to a certain limit, but when we find it as readily returning in a prolonged note the shrillest whistle, we are apt to marvel how so thick a string can subdivide itself into such necessarily minute vibrating segments. But even this is not all. A sensitive soundboard by itself, and irrespective of ulterior aid, will do the same—certainly, in a feeble but yet in an unmistakeable manner; and as in the latter instance we can hardly imagine the whole substance of the wood to so pulsate, it seems only accountable by supposing the agent to be either independent vibratory strata, or that the sound is a series of echoes resounding from the lining of miniature sound chambers existing in the grain of the wood. This is a portion of the subject in which I think our army of microscopists could give valuable aid. Every one knows how much superior is the tone, both in power and purity, of a genuine old Cremona violin over the best modern model. Now, this superiority cannot be in the shape, for the imitations are fac-similes. It must, then, lie in some minute difference of the grain, probably from the fact that certain saps have so shrunk with age as to leave the linings or walls of these chambers free to pulsate; but this Art, as yet, has been unable to imitate.—W. H. Davies.

[32345.]—**Violin.**—On page 47, instead of "flat backs," it should be slab backs, and, instead of combine to "send" the truck over, it should be bend.—Bosh Faker.

[32364.]—**Experiment with Magnet.**—The best method for showing any reduction of magnetic power is to have short pieces of iron wire, and have them coloured so as to be distinguishable, and their ends well polished; then suspend them from the pole of magnet. Probably six or seven will hang. Then on the lowering of the magnetism, the bottom one will fall off. I am not sure that a magnet will let them fall, unless you weight the magnet to its utmost inductive power.—W. J. Lancaster.

[32366.]—**Organ Queries.**—I am obliged by Mr. J. S. Taylor's reply. I admit that in asking him to refer me to a "good old organ" by Walker, I did so with the mind to put a value on his opinion. I certainly did not expect to be referred to the Exeter Hall organ. We now know the sort of standard by which Mr. Taylor criticises Schmidt, Harris, Schulze, and Lewis. Quality and weight of metal are simple matters of fact. If Mr. Taylor knows of English builders who "continually us better metals than Schmidt's (according to Hopki over three-fourths tin), why should he not na them? I was under the impression that no Engli builders used more than half tin, except perh occasionally for gambas, &c., and reed tubes.—S.

[32372.]—**Contraction of Pupil of the Eye.** I could tell you what to do under ordinary circu stances, but I do not feel inclined to recommend y to do anything which might give temporary relief probably, a greater cost. Now, you had better se good oculist, and let him know the history of yo case, and, doubtless, he will soon correct the erro Don't drop any of the eye lotion or any tinctu into your eye until you have good advice or st your case more clearly, with every variation of pu for morning and evening, and note how much pupil alters when looking at a bright light, and th passing into the dark. Get a friend to do this you by screening your eyes, and then let him m the amount of contraction when the shade is remov and vice versâ. State this, and your occupati and I will endeavour to assist you. Still, it wou be better to go to the oculist.—W. J. Lancaste

[32379.]—**L. and N.W. Railway Engines** The class whose dimensions "Douglas" wants ha I believe, wheels, 6½ft. diameter; cylinders, 17in. 2in.; boiler, 10ft. by 4¼ft.; about 200 tubes; fire-b 4ft. 8½in. by 3ft. 6in. by 5ft. deep. I have not their other dimensions. I do not know why boiler is so high above the wheels, unless it be beca the motion is very heavy to balance it, and to aff plenty of space in it and the fire-box. I do not thi they do maintain a high speed with a heavy lo better than the G.N. 8-footer. If "Douglas" w send his address to "G. L.," Post-office, Tamwort who will forward it to me, I will send him as ma of Cornwall's performances as I can muster togeth —Itzaex.

[32384.] — **Telescope.** — The plane should mounted at an angle of 45°, with the arm carrying and should have a second back, to which it fastened by means of either a ball and socket or screw with rounded back fitting into socket. Arou this, at equal distances, are three adjusting screw By means of these you can adjust the plane wi ease, and can have the centre of plane at the sa altitude as centre of eyepieces. You may mou the plane, together with the eyepiece tube, and ha the adjusting screws outside the body of telescope.- W. J. Lancaster.

[32388.]—**Apparatus for the Oxyhydrog Limelight.**—This question has been answered ov and over again in these pages. Personally, I pref the old gas-bag system to any other system I ha yet tried. Of course, there are drawbacks to eve method, but the simplest method for production the light is the gas-bag method—that is, I mea with reference to carrying it from place to place. I however, you want it in one place always, then all means fit up gasometers of galvanised iron.—W J. Lancaster.

[32395.]—**Reflecting Telescopes.**—Let the di tance from centre of speculum to centre of plane 4ft. 6in., then from centre of plane to eyepiece tub 4in., and have a sliding tube covering another 4 to slide.—W. J. Lancaster.

[32408.]—**The Phonograph.**— In answer "J. H. H." I only refer him to the *Times* of Janua 17, but give from memory the following dimensio The cylinder is 4in. diameter, and 4in. long; diamet of diaphragm, 2in; pitch of screw, ten threads to inch. The point in the centre of the diaphrag should be blunt. I believe these measurements a right.—T. L.

[32410.] — **Music.** — Let Cornet take lead, S, E♭ take T; baritone, A, E♭ bass, basso, or c cornet lead, one alto, transpose tenor for barito and bass for bass.—Bandsman.

[32413.]—**Return Tickets.**—The Midland and t London and North-Western, as well as Gre Western, have considerably lengthened the time f return journey; but I do not see that any advanta could be gained by letting them run over twel months. The tickets would be lost, and the own would be much more out of pocket than by t present system. There are other reforms requir in the railway companies beside the one referred t —W. J. Lancaster.

[32414.]—**Heliopolis.**—In reply to "Inquirer, Heliopolis, or the Scriptural On, is situated eig miles N.N.E. of Cairo, or, to be more particular, Bett's map of Romanum Imperium its position placed in lat. 30.10 and long. 49.30, and in same ma "Inquirer" will see the Syrian Heliopolis be refer to in lat. 34.7, long 54.30. The former place is i ruins—in fact, its position now is only to be trace by mounds of earth, and an obelisk 68ft. 2in. i height. In Lempriere's Classical Dictionary Helio polis is stated to be a city of lower Egypt, now calle Matarea; to have had a temple sacred to the sun and a worship by the inhabitants of a bull calle Mucvis. The geography of the ancient writ Strabo, and perhaps "Rollin's Ancient History," ar the only works, I believe, in which "Inquirer" woul find any description or history of the Egyptia Heliopolis; but where he will be able to see the forme work I cannot say.—Argus.

[32419.]—**Telephone.**—1. The magnet is in fault it should be sufficiently strong to pick up an ounce weight easily. Have them remagnetised; then probably, they will work well. 2. By all means, for

:es. use double-line wire. The plate the proper distance from magnet, sound will be feeble.—W. J. Lan-

'elephones.—Apparently the magnet ," instrument is not close enough to the he magnet, although weak, should act ment is carefully looked to, but it is it hardened and strongly magnetised. wire. There may be a defective joint in —A. McNae.

)xyhydrogen Light.—I cannot think uld be gained by heating the oxygen it; the difference in the heat of flame naterial, and beside the gas would be , and the supply would be diminished; ore than counterbalance the gain.—W. R.

rickmaking.—"Ishtar" must know aker of machines "makes the best," m is no exception with makers of brick My advice is, if you really want the :tice and time, spend a week in York-rickmaking district, where nothing but used. Visit a score of yards where you dozen kinds of machines, and perhaps inds of clay, and if you make good use ears, and tongue, you will learn more of written matter could teach you. I that if this system was more adopted ening new yards there would be less of work. For instance, B opens a yard ne highly spoken of, and in less than nds out it does not suit his clay. At a oss he tries another, which is replaced thin a couple of months, and then the on his mind that he has gone the wrong ltogether. If "Ishtar" thinks proper is address, any information would be y—Foreman Brickmaker.

rickmaking.—I can strongly recom-ne I saw working the other day. The no mixing, but was thrown into a pug rced it into moulds placed in a circular revolved. The filled moulds are now great pressure, then in another press, e to the kiln, all the work being auto-machine was most highly spoken of by ut "Ishtar" cannot do better than articulars to the makers, Messrs. raven.—Wanderer.

rickmaking.—It all depends on the experienced different machines, and I d's, of Preston, Lancashire, the best, omical, durable, and perfect (viz., No. dies and Murray's patent side delivery is advisable to cast the clay in a rough winter; it puts a more brilliant face to working through the dies with more m working one now near Manchester, Murray's tables. It is worked by one and Holland's horizontal expansion orse-power nominal. It will realise r indicated, and is fitted with equi-rnors. The working of it and the nirable. It is capable of making 2,000 Ve have exceeded it; we have made rs with ease.—H. J. W.

Kloz" Violin.—I suppose "Poor as Klotz. If so, Matthias Klotz, the first of this name, was a Tyrolese, and con-a pupil of Steiner, date about 1670 to and artistic workman. Egitia Klotz ias), good instruments with good var-Klotz (brother to Egitia), Sebastian r brother). The best maker of them el Klotz, 1771. Joseph Klotz (son of wood, but bad varnish. That is about s say on the subject. Now for what I All the violins I have seen bearing the z were good useful instruments (most e possession of professionals), much hestral work than Steiner's, or any of ilt" school. They have no especial out simply look good to the eye of a were not copies of any one maker, but —that is to say, as original as any s been since Straduarius and Guar-at is about as original as any good been since Shakspeare, Bacon, and members of the Klotz family were ey seem to have published nearly all nts properly signed. I very seldom see now, although I knew a good many ears ago, and, as they were in hands them, I don't think they are destroyed re say, if I attended big sales, or could the cabinets of connoisseurs, I should ny old friends with very high falluting . (I know I often meet my old friend ey under the name of Steiner. Would be very proud about it? I think not.) re information (interesting or other-bout the men or their violins, but, no er" has, and will give it; and here I ardon for answering a question put to 'aker.

loz Violin.—There were four makers the Tyrol, first, Matthias Kloz, about three sons, Sebastian, George, and instruments of Sebastian are the best, prices—also some of Egidius's. The tone of most of the Kloz fiddles is powerful and good, but the varnish and shape of many are very bad. Matthias was a pupil of Jacob Steiner, and mostly followed his style. His son's instruments are often as flat as a "Strad."—C. P. T.

[32433.]—**Kloz Violin.**—I give an extract from the "History of the Violin," by Sandys and Forster:—"Egidius seems to have been the best maker of the Kloz family, working in the latter part of the century from 1675, and generally putting his own name to his instruments. He was particular in using good wood, and his instruments are well made, and have a finer and fuller tone than any other of the Tyrolese make. They have amber varnish. He was a pupil of Jacob Steiner, and imitated him. After Steiner's reason became affected Egidius Kloz or his sons (for this seems a little doubtful), and Techler, worked in his shop, and placed Steiner's tickets in the instruments then made. George, Sebastian, and Joseph are named as his sons, and Joseph's instruments are considered superior to his father's. We have the following ticket of George:—'George Kloz in Mittenwald an der Iser, 1761;' also one of Joseph, but from the date he would seem to be more probably a grandson than a son of the original Kloz, 'Joseph Kloz in Mittenwald an der Iser, An. 1774.' There was also a Michael Kloz, whose ticket we have, dated 1771. Parke, in his 'Musical Memoirs,' says that Mr. Hay, formerly an excellent leader of the King's band, had a celebrated Kloz instrument, with a sweet and powerful tone, for which a noble lord offered him £300 and an annuity of £100 (the price seems incredible). Hay, having an independence, declined the offer, and on the sale of his effects after his death the instrument was sold for £40 only."—M. G. F.

[32435.]—**Boiler Feed.**—The steam which issues from the boiler is much more bulky than the water injected, so that although the volume of water in the boiler is increased, its temperature is lowered, and the pressure of steam diminished. The effect, therefore, of the injector is no more paradoxical than that of the feed pump. The injector will not work if the temperature of the feed water is above 120° F., as it is then incapable of condensing the steam. Condensation of the steam is therefore necessary to the result.—E. J. Marshall.

[32435.]—**Boiler Feed.**—The steam taken to work the injector on leaving the boiler reduces the pressure in it, and the injected water being forced into it with a rush, and being at a less temperature than that in the boiler, accordingly overcomes the pressure.—C. E. G. H.

[32437.]—**Cistern Leakage.**—The slate cistern must be taken to pieces; scrape and dry, and then paint the edges and grooves. Then put together again with a mixture of white and red lead. Don't try to repair it, for it would only have to be taken to pieces in the end.—J. A. P.

[32441.]—**Gas Engine.**—If you intend working it by means of a true explosive mixture, as is done in Otto and Langen's engine, I should say no, as the sudden shocks to which it would be exposed would be fraught with danger to the cylinder, and the condensing apparatus would occupy nearly, if not quite, as much room as a vertical boiler. Not having read a description of, or seen, a gas engine working by expansion, I am unable to say whether it could be accomplished so or not. Perhaps some other reader will give a description of an expansive working gas-engine, which would no doubt interest others besides—E. J. Marshall.

[32442.]—**Heating Glue.**—"C. O." has most probably to find fault with the gas, and not the glue-pot. When a cold substance is put closely over the flame it deposits a large quantity of carbon. This decomposes some of the burning gas, and acetylene is formed, which has a most disagreeable smell. "C. O." should get a Bunsen burner.—Ferrum.

[32442.]—**Heating Glue.**—Keep the bottom of your glue-pot boiler clean, and do not turn up the gas high enough to smoke. It is the burning gas-black that stinks.—Bosh Faker.

[32447.]—**Electrical Indicator.**—An "Old Reader's" problem is a very interesting one, and I think some of your ingenious readers will show him how to arrange his apparatus. The apparatus he intends putting near the river is, I believe, shortly to be taken up by the Admiralty and put into some of her Majesty's gun-boats. One of the open-bottomed boxes will be put at the bottom of every compartment of the ship, and the siphon gauges will be all grouped together in the cabin, so that the officer in charge can see at a glance how much water there is in every part of the ship, fresh-water tank included. Any one can see the great advantages of such a simple arrangement. The whole lot will cost much less than the old sounding pipes, and no part of the apparatus is in the way or takes up any room. The patentees call the apparatus the "patent sounder." I have rather wandered, but this part of the subject is very new and very interesting. How would this plan, as follows, suit for the electrical indicator?—One end of the siphon gauge of the patent sounder will be attached to the air-pipe, and the other will be open to the atmosphere. Into this open end put an iron wire right down at the bottom of the siphon, and making perfect contact with the mercury, and alongside of this wire, but not touching it, place another wire of some very bad conducting material. These two wires can then be connected with battery and line to the office, and there connected to a diverging needle or other magnetic apparatus. Now, suppose the bad conducting wire terminal was just touching the mercury when the tide was at its lowest, the electric current passing would be so weak that the needle at the office would be scarcely affected, and would point at 0 on the prepared scale. As the tide rose the mercury would also rise, and more of the wire would come into contact, and the electricity would increase, and in the same proportion would the needle travel along the scale, and this would continue as long as the tide continued rising; so, by looking at the needle, you would see at once the state of the tide. Now this, as far as I can see, is all right if we can get over one difficulty, and that is, the battery power, which should be constant, and not liable to fluctuations. The same amount of wire covered by the mercury should always send the needle to the same position on the scale, and this point I leave to some of our electricians, expecting that there is no difficulty in it.—Draughtsman.

[32447.]—**Electrical Indicator.**—Would it not be more economical and simple to indicate the state of the tide by mechanical means in preference to electricity? The latter would require some complicated means to accomplish, I think, whilst the former could be attained simply. Why not have something similar to the following? Fix securely a pole upright in the water, have a float to support about 1cwt.; this float to slide up and down the pole, as the tide rises and falls. Fasten to this float two wires, running over the pulleys, fixed on the top of the pole, which two wires are fastened to a line wire running and supported on pulleys fixed to supports, the distance required to carry the line. At the end of this line attach another weight, sufficient to keep the wire tight as the tide rises and falls. This latter weight will move up and down, indicating the state of the tide. A strong cord, wire, or catgut can be used.—J. Jones.

[32449.]—**Filling Teeth.**—The gold used is not a "composition," but gold foil either pressed or malletted in. It would be absolutely impossible for you to put a gold stopping in yourself, or, in fact, any other stopping. In order to be of any service it requires an experienced and practised hand.—Os.

[32449.]—**Filling Teeth.**—This can only be done by a competent dentist. The great thing is to remove every particle of decay, and fill the cavity with a material that will prevent any moisture from getting in, and that will be hard enough to bear mastication. I see "Fiddler," in replying to above, says, in his opinion, filling hastens decay. If it is not done properly it undoubtedly does, as when moisture can get underneath a filling (if metal) it decomposes the tooth more rapidly than it would if no filling were there; but any tooth properly filled is certain not to decay from the same place, and is as good as a sound tooth.—Geo. Beavis.

[32451.]—**Telephone.**—A telephone would be useful, but I am afraid you would still require some means of calling attention—so retain the services of your bell. The iron pipe would not at all interfere with the insulation of the wire you might use for telephonic purposes. But would it not be cheaper and more convenient to join your residence and business place by means of about 40yds. of thin galvanised iron wire, uninsulated, run along the walls, and fastened with nails or staples? I don't know what the 5s. telephones you refer to may be, for none of the Bell's electric telephones are sold, made up in this country, under £20, but you may buy the materials ready to put together for a pair, which will be quite equal to Bell's, for about 7s. 6d. See advertisements in back Nos.—L. S. Y.

[32451.]—**Telephone.**—A guttapercha-covered wire would be necessary. You may either have electric bells, or use the ones you already have, to call attention. Telephones at the price you name must be unutterable rubbish. I suppose that "Towe" is aware that he will lay himself open to an action if he uses telephones for business purposes, unless such instruments are bought from the patentee or his agents. Why not use the gas piping as a speaking tube?—M. S. T. E.

[32451.]—**Telephone.**—I think "Towe" would find a speaking tube answer every purpose, and be cheaper than telephones. I have occasion to use two, each over 200ft. long, and having a great many bends altogether, but the slightest whisper can be heard through them with ease. Of course the tube must be air-tight, and have whistles fitted in the ends to call attention with. The bends in the tube must not be sharp, and it should be about ½ or ¾in. diameter.—T. L.

[32455.]—**Colours for Confectionery.**—Cochineal (powdered) and salt of tartar, of each one ounce. Boil these in a pint of water, and strain, add one ounce of spirits of wine, and bottle for use. The original recipe contains also one ounce each of cream of tartar and alum, which, however, I don't altogether see the use of.—Os.

[32459.]—**Carbonate of Ammonia.**—I don't think this has any effect in suppressing acute pain; used as a stimulant in extreme depression.—Os.

[32460.]—**Geology.**—In answer to your correspondent, I would remark that conglomerates in the Silurian rocks are generally formed of pebbles of quartz (silex), and are like all similar formations derived from previously existing rocks, rounded by the action of water, most probably on the sea-shore, and cemented or bound together by a matrix, either of iron, lime, sand, or clay, or a mixture of more than one of these. Sometimes these pebbles are of jasper, as I have seen them in the Silurian rocks of Connemara of various shades of colour, red predominating; green and yellow colours are also met with. The colours are chiefly caused by silicate of alumina and iron. In the chalk the concretions of silex are called flints. They become disintegrated, and falling on the shore are rounded into pebbles by the action of the sea. In the older rocks they are termed hornstone or chert. — W. H. Baily, F.G.S., M.R.I.A., &c.

[32461.]—**Tasmania.**—A few days back I had a pamphlet sent me by the Emigrant and Colonists' Aid Corporation, 25, Queen Anne's Gate, Westminster, containing the information R. J. Johnson requires. If he sends to the above office I have no doubt he will receive a copy of it.—M. S. T. E.

[32470.]—**Telephone.**—To J. Wilson.—By using a soft iron core you will have every word distinct, not any louder. You should have the end of the magnet turned down, and leave this end soft. Have a boxwood reel turned to fit, and wind your wire on the reel.—George Tolman.

[32472.]—**Wire Tramway.**—The following particulars of a wire tramway at Aalsund (Norway) may perhaps interest "Etna." This tramway was constructed for carrying the ore from a mine to the sea-coast, the mine being situated far above the level of the sea. The "permanent way" consists of two steel ropes, the breaking strain of each being 40 tons. The ropes are fixed at the mines, and stretch direct to the sea-coast without support, the distance being 750yds. Two cages which run on small-grooved wheels form the "rolling stock." Each cage carries 12cwt. of ore. The loaded cage in descending draws up the empty one by a light steel rope, which passes round suitable brake sheaves at the mine, and by which the speed of the load is governed. At the bottom the ore is discharged into a large truck, from which it is discharged into the vessel. The empty cage in the mean time arrives at the top, and being filled, is allowed to descend, and to draw up the empty cage. The incline of the ropes is an angle of 45°, and the speed of cages is from 15 to 20 miles per hour. About 100 tons are transported every 10 hours, the only expense being the pay of the five men required. The tramway was made by the Wire Tramway Company, from the designs of Mr. W. H. T. Carrington.—T. G. S.

[32478.]—**Brewing.**—The book you mention would be of very little use in your case; neither would any book alone give you the information that you require. What you want is good practical advice, and that immediately, as you are sacrificing a very considerable sum of money in every brewing, through your inability to extract the whole available malt constituents. Now, with ordinary malt weighing 320lb. per quarter, they amount theoretically to 78·3 per cent, and should therefore yield 90·4lb. per quarter extract; but this season we find that it is impossible to extract the whole theoretical amount of malt constituents within 5 per cent., by reason of the inferiority of the grain, and we may average the available extract from this season's malt as 85lb. per quarter. Now 14½ barrels of wort at 33lb. gravity, from 6 quarters of malt, give a gross extract of 79·75lb. per quarter only, or 69 per cent. instead of 78·3 per cent., showing a loss of available malt constituents of 9·3 per cent., when following the system advocated in the book you mention. Now if you find it impossible even to obtain that amount of extract, I must say that your system is radically wrong, and that you are undoubtedly losing a very fair profit. I shall be happy to hear from you privately.—H. P. Harris, Rotherham.

[32483.]—**Mercury.**—It is kept in metallic bottles, because these are strong enough to contain it safely, which unmetallic vessels would not, while it has no action on iron.—Sigma.

[32483.] — **Mercury.** — A bottle of this metal weighs about 75lb. It would scarcely do to ship a lot of earthenware or glass bottles full of this liquid, as the least jar would crack either of them with that weight in them, and how about corking?—George Tolman.

[32483.]—**Mercury**—is usually imported in iron bottles because they are the most convenient for the purpose. They are not liable to breakage as glass or wood would be. A glass vessel containing 60lb. or 70lb. of mercury could hardly be handled with safety.—Os.

[32492.]—**Varnish Stains.**—A little spirits of wine carefully applied will most likely answer the purpose.—Os.

[32495.]—**Colourless Spirit Varnish.**—Perhaps the wood was damp; this might give a mottled appearance. Such varnishes are best applied with a broad flat brush, and in a warm room. The brush should go quickly over the work, and should not cover the same spot twice, and if your varnish is perfectly clean there will be no spots or frosted appearance.—Os.

[32500.]—**Cement.**—Corks will not stand 800° F. without becoming charred, to say the least. Cannot you use plugs of asbestos?—Os.

[32501.]—**Bichromate Battery.**—The electromotive force is about 2 volts when fresh, but falls considerably in use; the size of cell has nothing to do with the force. It can be used for light but large cells, and 40 or 50 would be required. A Bunsen battery can be, and is often charged with bichromate solution.—Sigma.

[32503.]—**Chemical.**—The precipitate is brown when the solutions are very dilute. It is called the purple of Cassius, after its discoverer, and it is used for colouring glass. I have looked it out in several books, but in all it is said that it does not appear to have a definite composition. In one I find it put as $Au_2Sn_3O_64H_2O$.—Benjamim Snooks.

[32506.]—**Emery Wheel.**—Some are used with water and without. Why not explain to a maker for what purpose you require them?—George Tolman.

[32508.]—**Batteries.**—The mercury cells are left all standing when circuit is broken, there being only very slight local action. The bichromate bottle battery can be seen in an any scientific instrument dealer's window, and is quite useless for bells, except where one can be used and act as its own commutator or contact-closer.—Sigma.

[32508.] — **Batteries.** — Bisulphate of mercury batteries are sometimes uncertain. If you require them for electric bells you have no occasion to remove carbon or zinc. I have had some in use and not touched for 18 months. They are rather expensive to maintain, and I now use the Léclanché. The bichromate battery consists of two carbon plates, with a zinc plate between them, either a fixture or made to slide in or out of solution when required. Some are in a plain jar or glass bottle, with a round globe at bottom, and a long neck. To make the solution, dissolve half an ounce of bichromate of potash in a pint of hot water, allow to cool, and then add 3oz. of sulphuric acid by weight. The addition of this acid will cause a considerable degree of heat, and should be allowed to cool before using, as in this hot state it violently attacks the zinc. This battery will work constantly for about two hours—so it is useless for electric bells. Why not use the Léclanché? It requires no attention from twelve months to three years.—George Tolman.

[32509.]—**Magnitude of Lunar Eclipse.**—"Amateur" can find the quantity of a lunar eclipse in the following manner: For an example we will select the eclipse which will occur on August 13, at 0h. 8m. morn, and will be a partial one. At that time the moon's latitude will be 36′ 55″ N.

	′	″
The moon's horizontal parallax	54	56
The sun's „ „	0	9
	55	5
The sun's semidiameter subtract	15	49
Semidiameter, of the earth's shadow	39	16
Add for the earth's atmosphere $\frac{1}{70}$	0	33
	39	49
Moon's semidiameter, add	15	0
	54	49
Moon's latitude, subtract	36	55
The quantity or part eclipsed is	17	54

which equals ·59 of the moon's diameter. The quantity of a lunar eclipse is sometimes expressed in digits. A digit is the twelfth part of the diameter of the sun or moon, so we should say that about 7 digits of the moon would be eclipsed on August 13. The greatest number of digits an eclipse of the moon can amount to is 23, as when she is at her node and in perigee at the time of eclipse.—J. G. Vine.

[32510.]—**Pianoforte.**—The wires, if properly strung, ought not to slip, even though the wrest pins are not bored. Modern music wire is very much harder than it was when "D'Almaine" was young, and requires softening in the lap to take away some of its spring. Also "J. G." must remember that concert pitch is now much higher than such an instrument was made for. The cost of new wire and bored wrest-pins would not exceed 7s. 6d. The work of re-stringing is the most important item, and "J. G." must be the best judge whether the preservation of the action, &c., is such as to make the expenditure worth while. The sizes for the wire would be:—Lower eight notes, brass wire weighted with open covered copper; following 12 notes, No. 13 hard brass wire; the remainder, 8 notes each, of steel, the sizes ranging consecutively from No. 12 in the bass to No. 8 in the treble, all music-wire gauge. If new wrest pins are decided on it will be necessary to open the old holes, or the wrest plank would be liable to split.—W. H. Davies.

[32519.]—**Cleaning Copper Cans.**—Scouring with sand and water. Muriatic acid might answer if you don't like the trouble of the above. This should be applied with a piece of rag tied on the end of a stick.—Os.

[32521.]—**Uranus.**—The "γ Leonis" to which Mr. Manning directs attention is a compositor's error for "ν Leonis." γ Leonis is of the 2nd magnitude, and not a 5th magnitude star at all.—The Writer of the "Astronomical Notes."

[32521.]—**Uranus.**—The "gamma" is an obvious misprint for a "nu." I should have thought any one would have understood that from a moment's inspection of a star-map. Mr. Manning seems to think that R. A. has something to do with north and south. If he had remarked on the discrepancy between the given declination of Uranus and that of γ Leonis it would have been more to the point.—Mac.

[32523.]—**Double Star.**—The double star alluded to by "Mac," is H. iv. 61 (= Σ 1964: S 674: h 255), and was discovered by Hi on the evening of July 18, 1782, when it was noted as "a close double of the fourth class, a little unequal." It was first measured in the spring of the next year, and the measures deduced gave P = 85·05°, D = 16·77″. Epoch 1783·22, the stars being described as "equal, and both pale red." The measures of the elder Herschel are frequently rather too large, owing to the fault of the micrometer employed, and he is rather inclined to ascribe a reddish tint to objects (though it is perhaps worthy of remark that he calls 95 Herculis, "a fine equal white-coloured double star"), but, all things considered, the measure of March 24, 1783, is a capital one. It is first described as triple (of course, without measures) in Struve's "Catalogus Novus," but Sir James South twice measured it as a double only in 1825, with his exquisite 5in. Tulley, the mean of two nights' observations being P = 265° 0′, D = 15·64″: Epoch, 1825·37, making the new-found star slightly the larger of the two. It is No. 255 of Sir John Herschel's first catalogue, and was observed with his 18in. reflector of 20ft. focus (the joint work of his father and himself), as a pair of equal 7in. stars, the position angle being either 80° or 260°, and the distance about 15″, the date of observation being between 1820 and 1826. In 1828 he again observed it, this time with the 5in., which had been used previously by Sir James South, and gave P = 85° 40′, D = 13·79″ [? 15·79″], and in a note he adds, "the light of the following star less concentrated than that of the preceding one, yet it is not separated" (the performance of the 5in. from 1828 till the beginning of 1830 was very indifferent, owing to the object-glass being severely pinched in its cell); and again, in 1831, he measured it with the same instrument, deducing P = 85° 13′, D = 15·42″, 7, 7 +, Epoch, 1831·38, but makes no allusion to its being triple. Struve's measures in the "Mens. Micr." are as follows:—

A B. 6·8, 7·3; 86·08°: 15·36″: subflavæ } 1830-87.
B C. C 8·8; 8·07°: 1·34″ }

Mädler, in 1842, gives A B: 86·1°: 15·02″.
B C: 5·7°: 1·36″.

And in 1843:— A B: 85·4°: 15·30″.
B C: 12·0°: 1·46″.

So that the relative positions of the stars are probably unchanged. It is not, as far as I am aware, in the catalogues of D, De, Se, Englemann, or any of the later astrometers. I believe that "Mac" has only a telescope of 2¾in. aperture, and therefore he could not expect to see the close double, even elongated, with his telescope, as the stars are unequal and small.—Herbert Sadler.

[32527.]—**Telephone.**—If the ferrotype plates are secured well round the edges, a battery current will not have any effect on the plate, as the magnet is so close to it. Should it touch it will spring back again. You need not make a hack of it, and don't send a current in the direction to demagnetise the magnet.—George Tolman.

UNANSWERED QUERIES.

The numbers and titles of queries which remain unanswered for five weeks are inserted in this list, and if still unanswered are repeated four weeks afterwards. We trust our readers will look over the list, and send what information they can for the benefit of their fellow-contributors.

Since our last "Ferrum" has answered 32042.

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31880. Gas Stoves for Heating.—To John Reed, 488.
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32142. Bookbinding.—To Mr. R. Smith, p. 586.
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32159. Tricycle for Invalid, 586.
32171. Medical, 586.
32176. Type Composing Machine, 586.
32179. Mixture of Iron, 587.
32181. Bleaching Paper, 587.
32188. The Recent Arctic Expedition, 587.
32190. Model Gas Engine, 587.
32195. Sewer Gas, 587.
32196. Chemical, 587.
32199. Paper Cartridge for Rifles, 587.
32203. Circle in Polygon, 587.
32208. Siebert's Object-glasses, 587.
32209. L. and N. W. R. Tunnel, 587.

QUERIES.

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[32532.]—**Varnish.**—Can any of our readers give the ingredients of a varnish or composition which, if applied to paper or to photographs, will render them permanently transparent without too much glaze, or if drying dead so much the better?—E. C.

[32533.]—**Sulphuric Acid.**—I wish to make some normal sulphuric acid. Will some one of our readers tell me how, and what should be the specific gravity of it? Also how to reckon Beaume's hydrometer by Twaddell's. —Derby.

[32534.]—**Organ.**—Will some correspondent kindly give me a specification of an organ, five stops (no reeds nor metal stops), and give a description of the stops enumerated? What sized bellows would be required? What would be the length of the sound board?—L. R. D.

[32535.]—**Cheap Bicycles.**—To Mr. Striffler.—Thanks for your reply to my query. I am a joiner and can have the use of a smith's shop close by, and can do a little in the way of fitting; have good smith near where I could get anything done, but shall try to do all the fitting I can myself. Have written "Druce" as you recommended; have price of rubber tires quoted at per pound, red and grey, in three qualities. What would be about their weight, and which kind and quality do you recommend? Can I be doing anything with materials for wheels before I obtain backbone, &c.? You make no mention of wheel hubs. Smith says BBH is the same kind as you recommend—is it? You think that I had better not use front fork, spindles, and part back. I have. What kind of steerage will yours be?—Pound a Week.

[32536.]—**Moulding.**—What is the best material for moulding fine iron work?—Leo.

[32537.]—**Stern Post.**—Will any reader tell me how to set the stern post of a wood man-of-war ship and end the rails, as I have tried several ways and cannot do it right?—J. T. H.

[32538.]—**Tellurium.**—What is a ready, sure, and simple test for tellurium? Telluride ores are not of unfrequent occurrence in this, the San Juan district. The best assay hitherto, so far as I know for a certainty, was from a telluride of gold which gave 606oz. gold and 193oz. silver. The gold I judged to be worth about 14dols. to the ounce, or £2 16s. of English currency. The ravines (here called "gulches") and canons are for the most part precipitous in the extreme. I mention this to show the necessity when tramping about here to reduce one's impedimenta to the lowest possible point. Possibly Mr. Allen, Mr. Clements, or some one of your 1,001 chemical experts (to use a favourite Americanism) will oblige me with the description of a practical and portable test, together with the apparatus employed, for the detection of this mineral? —San Juan, Lake City, Colorado, March 13, 1878.

[32539.]—**Economical Spring Motor.**—Could any practical brother-reader furnish particulars, &c., by which forenamed could be made to work successfully from one man to one horse-power?—W. W.

[32540.]—**Blistered Hands.**—In my laborious work I am constantly annoyed and distressed by blistered hands caused by the constant use of hammers. Can some reader give some remedies?—Young Boiler Maker.

[32541.]—**Painting and Lacquering Articles of Tin.**—I should be glad if any one could give details of the above process (the means by which Messrs. Bryant and May do lacquer their small tin match boxes), or like the little tea caddies are painted or lacquered, such as are seen in grocers' windows.—Bernhardus.

[32542.]—**Photographic Lenses.**—Given a combination for portraits of about 5in. focus, what would be the effect of shortening or lengthening the tube? Would it shorten or lengthen the focus? What would be the actual result either way?—Perplexed Photo.

[32543.]—**Brush Varnish.**—I have some small work that I cannot polish. Will some friend tell me how to make a brush varnish to use, and will look like polish?—J. B.

[32544.]—**Cooking Stove.**—I use with gas-burner on the Bunsen principle, closed baking oven; it does its work very well indeed. Will any of your subscribers inform me if the exposure to the open flame is injurious to the health? No taste or smell is given by using this method that I can find.—G. Blaikie.

[32545.]—**Incrustation of Boilers.**—I heard lately of a new method that has been successfully tried in the Royal Navy of preventing incrustation in steam boilers by means of a self-acting magnetic or galvanic current, but cannot learn the precise particulars of the discovery. Can any of your readers kindly supply any information about it?—Blank.

[32546.]—**Sundial.**—I have a pedestal sundial I wish to set up, and shall be glad if some one of your astronomical readers will kindly state in the Mechanic how to proceed so as to secure a correct reading of the time by it or say on what day the sun and clock should record the correct time of noon together?—Constant Reader.

[32547.]—**Railway Rates.**—A manufacturer whose trade is monopolised by an excess of railway carriage rates charged to him over those charged to a company for the same description of goods would be obliged if any of your readers could reply to the following question. Suppose a railway company carries from a station on their line the goods of a manufacturing company who guarantee to send over their line a given quantity in the aggregate per annum at certain rates per ton to various places, but no specific quantity to any one place, can the railway company refuse the same carriage rates for the same description of goods from and to the same places to another manufacturer who cannot guarantee a given quantity per annum, and can they charge him an excess of rates which gives a monopoly to the manufacturing company guaranteeing a given quantity per annum?—Pera.

[32548.]—**Westinghouse Brake.**—Will any reader inform me how the Westinghouse automatic brake contrives to close the ends of the tubes when any carriages break away, also whether Smith has anything to close the tubes in his automatic attachment?—J. F.

[32549.]—**Photographic Lenses.**—I have just purchased a couple of French lenses, also a second-hand one by Ross, and instead of having the diaphragms in centre of tube they have them fitted to the hood, in front of front combination? Is that position better than Waterhouse's method? Is so, why? They are portrait combinations.—Perplexed Photo.

[32550.]—**Boiler Pressure.**—I have a small steam boiler of which I should like to know what pressure it would stand. The dimensions are, 8in. diameter, 18in. long, 3-16th thickness of best Low Moor iron plate? Also would any of our readers tell me what size boiler it would take to drive engine, the cylinder made for 4½in. stroke, 2in. bore?—Droitwich.

[32551.]—**Selenographical.**—The crater 22 on Mr. Webb's map north-west of the Mare Crisium he calls Gauss. Beer and Madler call it Sulpicius Gallus, which name Mr. Webb gives to crater 71 on the Mare Serenitatis. How is this, and which is correct?—Brickwall.

[32552.]—**Boring Tool for Wood.**—Will some kindly disposed fellow-reader give me a drawing or description of one of the above to use in the slide rest for boring out hollow boxes, &c.? I want to get one made.—C. Watson.

[32553.]—**Coils.**—How are coils constructed so as to be either for quantity or intensity, and how can the current be made to flow in one direction?—An Englishman Abroad.

[32554.]—**Weigh Shaft.**—Could any of our readers inform me how to fix a locomotive weigh shaft either by geometry or a skeleton motion?—W. D. M.

[32555.]—**Boiler Scale.**—Would any of our readers say if they have applied zinc as an anti-incurstator (see p. 615, last vol.), and if they have with what result? If this plan is really successful it will prove a great saving to our boilers.—Ferrum.

[32556.]—**Electrical.**—1. How can I make the carbons used for Bunsens and bichromate batteries, and how to make the red varnish used for electrical purposes? 2. What strength of battery shall I require for a coil with ½lb. of wire on it—viz., 3oz. primary and 5oz. secondary, and also the probable size and cost?—Herculean.

[32557.]—**Shaking Grate Bars.**—Allow me to return you my humble thanks for your reply to a former inquiry. Your paper is to-day more looked for among my fellow-craftsman than any American paper of the same class. Can any correspondent tell me who was the patentee or manufacturer of the shaking grate bars that were in six of the furnaces of s. s. Edinburgh, of the Inman Line, running between New York and Liverpool in the years 1862 and 1863?—Wide Awake, New York.

[32558.]—**G.W.R. Broad Gauge Engines.**—Will some one give us the dimensions of the above engines? I mean the "Great Britain" class—viz., total heating surface, number of tubes, diameter of boiler, weight of engine and tender, weight on each wheel, also what number of gallons the tender holds? I should also be very much obliged if any one can say whether the G.W.R. are building any totally new broad-gauge engines, and, if so, what are their dimensions? They have already rebuilt some of the old ones, namely, "Great Britain," Sultan," "Tartar." I believe "Warlock" is the last, or very nearly the last out of the shops, and are, I believe, rebuilding more. I shall be thankful if any one can give the distance of each station from London as far as Swindon.—H.

[32559].—**Concrete Blocks.**—Having read about building with concrete blocks, I took a smooth cast-iron plate, and put sides on it with wood, so as to be a mould, oiled it with sweet oil, and cast the first ¼in. of the face with neat Portland cement, so as to be perfectly smooth, and filled up with concrete of broken brick and cement 4 to 1. On taking apart four days afterwards, the wood sides came off the block finely, but the neat cement stuck to the iron face so as to cause the block to be broken in pieces, the cement sticking very tenaciously to the iron. The second time, although I used more oil, it had the same effect. Can any one tell me why?—Cottager.

[32560.]—**The Manchester Bells.**—Can anybody inform me why a ring of 12 was not made out of the peal of 21 bells hung in the tower of the Manchester Town Hall? Ten only are hung for ringing, tenor C, 52cwt.; the next bell heavier is B, 71cwt. Now that would have made a grand cover bell, and that such a one could be rung "in" is proved by the tenor bell of Exeter Cathedral, which is nearly 68cwt., and 6ft. in diameter, and is rung in a peal of 10 only, the heaviest in England, and badly hung. Do the Manchester bells go well?—Ringer.

[32561.]—**Machinery Brass.**—Could any one furnish information as to the composition of best machinery brass, and also the composition of what is known as "dipping metal"—*i.e.*, for making gasaliers, &c.?—L. S. Y.

[32562.]—**Zinc Paint.**—Could any reader supply me with a receipt for making zinc paint or give any information concerning any paint that has a hard metallic surface and a good appearance?—L. S. Y.

[32563.]—**Flutina.**—Would some reader of the English Mechanic be good enough to tell me how to make a flutina?—Ignorance.

[32564.]—**Horns.**—Can any correspondent tell me the value of horns in England? Could they be partly manufactured here in Canada to suit the English market so as to occury as small space as possible for export?—Canadian.

[32565.]—**Pantagraph.**—I should be obliged to Mr. Lancaster if he will give a sketch and description of this instrument. It is some years since it appeared, and I cannot get the back number. I do not anticipate any difficulty in its construction.—Os.

[32566.]—**Naturalisation.**—I am a Frenchman, aged 20, settled in Manchester, in a situation in a mercantile house, and am very desirous to be informed in what position I stand with reference to making myself a naturalised Englishman? Would any one kindly say at what age I can do this, so as to avoid the conscription in France? I have been in England 3 years. In case I cannot at present be naturalised am I compelled to go to France and draw my number? Suppose I stay in England, and omit going to draw my chance until such time that I can be naturalised, would my then being made a naturalised Englishman shield me from present refusal to go and draw my number? I may say that my parents have been settled in this country upwards of 10 years.—D. Fosterier.

[32567.]—**Accident to Bicycle.**—The other day a friend and I were practising on a bicycle I have just bought, when on dismounting he caught his coat round the saddle, and fell with his legs between the wheels. On raising the machine we found the front wheel rim was bent quite out of shape, so that it was forced tight against one side of the fork, and would not turn. Rather than have to ignominiously carry the thing home, we took hold of the wheel to try and bend it a bit straight, when to our surprise it went back with a metallic ring perfectly straight again. Will some one tell me whether there is anything peculiar in this, and if the wheel ought to act in this way? Is it liable to do this during a journey, because, if so, it might cause a serious accident? The machine is a good one, and no trumpery piece of goods. Would brush polish prevent the spokes from getting rusty, and keep them bright if they were varnished with a few coats of it?—S. Y.

[32568.]—**Iron Depositing.**—To Mr. Sprague.—On page 307 of "Electricity, its Theory, &c.," is the sentence, "The deposit of iron is likely to have important scientific uses, as in examining the laws of magnetism." Would the author, or any other correspondent, kindly refer me to any accounts of experiments, with which he may be acquainted, where an iron solution was used for this or a similar purpose.—J. Brown, Belfast.

[32569.]—**Bisulphite of Lime.**—Would some of your correspondents inform me the best method of preparing bisulphite of lime?—F. R. M. S.

[32570.]—**Model Locomotive.**—What is the cheapest and best oil to use for a small locomotive engine boiler, 2¼in. diameter, 6in. long? I use at present methylated spirits, but find it rather expensive. What amount of wick would be required to keep up steam so as to supply two oscillating cylinders, ⅜in. bore, 1¼in. stroke? I use four wicks, each about ⅜in. diameter, and find that they are inadequate to keep up the pressure; the spirit lamp is simply hung underneath boiler. Is there any way for having the fire applied so as to give an additional amount of heat? What distance should the top of the wick be from boiler?—A Juvenile.

[32571.]—**Fingering.**—1. Which is the easiest way to finger a shake on middle D, top D, F♮, C♯ (middle and top), and the easiest fingering for top A, on the common 4-keyed flute? 2. If I have to shake the note above, whether tone or half tone? 3. If the small grace notes have to be played on the beat, or before the beat, and if there are any exceptions to the rule? I have been playing at the Manchester flute contest, and the bandmaster ordered us to play some on the beat, and some before the beat, which I could not understand.—Thomas Ryan.

[32572.]—**Chicken House.**—I want to brighten up the woodwork, &c. Will some of "ours" inform me whether paint would be in any way detrimental to my live stock?—J. S.

[32573.]—**Glycerine Jelly.**—How can I make a good firm transparent glycerine jelly?—Highbury.

[32574.]—**Leclanche Battery.**—I have made one of the above batteries to work a small bell, but I find a difficulty in attaching the wire to the carbon plate, as it is so soon dissolved. A hole is bored through the end of the plate, and the wire pushed through and twisted tightly, but the wire has to be renewed every day or so, in consequence of the galvanic action between the copper and carbon, the former being all dissolved. Would gold or silver wires answer the purpose? Any hint on this subject would be gladly received by—T. L.

[32575.]—**Beale's Camera Lucida.**—I had one of the above fitted to my microscope to enable me to sketch objects, but though I seem to follow all the instructions given, I can see nothing on the white paper. I have placed the micro in horizontal position, with camera lucida attached, and object in position, and tried at all distances above the white paper, but can see nothing whatever, either on the neutral tint glass, or on the paper. What can be wrong? A hint from Mr. W. J. Lancaster, or any one else who knows, would greatly oblige. Does it require a very strong light reflected through?—W. R. C.

[32576.]—**Dilapidations.**—I should be glad if some of our legal correspondents would inform me on the following:—I have a lease of twelve years to come. The lord of the manor gave me notice three years ago to repair, which I did, and painted two coats of oil colour inside. The lord of the manor has allowed three years to pass; he has now sent a surveyor, who has sent in a schedule of dilapidations. Can he make me paint, and do all the repairs over again? The lease says paint two coats of oil colour inside once in seven years. Will the first notice protect me, and what has been done for seven years? He says he will eject.—A Poor Leaseholder.

[32577.]—**Chicory in Coffee.**—Will Mr. Allen kindly say how I can detect chicory or burnt sugar in the infusion of coffee?—An Old Subscriber.

[32578.]—**Brakes.**—What pressure per square inch is used in the G.N.R. air-brake trains? Is it true that the North Eastern are to have the air brake? What brake is it upon Midland engines 66, 239, 135, 1304, 1332? My experience is that no brake is better than Barker's, as used at Bedford, but it is not self-acting; this is, I think, a fault.—S. D. J. R. Loco.

[32579.]—**Pullman Car Trains.**—Is it a fact that these trains are running on the Midland now? I saw the train on Tuesday, the 19th ult., but not since. What is the cause?—S. D. J. R. Loco.

[32580.]—**Midland Engines (No. 1A and 2024).** —Please say what A indicates; and have this company as many as 2024 engines?—S. D. J. R. Loco.

[32581.]—**Files.**—What, precisely, is the reason that hand-made files have held their own so long against machine-made files? Is it that machines generally cut too regularly?—Todleben.

[32582.]—**Rays of Light.**—When looking at th flame of a candle, or of gas, or any other source of light, through partially closed eyes, particularly when seen external to a dark room, or at night in the streets or open, many long and short rays of light seem to stream in all directions from the flame. What is the explanation of this appearance? Is it caused by the intervention of the upper and lower eyelashes between the pupil and the light? I used to think so, but have been led to doubt this theory on discovering that the rays which shoot

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The English Mechanic
AND
WORLD OF SCIENCE AND ART.

FRIDAY, APRIL 12, 1878.

ARTICLES.

EMERY WHEELS.

THE use of emery in the form of powder for grinding metallic surfaces has been known for many years in the United States, where it was employed for working up the cheaper kinds of machinery before the comparatively modern emery wheel was introduced; but the results attained by its means were not of so satisfactory a character as to insure the practice a long life in shops where the work is turned out in as highly-finished a state as can be attained by human skill. Emery wheels are undoubtedly useful assistants in the workshop, but it is questionable whether their usurpation of the provinces of the cutter and the file will commend itself to the mechanic who studies perfection of work. Except on very hard substances it is questionable whether cutting is not in reality much cheaper than grinding, while as to the life of the machines themselves there can be no doubt that a cutting machine will have only about reached its prime when a grinding machine is worn out. Emery wheels have, however, taken their position in the mechanical world, and their exact value must be tolerably well known. These reflections follow upon a perusal of a paper read by Mr. A. H. Bateman, before the Society of Arts, dealing with the employment of emery and corundum wheels for grinding and surfacing metals. Emery is a mixture of corundum and oxide of iron, taking its name from Cape Emeri, in the Island of Naxos. Corundum is almost pure alumina, with a little silica, and its purest form, when contaminated with only sufficient iron to colour it, is seen in the sapphire and ruby. The difference in composition may be better appreciated by the following figures, obtained by analysis:—

	Al_2O_3	SiO_2	FeO	CaO
Sapphire	98·5	—	1	0·5
Corundum	89·5	5·50	1·25	—
Emery	86	3	4	—

It will be seen from these figures—which, however, are only approximate for any given sample—that emery contains the largest percentage of oxide of iron, and, as a matter of fact, the powder is sometimes called steel filings. The Turkish deposits of emery were discovered some thirty years ago, and were very speedily utilised, although it was not until some time afterwards that the valuable deposits of granular emery in the Adirondacks attracted the attention of American inventors. It appears that Indian and Turkish lapidaries have been well acquainted with the cutting properties of emery for centuries, and employed it, in the shape of a wheel moulded by means of shellac, for cutting and faceting gems. The colour of emery varies from dark grey to black, but to suit the tastes of their customers the majority of English firms colour the crushed emery to a uniform tint, which is popularly taken as a test of quality. The most important feature of emery is its tendency to break with a rough surface—what is known as conchoidal fracture—no matter how finely it may be crushed; and it preserves this peculiarity in each individual grain, so that when the powder is properly cemented and moulded into the form of a wheel it presents a constant succession of fresh cutting surfaces. The question has been asked why a disc of solid emery rock should not be used instead of the wheel compounded of emery and the cementing substance; but it will be obvious that as the roughness or cutting power of the emery depends upon the immense number of cutting surfaces presented by the wheel, the emery must be crushed to obtain the sharp angles and points which would be absent in a wheel made out of the solid rock—even if it were an easy matter to prepare such a wheel. The peculiar property of conchoidal fracture is not shared by corundum in anything like an equal degree, and though wheels made of corundum may do as much work as those of emery, unless run in water they heat the metal more. The natural corundum found in the United States has a rougher grain than the ordinary "ruby" corundum, and wheels made of it are used by one firm with excellent effect in trueing and finishing calendering and other rolls (see pp. 446, 471, Vol. XXII.). The first mention of an emery wheel is said to occur in the patent of Henry Barclay (1842), who mixed equal parts of Stourbridge clay and emery powder, and pressed the wet compound into moulds, subjecting them subsequently to a red heat. Owing to the difficulty of preventing distortion and cracks, only small wheels were made by Barclay, but there is a certain satisfaction in learning that the progenitor of the modern emery wheel was an Englishman, although it must be confessed that we owe thanks to the Americans for showing us what could be done by its means. Mr. Bateman thinks that the reason why the emery wheel has not made its way more rapidly into our workshops is the conservative nature of the English mechanic, who objects to using a tool he has done without, and who dislikes American notions. Where emery wheels have been introduced he thinks they have often been condemned because they have failed when put to unsuitable work, and he also asserts that there is a "dread, or fancied dread, of the necessary speed." We think Mr. Bateman is in error. There is no dread of the speed of emery wheels, but there is a certain knowledge that they are not altogether economical assistants in a factory, and except for certain kinds of work do not commend themselves to the mechanic who desires the greatest accuracy and finish. Mr. Bateman tells us that in many shops grindstones have vanished, in others the file bills have been cut down to one-half or one-third, while in others work heretofore regarded as impossible has been accomplished with ease. The facility with which dead hard metal can be treated (skinned) by means of an emery wheel is well known to most mechanics, and due credit is given to the new appliance, but many of the most thoughtful workers are of opinion that for shaping softer metals the cutter is not only more economical but produces better work. As compared with the file for ordinary duties the emery wheel is, of course, far in advance, for the file moves at the rate of, say, 60ft. in a minute, and is useless when about 5 per cent. of its own weight is worn off, whereas the wheel runs at 5,000ft. per minute, and is not worn out until at least 75 per cent. of its weight has vanished. Perhaps one reason why emery wheels have not made so rapid a progress as was expected is found in the question, what becomes of the dust? In some of the machines the bearings are, or were, so placed that the dust soon found lodgment between the surfaces, with a result that can be more readily imagined than described; but with machines properly designed, and with the bearings and rubbing surfaces suitably protected, as they are in some of the wheels now on the market, the greatest objection to emery wheels falls to the ground, or is at least materially reduced. The earliest commercially successful solid emery wheel of English make was produced under the patents of Coles, Jacques, and Fanshawe, clean and good emery being mixed with oxydised oil, pressed into moulds and subjected to a high temperature by means of superheated steam. Wheels made by this process are strong and homogeneous, and can be had in thin discs. Shellac is also prepared in a peculiar manner, and used as the cementing material. The Union wheel, known as the magnesian, is made by means of oxy-chloride of magnesium, and is said to possess enormous inherent strength. The cementing material of the famous Tanite wheel is stated to be a solution of leather; while another well-known wheel is made by binding up the grains of emery in an insoluble silicate of lime, by a process which is extensively employed for the manufacture of artificial stone. Mr. Bateman pleaded fairly that those who tried the emery wheel should try it under suitable conditions, and give the workmen time to learn how to use what he regards as one of the most wonderful labour-saving inventions since the practical application of steam. The praise is, perhaps, not too high, but the error that has been made was imagining that emery wheels were adapted for all kinds of work. In the discussion that followed the reading of the paper several instances of the legitimate use of the emery wheel were mentioned—*e. g.*, the finishing up of wrought-iron gratings and the skinning of work previous to placing it in the planer or the lathe. One of the speakers said that he had seen emery wheels used to cut the ridges on millstones. Mr. Wilson stated that to grind surfaces mechanically flat a great deal of skill was required on the part of the workman, but for grinding tools there was a great saving in using emery wheels. As to grinding up a shaft or a crank pin, he thought that emery wheels would not supersede the lathe until hydraulic forging was also adopted, for if, say, a quarter of an inch of metal had to be taken off, the cutter would do it quite as quickly as the emery wheel. At the meeting a crank pin was exhibited which had been forged and turned, then case-hardened and finished on the wheel. Mr. Mather exhibited some locomotive slide-bars which had been faced up by means of an emery wheel. Slide-bars become hollow in course of time, and were formerly trued up by a copper lap and emery. Now they are put in a machine under an emery wheel 4in. wide, and in about an hour the hard steel bars were trimmed up. Recently they had used metaline bearings, which gave evidence of being long lived, whereas the brasses wore very rapidly, owing to the particles of emery being carried between the rubbing surfaces by the lateral motion. Mr. Mather gave a very good character to the metaline bearings, which in the case in question are rather severely tested, for after the slide-bars have passed once or twice under the emery wheel considerable pressure is put upon the bearings, the wheel being screwed down hard. The subject is one that deserves the attention of mechanics, and Mr. Bateman has done good service by introducing it in a public manner, and inviting discussion.

CORRUGATED BOILER FLUES.

THE experiments recently made at Leeds with corrugated boiler flues, to which we briefly alluded last week, will exercise a considerable effect on steam-boiler construction. The results already attained are of the most extraordinary character, and have excited a lively feeling of interest amongst engineers and boiler-makers. Corrugated furnace crowns to locomotive fire-boxes are not unknown, and an approach to the present device is seen in the expansion rings frequently placed at short intervals in the flue tubes of Cornish and Lancashire boilers. These expansion rings are of ∩ section, and are bolted by means of their flanges to the plates of the tubes. It remained, however, for Mr. Samson Fox, of the Leeds Forge Works, to corrugate the flue-tubes, and when suitable machinery has been devised for effecting the object, a new departure in boiler construction will be taken, with results that remain to be seen. At present the corrugation is done by stamping between two dies, and in the tube experimented upon the pitch of the corrugations was 6in., with a depth of about 1½in. It is obvious that metal capable of undergoing the requisite treatment must be of a very ductile and soft character, and from the absence of any suitable means of doing the work in the best manner it is clear that whatever results may have been obtained can be vastly improved upon. Before giving an account of the experiments and the results obtained, it will be as well to consider briefly the effects of corrugating a boiler flue. It is well known that the flue-tube of a Cornish boiler is a most excellent stay for the end-plates, but a consideration of the effects exercised by its expansion severely discounts whatever value it may have in that respect. Naturally there must be a certain amount of play in the flat ends of Cornish boilers, but if a rigid tube is inserted and secured to them, and such tube is the most intensely heated part of the boiler, its alternate expansion and contraction when the fire is lit and allowed to die out must tend to bend the end-plates near their seams of rivets. When expansion rings are placed in the flues, they take up all, or nearly all, of this lengthening and shortening movement of the tube, and undoubtedly save the end-plates from bending strains. The corrugated flue will probably take up the whole of the expansion in itself, but at the same time it is probable that it will cease to act as a stay. As, however, the end-plates can be stayed by other means, there would appear to be no loss of strength from this aspect of the new method. With a corrugated flue it is evident there will be an increase of heating surface, with the advantage, in one way of looking at it, that the gases will impinge against the deflected "ribs," or corrugations, in a manner which is believed to insure the taking up of the heat. One side, however, of the corrugations will be turned away from the flames, so that the actual amount of surface exposed to the fiercest heat will not exceed that of a plain tube, but if no disadvantage is found in the continued action of the flame on the projecting ridges of metal it is probable that a corrugated flue, by breaking up the current of flame and hot gases, will be found to evaporate more water per pound of fuel than the plain tube. At one works, indeed, where two new boilers have been put down, which are exactly similar except that one has a corrugated flue, it is found that the latter evaporates 2lb. more water per pound of coal than the plain flue, but it is evident that trustworthy results are not to be obtained from new boilers until they have been so long in work that incrustation may begin to exercise an effect. These, however, are points that must be considered hereafter. At present we are brought face to face with the demonstration of the extraordinary fact that simple corrugation of a flue tube vastly increases its strength. The formulæ used for estimating the strength of boiler flues are known to give only an approximately accurate result, and a very large factor of safety is taken by all careful boiler-makers, but when we are told that a tube representing a portion of a very common-sized flue, save that it was corrugated, withstood 1,000lb., whereas a plain tube yields at 200lb. or thereabouts, it is evident that a remarkable discovery has been made. The test was a cold one, and was carried out in the following manner. A strong welded cylinder of wrought iron, 1¼in. thick, 7ft. long, and about 3ft. 4in. in internal diameter, was fitted at each end with a strong cast-iron ring, in which a groove was sunk for the entry of the end of the cylinder. The latter was strengthened by five welded rings, 5in. by 3in., bored and shrunk on, and the two cast-iron rings were held together by bolts and nuts. The ends of the flue tubes to be tested were turned, so that when placed within the cylinder they made a water-tight joint, with a ring of indiarubber of cup-leather form sunk in a groove in the cast-iron rings. By this arrangement the whole interior of the flue-tube to be tested could be examined and measured with accuracy at intervals during the experiment. The mean diameter of the plain flue, which was tested under the superintendence of officials from the Board of Trade, the Admiralty, and Lloyd's, in the presence of a number of well-known engineers, was 36·85in., having a departure from a circular form of 0·34in. It had a thickness of 0·375in. The pressure was put on in increments of 25lb., as shown by a 7in. dial gauge capable of registering up to 700lb., the indications being higher than those of a 12in. gauge capable of registering 1,200lb. Measurements were taken after each increase of pressure, and the vertical and horizontal deflection measured at two places; but with these details we are not now concerned—suffice it to say that the tube gave way at 200lb. on the square inch, or at about half the pressure it was calculated to withstand according to the formulæ. The corrugated tube was then inserted, its dimensions and thickness being almost the same as the plain tube, except that it was about an inch smaller in diameter. The test was commenced at a pressure of 200lb., the increments being 50lb., but the whole being taken off between each increase. As stated last week, the corrugated tube bulged at 450lb., but retained a large amount of strength after it failed; whereas in the plain tube the rapid spread of the bulge under a reduced pressure showed that when flattening of a plain flue tube once commences it will go on rapidly, and explained why, in the case of boilers exploded from weakness of the flue tube, the latter is frequently found collapsed from end to end. Subsequent examination of the corrugated tube disclosed the fact that the weld near which the distortion had commenced was imperfect, and its comparative failure was thus explained. That simple corrugation should more than double the strength of a flue tube is, however, sufficiently remarkable, and as there is no doubt that future experiments will give very much higher results—a similar tube previously tried gave way at 1,070lb.—we may expect to hear shortly of a revolution in boiler construction. Already many of the foremost marine engineers have adopted the corrugated flues, and the results obtained in practical work will be looked for with some degree of anxiety.

INFLUENCE OF HEAT ON THE GERMINATING POWER OF SEEDS.

THE fact has been demonstrated by M. Sachs, that most sap-containing plants are killed by an air temperature of 51° C. in 10 to 30min., while for killing in water a temperature 45° to 46°, operating for 10min., is sufficient. It is quite otherwise, however, with some organs of plants which represent the state of rest of plant life—especially seeds. The question what temperature these may bear without losing their germinative power has been studied by several experimenters. Among the most recent researches on the subject are those of M. Just, described in the *Beitrage zur Biologie der Pflanzen*. He experimented in two successive winters with barley and oats. The results of his own investigations and of those of previous students of this subject are summed up in the following propositions:—

1. There is no determinate temperature maximum for the germination of the seeds of a species. This rather shows small variations, according to the individuality of separate seeds.

2. Seeds suffer during action of the maximum temperature a deterioration observable both in delay of the time of germination and in slower development of the germ.

3. The germination of healthy seeds takes place, under favourable germinating conditions, irregularly. That is to say, of a large number of seeds placed for germination, a small number at one time begins to germinate; later, the number of seeds germinating in the same period rises and reaches a maximum, then gradually falls to zero. The beginning and end of the germination, and occurrence of the maximum, are different both according to the species and according to the nature of the seeds in a species.

4. Under ordinary conditions seeds lose their germinating power more or less quickly, according to species and individuality of the particular seeds. This loss of germinating power occurs in air saturated with vapour more quickly, the higher the temperature. At a temperature of about 60° C., in air saturated with vapour, and even in 24 hours, but also at ordinary temperature, there appears in some seeds very quickly a deterioration of germinating power.

5. In vapour-saturated air seeds do not come to germination through the influence of the air moisture alone, when the temperature remains constant. A germination can only occur when through great and repeated variations of moisture, a dew formation occurs on the seeds.

6. Many seeds, by remaining in water, suffer loss of germinating power, more or less rapidly according to species and individuality. While even water of ordinary temperature causes this injury, it appears more quickly the higher the temperature. Seeds, however, can always bear for several hours in water a temperature which is not too high above the maximum of germination (up to 55°).

7. If the seeds, when heated under water, experience a want of oxygen, they suffer more than with free access of oxygen.

8. Seeds that are moist and swollen show, indeed, a somewhat greater resistance to the injurious action of high temperatures than sap-containing parts of plants (stem, leaves, &c.), but the difference is not very great. A greater difference consists in the fact that seeds are better protected against injury through high temperatures the more they are dried, while sap-containing parts of plants perish through drying.

9. While seeds by careful drying may be well protected against the injury of high temperature, the most thorough drying does not suffice to obviate altogether injury from high temperature.

10. The highest temperatures which many seeds in the dried state can bear are between 120° and 125° C. One cannot, however, give a quite determinate killing temperature for the seeds of a species, as this varies slightly according to the individuality of the seed. Further, the seeds of different species are killed at different degrees of temperature.

11. Certainly every temperature above the upper zero point is more injurious to germination, in the case of thoroughly moist seeds the higher the temperature is, and the longer it acts; and, further, with seeds not quite dry any temperature above the upper zero point will damage germination in general, more the greater the quantity of water in the seed. The limitation, however, remains, that temperatures up to 60°, 70° C. (in some cases even higher), act favourably to the germinating power of many seeds when the water in them does not exceed a certain amount.

12. When seeds in boiling water do not lose their germinating power, this must always be due to the fact, that the organs concerned are protected by certain conditions of organisation against the entrance of the warm water to the inner tissues.

13. The injuries caused to seeds, both moist and dry, by action of heat, have great similarity to those injuries which seeds suffer, under natural conditions, with increasing age—at least, so far as the beginning of germination, duration of the process, and percentage of germination are concerned.

14. The injuries caused by high temperatures appear in the following way: The beginning of germination is delayed; the absolute germinating time, as also the relative, are prolonged; the maximum of germination always occurs later, and is always more indistinct; the percentage of germination is less.

15. The killing of seeds by actions of temperature (25° to 125° C.) has nothing to do with the coagulation of the albumen.

THE ORGAN: A COMPREHENSIVE TREATISE ON ITS MANUFACTURE, PROCURAL, AND LODGMENT.*

By John Watson Warman,

Associate of the College of Organists, London.

PART I.—GENERAL TREATMENT IN MANUFACTURE.

u. IT will be obvious that in a location liable to considerable rise of temperature (as in a crowded concert-room) the wind supply should be drawn from a colder region, as, a lower unheated chamber; thus cool air will be constantly passing into the Organ, so preventing the Pipes rising in pitch. Mr. Willis, in 1867, took out a Patent (No. 1061) with respect to this arrangement.

v. *Examples.* In *Cathedral* arrangement it is generally both best and easily practicable to have the Bellows away from the Instrument, unless the latter stand on or near the ground, and with ample space above; in which case, as the whole of the Manual Soundboards ought to be kept well up, the space at bottom of the Case may well be occupied with the Bellows. This arrangement is carried out in the large Organ by Hill in the nave (or, rather, I believe, West transept) of Worcester Cathedral.

w. In Canterbury Cathedral the Organ is placed in the triforium—of course spread along;—the Bellows consequently are at the side of the speaking portion of the Instrument—occupying, in fact, one bay. The arrangement is that of Longhurst, *sen.*

x. At Winchester Cathedral (Henry Willis) the Bellows proper occupy the usual position at the base of the Case; the Organ elevated considerably. On the floor of the Cathedral, however, is a set—added, I believe, by Hill—of Vertical Double-action Feeders, driven by hydraulic power, and suppyling up through a large Trunk into the Receivers of the Bellows (which Bellows are of the usual form with own feeders complete). *See* also Blowing action (8, y.).

y. At Westminster Abbey (Hill's arrangement) the Bellows are just beneath the choir screen-roof on which the Organ stands—hung, in fact, over the heads of the Blowists, the object of so raising being to shorten the Trunks; Bellows and blowists thus occupy a room forming a portion of the screen.

z. At Gloucester Cathedral the whole of the Organ (arrangement, I believe, by H. Willis) is on the screen; the Bellows outside the case, but hidden from view from beneath by the parapet of the screen.

[8, a.] At Manchester Cathedral (Hill) the Bellows are placed in a side chapel, together with the Hydraulic Engine that drives them, the communication with the Organ being by tin-piping.

b. At the Cathedral of Ulm, in Swabia (Walcker), the Bellows are placed in the crypt.

c. At St. Paul's, London (H. Willis), and York Minster (Hill), the crypt is, I believe, the position selected. In the first-named there seems hardly any other location possible, the Organ being divided into two halves, lofty, but very shallow at the base; in the latter case the Instrument is on the screen, but owing to the great number of the Stops the space inside it has had to be utilised for a portion of the speaking or working parts of the Instrument.

d. In *Chamber* arrangement the problem is somewhat simpler: there is not here—if instrument be small—that strict necessity for keeping Bellows outside of Case; for entire Instrument ought to admit of being drawn forward (*see* 46, v.), and this, if Building-frame properly constructed (*see* that *Department*) Bellows will admit of easy access or withdrawal.

e. A very excellent Chamber Arrangement is to have the Bellows immediately beneath the Organ—that is, hung from the joists of the portion of the floor on which the instrument stands, the Windtrunk passing through the the floor; the only drawback is the necessity of disconnecting the Trunk to be able to run the Organ forward, but it must be borne in mind that the removal of the Bellows gives such excellent access to the lower part of the instrument that the necessity for drawing it forward is very much lessened, or got rid of altogether. Of course it is preferable that the room beneath the Organ be sufficiently high-pitched to allow of free passing beneath the Bellows, and it is desirable that the temperature of the two rooms be the same.

f. In the small Organ (by Gray and Davison), in the private apartments, Buckingham Palace, the Bellows are in an adjoining passage, where they appear as a table.

g. In the Organ (by King, London), built for Dr. Huggins, of Upper Tulse-hill, London, the Bellows are in the coach-house, adjoining the kitchen; the Trunk (Drain-piping) runs round or under the house to the drawing-room, in which the Organ is placed; steadiness is here very much wanting, owing to the diameter of the Trunk being too small in proportion to its considerable length.

h. The Organ (by T. Jones, London) built for S. D. Arundel, Esq., of Hackney, London, has two complete Bellows—one of the ordinary kind, occupying the usual position in the base of the Case, and supplying for Hand-blowing; but trapped Automatically, so as to serve as a Reservoir to another Bellows, placed in the basement of the house, weighted ¼in. heavier, and driven by hydraulic power. This is a very excellent, but, of course, rather expensive arrangement.

i. With *Church Organs* rather more consideration is required, the treatment of the instrument itself being subject to so much variation. Here the desirability of keeping the Bellows outside the Case remains strongly in force; a very excellent plan is that followed at St. Martin's-in-the-Fields, London (Bevington), where the Organ, being in a West gallery, the Bellows are in the belfry, behind the instrument. The present craze in favour of having the Organ at the East portion of course militates against this arrangement, except in those comparatively rare cases in which a tower is placed East of the centre of the building. At St. Philip's, Waterloo-place, London, the Bellows are also in belfry behind Organ.

j. At the Parish Church, New Romney, Kent, the Organ (Matson and Sturges, Ashford) has no regular Case, merely a Screen from which the Buffet projects; the instrument is spread abroad in a very accessible manner at the East end of the South Chancel aisle. The Bellows are quite clear and free, both all round and over, being, in fact, totally disconnected from the Organ, though still kept as close as convenient.

k. At Boughton Malherbe Church, Kent, the Organ (by preceding) being hung from the principals of the roof by iron rods, the Bellows are beneath on the ground, enclosed in a boxing or breastwork in harmony with the seating of the church.

l. At Sturry Church, Kent (Wedlake, London) the Bellows are similarly placed to the last-named, but the Organ, instead of being hung, here occupies the usual *Cathedral* position on the Screen dividing the Chancel from the Nave. (*See* also a little back, 7, t., for reasons why supply is not here steady.)

m. At St. Mary's R.C., Newcastle-on-Tyne (Lewis), the Bellows proper are at the extreme flanks or side ends of the Organ, which is triangular (approx.) on plan; they are thus separated by the halves of the Pedal Organ from the body of the instrument. For an Organ triangular on plan (a very excellent form) this is sometimes the best arrangement.

n. At the Temple Church, London (arr. by Robson, London, believed), the Bellows are in a room beneath the Organ, the instrument itself being in a chamber projecting from the North Aisle at about the centre of the length of the building.

o. At Willesborough Church, near Ashford, Kent, the instrument was many years ago converted by Mr. W. Steddy, the Organist, into the pattern now known as Scudamore (quite independently, however, of any knowledge of Mr. Baron's designs), with reversed Claviers; the Bellows occupying the usual position at the base of the Case, but, of course, behind the player, and quite free of the Claviers. The main Organ stands against the North wall of the Chancel.

p. In *Concert* instruments it is, as a rule, most desirable to keep Bellows outside the Case—1st, for assisting to keep latter, when crowning an Orchestra, within reasonable limits; 2nd, for purpose of convenience for operation of Blowing, which, whether by Machine or Personal, must, of course, not be visible to the audience.

q. There is here the more reason for so placing Bellows: 1st, because of economising the ample room generally existing beneath orchestra; and, 2nd, for the reason that one or more of the Soundboards may often be much elevated, thus giving chance of necessity for Reservoir.

r. The most noteworthy Concert Instrument, so far as I am aware, in which this arrangement has been departed from is at Exeter Hall, London (Walker, London), where the Bellows occupy the usual position in the lower part of the Case; whether any more suitable position was here available I cannot say.

s. At the Crystal Palace, London, the Organ (by Gray and Davison) has its numerous Bellows in a sort of Chamber at the back of the Instrument.

t. At the Bow and Bromley Institute, London (Brindley, of Sheffield); and the Town Hall, Melbourne, Australia (a large Instrument, by Hill), the Bellows are, I believe, beneath the Organ proper, under the orchestra.

u. At the Albert Hall, London; St. George's Hall, Liverpool; and the Pavilion Dome, Brighton (all by Willis), the Bellows are in an ample chamber beneath the Instrument. At the Leeds Town Hall (Gray and Davison) the Bellows are also thus placed.

v. All the foregoing arrangements are, except in the two specified (Sturry and the Tulse-hill Organ), quite satisfactory so far as author is aware.

w. Exact Location and Arrangement. It will be seen in Blowing-action (18, b.) that it is always best where practicable to have two handles as close as permissible, so that a single blowist can as a makeshift supply a *little* wind to both departments.

x. There may, however, be cases in which the two Handles *must* be placed at different parts of the Instrument. When this is so, more consideration is required. Supposing the pressure Apportionment such as to obtain a practicable or sufficient amount of wind (that is to say, sufficient for some purposes on occasions) from one only of the Handles the putting of the latter apart need not entail any additional labour. With regard to this point circumstances must, of course, be borne in mind, in addition to the actual Apportionment. Consult latter (9, x), and then consider under what circumstances Organ is likely to be required when both blowists not present. For instance, suppose one Bellows supply only Pedale (a very common, though, in author's opinion, very unadvisable arrangement, as a rule) it is evident that one Handle will do both for choir and private practice—that is to say, it can be made shift with: the Pedals can be dispensed with entirely at ordinary choir practice, and for private practice there are the Man-to-Ped couplers.

y. As a rule, however, it will be best, when two Handles are separated, to be able to get a little wind for every department by means of the one Handle; and the best method of doing this will be to have the Lighter pressure Bellows furnished with Automatic valve of the usual kind (*see* 14, k), so as to convert at pleasure the Receiver of said Bellows into a Reservoir in connection with the heavier pressure Bellows. Of course, this Valve must be under control from the outside of the Organ, so can be closed when desired; otherwise the Feeders of the lighter pressure Bellows will be useless, for they cannot supply the heavier Bellows, as the latter will not rise till the lighter Reservoir is full, and when this is accomplished the communication between Feeders of lighter Bellows and Receiver of heavier Bellows is cut off—the lighter Receiver being *kept* filled by the heavier. An example of this connection-at-pleasure occurs at St. Michael's, Cornhill (Bryceson or Robson; Organ originally by René Harris).

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z. The foregoing arrangement has only one disadvantage—viz., that if the connection were inadvertently left unclosed the wind supply would not be sufficient; but this is obviously of little real importance, for regular blowist and organist will, or should, both be acquainted with the working of the Valve, and it is not likely that on any important occasion both persons would be absent; besides, if desired, the Valve can be put in automatic connection with the little door locking beneath lighter Bellows-handle, so that any use of latter without the Valves being closed will be rendered impossible.

[9, a.] There is an arrangement by which the foregoing and the Valve connection itself might both be saved, and at same time either Handle rendered available; it consists simply in providing the Lighter Bellows with a second bottom to its Receiver, this Second bottom being above the usual one, and having on it the Automatic Valve; the Suckers of the Receiver on the true bottom of Receiver as usual. A hollow space thus extends beneath the whole of the false bottom, and into this space the Feeders supply. Thus, it will be obvious that, no matter which Handle is used, the lighter Receiver will be first raised, then the heavier; when both Handles are used both, of course, feed into heavier, which itself supplies the lighter. There must here be a tell-tale from heavier Receiver to *each* Handle.

b. This arrangement is not recommended by author, for two reasons: 1. Each Blowist may try and shirk his work, and the result be that wind "go out;" at the same time it is almost impossible in such case to discover the real culprit. 2. There is great danger of unsteady blowing, from both Handles supplying into one Receiver. This, of course, is the more likely when the lighter Reservoir is not being drawn on, and for this reason the Apportionment might be fettered. Where, however, the connection-at-pleasure does not seem desirable—either through difficulty of getting at Valve in case of derangement or constant change of blowists and organist—and the Apportionment of pressures can be suitable (*see* as given with COMBINED BELLOWS, 12, a), the arrangement may occasionally be of use.

See now RESERVOIRS (14, m.) with reference to size of Trunk, &c.

c. For more than two pressures, whole of preceding holds good; Handles should be kept as near together as possible, but when this is impracticable connect any suitable two Bellows in manner described.

For Combined Bellows—it being a complete structure without division, and therefore not coming under head of ARRANGEMENT except for GENERAL LOCATION (*ante*)—*see* DESIGN (7, f.).

(*To be continued.*)

IMPROVED LOCKS.

THE improved construction of locks, illustrated in the annexed engravings, is the invention of Herr T. Kromer, of Freiburg, and has been patented in this country by Messrs. Chubb. The improved lock is formed of two cylinders—one, the outer one, fixed and forming part of the lock case, the other capable of revolving within it, and carrying in its interior a number of slides which lie across it one above the other, and project alternately through slits formed in its two opposite sides, and enter corresponding slits formed in the opposite sides of the interior of the outer fixed cylinder, thereby locking together both cylinders by, as it were, a series of cross bars, which offer great resistance to the lock being opened by force. Fig. 1 is a front view of the lock, with the cover plate removed, and Fig. 2 is a transverse section. A is the outer cylindrical case, which can be secured, say, to the door of a safe by screw bolts entering the holes in the enlarged flange, which projects beyond the remainder of the case, as shown; B is the inner cylinder, of two different diameters, fitting the interior of the cylinder, A. The larger end of the cylinder, B, is hollow, and receives within it a number of slides, C, which lie one above the other, as seen in Fig. 2. The opposite sides of this part of the cylinder are notched or cut away for the ends of the slides to pass through, and enter corresponding notches in the sides of the interior of the outer case. Each slide, C, has a spring, C^1, secured to it; the outer end of the spring is made into a small coil or bend, so that it may be held in one or other of the slotted undercut recesses, D, in the sides of the cylinder, B, as shown. There are two of these recesses, D, and they are on opposite sides of the cylinder. The slides are placed so that their springs come alternately into the two recesses, the end of the spring of one slide being held in one of the recesses, D, whilst the ends of the springs above and below it are held in the other recess, D. By this means the alternate slides are forced outwards in opposite directions to their springs.

FIG. 1

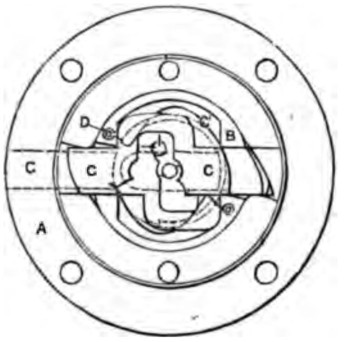
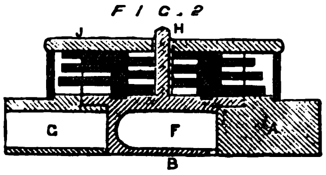
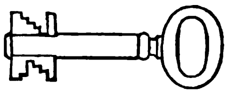


FIG. 2





The lower part of the cylinder, B, is solid, and around one-half of its circumference is a groove, into which enters the end of a pin, carried by the outer case, A. A radial hole, F, is also formed in this part of the cylinder. The end of this hole can be brought opposite to a corresponding hole, G, formed through the outer case, A, or can be turned away from it into the position shown in Fig. 2, so that the lower part of the cylinder then forms an obstruction to prevent a bolt, not shown in the drawings, from being drawn back. H is a pin which stands upwards from the centre of the cylinder, B, and serves as an axis for the key. Standing up from the solid bottom of the cylinder, B, is also a short stump, I, against which the key acts to turn the cylinder, B, from its unlocked into its locked position. The key is formed with stems or projections on two opposite sides, and the end of the stem is also bevelled. In order to unlock the lock the key is turned in a direction away from the short stump, I; the steps on the opposite sides of the key then act on the slides, and draw them in opposite directions, until, when the key has made, say, a quarter turn, they all lie within the outer limit of the cylinder, B. Two opposite steps of the key then bear against one of the slides, by preference the lowest slide, and the key cannot turn further without carrying round this slide with it. The slides and cylinder, B, are therefore turned by the key, and when the cylinder has made c
it comes into its unlocked position,
turn further, by reason of the st
ends of the slides, but in reversed
now again opposite to the notches
of the outer case, A, and are press
by their springs, so turning the k
a short distance, and bringing the
jections on its end opposite to the
allowing the key to be withdrawn.
is withdrawn the slides, or some
pressed outwards still further by t
When the lock is to be again locke
inserted, and its bevelled end acti
slides, withdraws them a short d
key is then turned towards the sho
and bearing against it turns the c
slides then move back into the cy
ends being rounded off, as shown
their being moved back when tu
direction. When the cylinder has
into its locked position the ends
have been brought opposite to th
the outer cylinder, and the slide
outwards by their springs, and
cylinder from turning, and as th
ject from two opposite sides of the
lock and hold it as though a sol
passing through the cylinder, and
the notches in the outer case. By
lock and key in such a manner th
lock has been unlocked the slides
distance outwards on the withdraw
the lock cannot shift out of its u
tion either by accident, or by the
of any kind of key, so long as this
the same diameter of stem and be
the proper key. The fact also tha
unlocking the lock does not act d
the inner cylinder to turn it, but on
it by pressure against one or more
adds greatly to the difficulty of
lock by a false key, as the action
having any of its steps either a litt
or too high, or not rounded off at
the same extent as the steps of the
would not properly withdraw the
even if the slides were nearly b
withdrawn into the inner cylinder
the key would force them against
the outer cylinder, and cause the
brakes and prevent the inner cy
being turned. As before stated
the slides, where they bear against
the notches or openings in the cyli
the inner cylinder is attempted to
a direction to unlock the lock), h
notches formed in them; and the
the notches are brought to a bl
that the slides, when moved endwi
edges, have a perceptible rise and
them, which prevents the correct
the slides being ascertained by "fe

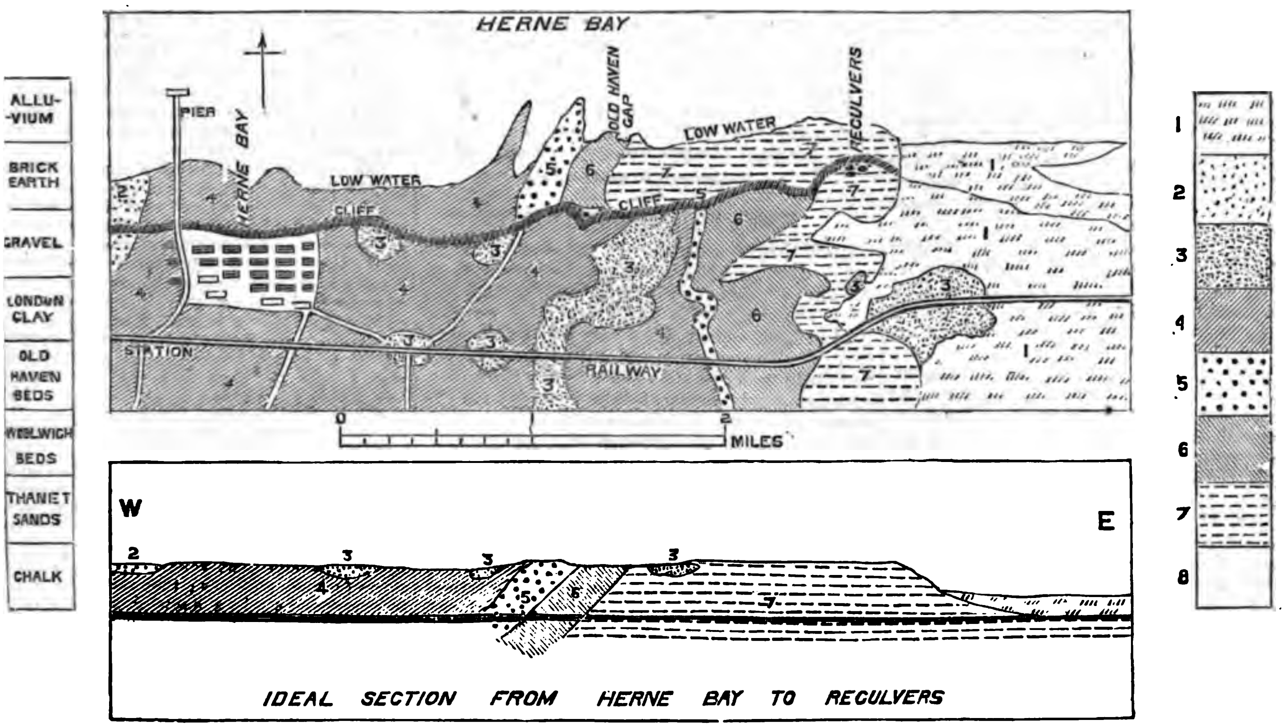
GEOLOGICAL FEATURES
NEIGHBOURHOOD OF H
AND HERNE BAY, IN EA

IN a former article in the ENGLISH
No. 578, of the 21st April,
such a sketch of the geology of t
Sussex and Kent as might enable
of contemplating its salient featu
without extensive reading or that
study which few men can devote t
science of geology. In doing so it
my object to offer that which ap
reasoning power of the mind, b
which gives such pleasure to the
rejoices amidst the beauties of natu
sketch, too, it is my object, be it
perfectly attained, to invite others
joy, that I have felt when, with ge
and hammer, I have traced out t
that cover the chalk on the woode
especially in the neighbourhood o
and on the coast of Sheppey, Whi
Herne Bay. For our knowledge of
tions we are mainly indebted
Whitaker and Prestwich for their
work on behalf of the geologica
England. I have taken up the d
Shottenden-hill, the Selling Rail
Boughton, and Hern-hill, as I am
acquainted with it, and on account
turesque beauty, which is perhaps

ning than during the autumnal tints of ber. The best geological section, however, orded by the sea cliffs between Herne Bay Reculvers, at a distance of two miles east Herne Bay pier.

rn-hill occupies geologically a position the eastern margin of that great depres- in the chalk known as the London Basin, h may be traced on an ordinary map hly included within a line running from stoft and Harwich, on the east coast, gh Hertford, including Reading, a few to the west of Newbury; and then turn- south and east, passing Basingstoke, lford, Croydon, Chatham, Faversham, the t of Blean, to Herne Bay, where fine ns are afforded by the cliffs terminating Reculvers, but reappearing at Pegwell from under the alluvium between the Isle anet and the mainland.

s great hollow—called by geologists the n Basin—has been filled with a series of loams, and clay, known as the London ries, and included in the Eocene forma- of the geological scale, representing that of the earth's history when the great an age of animal life had been replaced igher form, the true mammal, which has continued to be the dominant race, show- at there is much truth in the saying that ery dog has his day," for we find there was day, or period, of the mollusc, the fish, the ile, and the mammal, culminating in man.



IDEAL SECTION FROM HERNE BAY TO RECULVERS

s latter or Lower Tertiary period, repre- ted by the formations in the immediate ghbourhood of Herne-hill, cannot fail to ke the most casual observer of nature, from great contrast lithologically to the much re extensive formation of the chalk.

t was at the close of the Cretaceous period t a great wrinkling of the earth's crust took ce, the hollows such as the London Basin ng filled with the Eocene deposits, which s the dawn of that higher development of e animal creation which we now see around . In this locality were first deposited a fine- ained and evenly-deposited succession of nds and loams, passing in some places—as at ulvers—into sandstone, containing many ils. In the lower part frequently a green nd, particularly near its junction with the alk, where there occurs a band of green- ated flints, which in places when the chalk s been laid bare by denudation, are frequently ned up by the ploughs. These sands, though parts originally green, are often weathered wn where they have been exposed to the . The fossil shells are those of a warm mate, and are marine. The bedding is ular, and tells of a quiet deposition in a deep sea until they had accumulated to 100ft. in thickness. Next succeeds the formation called the Woolwich Beds, which also tell of a shallower sea, in many places estuarine in character, the fossils often silicified, being occasionally fresh water, and the sands unevenly deposited, as if by tides and eddies, containing water-worn pebbles rubbed round and smooth by the waves. These beds are from 50ft. to 60ft. in thickness, resting in many places unevenly on the Thanet sands below them, and, though frequently very difficult to distinguish from the latter, are coarser and much more unevenly bedded. Next in ascending order come the Oldhaven Beds, receiving their name from their typical development at that place, near Herne Bay. It is a very curious and variable formation, containing beds of small pebbles, generally black, and remarkably of the same size. These pebble beds are sometimes replaced by a silicious ironstone, which, on the road to Selling, near the hill known as the Sugar-loaf, was some years ago experimentally mined, with the view of furnishing the coal vessels with a remunerative freight on their return voyage to the North, instead of going back in ballast. The fossils, like those of the Woolwich Beds, are, in places, both marine and estuarine. The formation varies from a few inches in thickness to 30ft. at Shottenden Mill. Where fossiliferous or lithological characteristics fail to mark the junction of these beds and those of the Woolwich series below them, a purple band of sand frequently marks the place of junction, as may be seen at the entrance gate to the vicarage at Herne-hill, with blocks of ferruginous sandstone on the opposite side of the road. Near Reculvers there is a curious form of selenite, with grains of sand caught up between the planes of the crystals. The next and highest in geological order occurs in the well-known London clay, forming Dunkirk-hill, and underlying the Forest of Blean. It is as characteristic of deposition in a calm deep sea as the Oldhaven pebble beds are of a shallow and stormy one. It is of a bluish grey colour, weathering to brown, having a thickness in the Isle of Sheppey of nearly 500ft. The nodules of limestone found in it, called Septariæ, from the manner in which they are divided by planes of calcareous spar, have been for a long time collected on the sea-coast, especially at Harwich, as well as dredged up from the sea bottom, for the purpose of making Roman cement. They occur in bands, as do the flints in the chalk, being segregations of carbonate of lime from the surrounding clay, frequently around some organic nucleus. The London clay contains, in addition to these, a great number of fossil shells, which are of a character denoting a warm or tropical climate, lobsters, crabs, a small serpent, and great quantities of mineralised wood, which is sometimes bored through and through by Teredoes, still containing the peculiar linings of their tubes; also a vast quantity of wood where the vegetable matter has been replaced by pyrites to such an extent that it is collected on the sea-shore in heaps, and sent to the sulphuric acid manufacturers for conversion into that useful acid, the quantity of which manufactured by any country has been taken as an index of its civilisation. The grain of the wood, the minute markings of the bark, are faithfully preserved, looking as if cast in bronze. Palm nuts and other tropical productions, some resembling custard apples, abound; which, together with nautili, cowries, and other shells of warm climates, spell out, as do the letters of a book, that there once existed a warm and sunny land, on which a luxuriant vegetation grew, and that storms occurred which swept into its rivers the wreck of its jungles; and so the spoils of the land were borne to the sea, where, floating until bored by Teredoes and other molluscs, they in time became water-logged, sinking to the bottom of a quiet sea, which, like all nature, was diligently at work forming the London clay from the washings of the lands, and in its mysterious laboratory transmuting organic forms to stone.

The writer obtained from a Septaria on the Sheppey coast some very curious foliated crystals of sulphate of baryta, which are very remarkable, as baryta is neither mentioned by Lyell or Phillips, or by Faraday in his analysis of the London clay and Septaria. They were not more than 1in. in length, and of a dull grey colour, very different in this respect to the large and lustrous crystrals of gypsum or sulphate of lime. The sub-angular gravels that cap many of the hills of the neighbourhood, or lie upon their flanks, are of a much more recent period—a lapse of time so great that years are units too small to give expression to the enormous gulf of time that separates the one from the other.

The earth's crust, through many oscillations, giving rise to varying conditions of deep and shallow seas, at last stood up at a general level above the waters, for the action of the sea has been likened to a carpenter's plane, which smooths off inequalities both in vertical and horizontal planes; whereas, to carry out the analogy, the rivers, like saws, cut up the earth's surface into hills and valleys, the frost and other atmospherical conditions acting as chisels in reducing the rocks to small fragments for the streams to carry to the sea. And thus, by the quiet operations of nature going on continuously, as we now see them around us, have the features of the landscape principally been carved, until the pebble-capped heights of Shottenden were left standing in bold relief, and lesser heights so covered by the same protecting harder beds rise at different elevations —as that on which the church and vicarage are situated. The Sugarloaf Hill and inferior elevations along the road leading from Selling Railway Station to Boughton, and running under the loftier hills of the London clay, are so many ruins left standing of what were once continuous formations.

The higher grounds of Dunkirk and the Blean are composed of London clay, and are in places covered with beds of old river gravels. The rivers having rapidly and deeply cut their channels when the land stood at higher levels, and flowing sluggishly when the surface was lower, filling the valleys they had previously excavated with alluvium, denudation going on until some of the bottoms of the gravel-strewn valleys, became gravel-capped hills. Tennyson expresses this operation of nature so well that I cannot refrain from quoting him :—

There rolls the deep where grew the tree.
  O, earth, what changes hast thou seen?
  There where the long street roars, hath been
The stillness of the central sea.

The hills are shadows, and they flow
  From form to form, and nothing stands;
  They melt like mist, the solid lands
Like clouds they shape themselves and go.

Leaving the beauties of the inland scene for the coast at Herne Bay, the London clay is passed over from Whitstable to two miles east of Herne-Bay Pier, where at Old Haven Gap the pebble-beds which have received their name from this place show themselves, and are succeeded by the Woolwich Beds and Thanet Sands, until at Reculvers they all give place to the alluvium that separates the mainland from the chalk of the Isle of Thanet, but reappearing on the east coast at Pegwell Bay, where a great number of fossils of the Thanet Sands may be obtained at the southern extremity of the cliffs.

Mr. Dowker, F.G.S., has paid much attention to these formations, and has, perhaps, the finest and best-arranged collection of fossils to be met with in any private collection, at his residence, near Stourmouth, about four miles from the Grove Ferry Station, on the S. E. Railway.

The Rev. F. Thorpe, the Vicar of Hern-hill, has also many interesting specimens among his numerous and varied collection.

Mr. W. H. Shrubsole, of Sheerness-on-Sea, receives fossils from the working men, and sells them for their benefit at about two shillings and sixpence per hundred—fossil bones, nuts, fruit, shells, sharks' teeth, &c.

Along the coast, between Herne Bay and Reculvers, the Tertiaries of the entire district may be studied to the greatest advantage; but the lover of nature will lose much if he leaves unexplored the beautiful district between Shottenden-hill, Selling Railway Station, and Hern-hill.

In so brief a sketch, it is impossible to give more than the merest outline of the geological facts, or the supposed causes that brought about the condition of things that has resulted in the picturesque scenery of the district, so that the following epitomised topography of the geology of the neighbourhood may assist the field geologist, who is supposed to start on each investigation from the Selling Railway Station.

Thanet Sands.

Selling Tunnel, Station, South-street, Lower Boughton, Staple-street, Way-street, Oak Well.

Woolwich Beds.

Along road from Selling Station, running under the hill-side to Boughton, including upper part of Boughton, where there are some sand pits.

Between Staple-street and the hill-side, extending round Hern-hill and running in a very irregular line to the marshes.

Oldhaven Beds.

Shottenden-hill and ridge, cropping out over the Woolwich beds and under the London clay from the railway to Boughton, capping the Sugar Loaf-hill and Eastwood Mount, running out in a spur over the Woolwich beds to Staple-street, forming the hill on which the mansion of W. Daws, Esq., is situated, continuing North in a band a few yards wide under the hill-side to the east of the vicarage, the latter being situated on a patch of these beds, when it suddenly spreads out, and in an irregular manner covers the Woolwich beds to Dargate and the Sea Salter marshes.

London Clay.

The whole of Dunkirk-hill, Forest of Blean, sweeping round to the north of Hern-hill by Lambart's Lands, forming the Rough-hills, Graveney-hill, and Sand-hills above Broom-street, a conical hill about two miles north-west from Hern-hill, the latter affording in itself an epitome of the geology of the neighbourhood, for it rises from the Thanet Sands on the south, with successive strata of Woolwich beds, Oldhaven beds, and London clay, reminding one strongly of the mounds left by the workers in gravel pits, with the surface soil or turf at the top, to show the extent of their labour in a vertical direction. So has the great excavator, denudation, left this hill a silent witness of his works, and of the once continuity of the various strata.

The geologist might, in the flints that face the walls and tower of Hern-hill Church, find abundant subject for contemplation, as also in the interior of the church, where he may find pillars built of the blue limestone from the lower greensand, and slabs of Betheraden marble, containing fossil Paludoria, Cyclas, and other fresh-water shells, with their comminuted fragments, which once upon a time lived, and died, and were deposited in lake bottoms in the surface of the Weald clay. **Centurion.**

BOILER INCRUSTATION.

AMONGST recent "inventions" for preventing and removing incrustation in boilers, we find two which their discoverers have thought worth patenting, and we note that in both soda plays a very prominent part. Mr. E. Hunter, of Leeds, declares that his composition mixes with the water in the boiler, and thereby is brought into contact with the incrustation or scale, which is removed, loosened, or prevented from forming on plates by the chemical action of the composition. The ingredients contained therein are as follows:—For about 50 gallons of the composition: Common soda, 91lb.; Irish moss, 11½lb.; catechu, 17lb.; water, 55 gallons. Or instead of the common soda and Irish moss, the patentee in some cases uses hyposulphate of soda, about 45lb., combined with ground oak bark, about 65lb. These are placed in a suitable receptacle, and boiled for about two hours, after which the liquor is strained off, and is then ready for use. The quantities of the ingredients used in forming the composition of course may be varied in accordance with the quantity or nature of the scale or incrustation. When the composition is supplied at the commencement of the working of the boiler, and continued as may be required, the scale or incrustation is prevented; but when required to remove the incrustation or scale after being formed and adhering to the plates, the composition may be pumped or injected into the boiler by any ordinary known means. The patentee claims that this composition also prevents priming, and acts as a lubricator for steam cylinders by passing thereinto with the steam.

Another invention comes all the way from Chicago, having been patented by Mr. J. W. Petersen, of Birmingham, on behalf of Mr. R. H. Harcourt. This invention consists of a solution of the following chemical ingredients, in about the proportions specified:—Take 1lb. of extract of logwood; 10lb. of carbonate of soda or soda ash; 10lb. of biborate of soda; 10lb. of sal soda. Dissolve thoroughly in 20 gallons of water (at 205° Fah.), then add to this 5 gallons of treacle or molasses, and 15 gallons of tanners' extract. Stir while boiling until all the ingredients are thoroughly mixed. When thus mixed the compound is ready for use in the proportion for new boilers of about 1 gallon to every 10-horse power boiler, according to the quality of the water; or for cleansing foul boilers in greater proportion, according to the state of the boiler. The tanners' extract referred to is the extract used by tanners in the process of tanning leather, and may be made from any bark or wood abounding in tannic acid. This preparation obviously depends upon soda for its solvent action upon the boiler scale, and we suspect is remarkably like a well-known and thoroughly-appreciated anti-incrustator sold under the name of tannate of soda.

THE TECHNOLOGY OF PAPER-MAKING.—XIII.*

The Various Classes of Paper; Characteristic Differences. The Determination of the Ash or Loading. Water Supply. General Arrangement and Construction of the Mill.

FIRES, unfortunately, are not uncommon in paper-mills; provision should therefore be made so that, in the event of such an accident, the flames may be extinguished as rapidly as possible. This is all the more necessary when the mill is situated at a distance from public fire appliances. Fortunately, the existence of the mill itself implies the existence of an abundant supply of water, and arrangements should be made so that the whole of this may be readily available the instant fire is discovered. Force-pumps in various parts of the mill should have connections and off-takes for hose-pipes, so that, whatever their purpose usually, they may, by simply opening a few taps, at once begin to drive water wherever it may be required; a manual engine is also useful, as well as buckets placed all over the mill, which should on no account be used for any other purpose. When it can be done conveniently, a very good plan is to have special water mains all over the mill, with numerous off-takes, and a full supply of hose-pipes, the system being connected with a set of force pumps, worked by a little turbine, and drawing from the river.

The success or failure of a paper-mill will very largely depend upon its management. There is nothing that will so much contribute towards the prosperity of an industry of this kind as an energetic, progressive, and discerning manager—one who not only knows his work, but finds his chief pleasure in keeping both men and machinery moving sweetly; one whose mind is not a fossil, incapable of appreciating and yielding to altered conditions, but ever on the alert, seeking to develop and improve, and willing to accept improvements on fair evidence, even though the ideas have not been born in his own mind; one who can be at home with his men, and yet retain his position amongst them. He does not require to be a genius, but thinking, active, intelligent, and attentive; to such a man "brocke," and "retree," and "lost time" are hateful terms, and indolent and careless workmen a nuisance not to be tolerated. Such a manager should be appreciated and encouraged, and that their number may be increased, opportunity and encouragement should be given to intelligent young men to prepare themselves for such positions; they should be stimulated to study, and attain a knowledge of the principles involved in the various parts of the industry, and to go forward to the Society's examinations until they have passed the "honours" stage. Young men holding certificates to that effect ought to develop into well-qualified managers.

In drawing this course of lectures to a close I may mention that my attention has been called to a new method of working machine vacuum boxes, which has been patented and applied by Messrs. Mason, Wolstenholm, and Spencer. The appliance is simple, consisting as it does of a steam jet acting as an ejector. This neat device takes the place of the usual pump, and is said to give very good results. The advantages claimed for it are, that it maintains a steadier vacuum, and allows of [illegible] water being run on to the wire with the pulp [illegible] practical result being more uniform paper with [illegible] "brocke." I have no doubt at all as to the effic[illegible] of the arrangement; it is simple in constru[illegible] steady in its action, and easily kept in order, [illegible] suspect it will be found to consume a consid[illegible] amount of steam.

My attention has been directed to an inter[illegible] historical fact with which I regret I was not [illegible] acquainted, but which justice to the memory [illegible] who virtually sacrificed both his fortune and [illegible] in working out the appliances now in commo[illegible] for surface sizing and drying, compels me [illegible] closing these lectures respectfully to notice. [illegible] the year 1812, Robert Gill Ranson, of Ipswic[illegible] vented and patented the appliances refer[illegible] Previous to that time the endless web made o[illegible] Fourdrinier machine had to be cut into sheets [illegible] it could be sized and dried; the labour invol[illegible] so doing can be imagined. Since Mr. Ra[illegible] death in 1813, the drying machine has no[illegible] undergone a great development, but both the [illegible] and drying machines of to-day are essentially [illegible] which Mr. Ranson left behind him, which is [illegible] ony to the correctness of the principles which he at himself to work out.

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* Being the substance of the Cantor Lectures de[illegible] before the Society of Arts by Mr. W. Arnot, F.C.S.

I have also to express my indebtedness to many riends, both in England and Scotland, for kindly upplying me with specimens of their produce, and nformation as to their manufacture, and to others or invitations to examine their processes, which regret it has been quite out of my power to accept. lany questions of a technical nature—chiefly hemical—have been addressed to me since these ectures were announced, some of which I have eplied to in the course of the lectures, but to thers I have not been able to give satisfactory xplanations, and for this reason, that the subjects, hough of great practical interest to the paper-makers, have, so far as I can learn, never been roperly investigated.

Among the subjects to which I refer, are:—irst, the nature and origin of, and cure for quite variety of specks and spots, some of which appear d disappear in the most unaccountable way. That, some cases, the specks are due to the presence of e uncombined resin precipitated by acid aluminous kes, I have little doubt; others, again, are clearly an oily or greasy nature, while to many more it very difficult to assign an origin. Of course, I not refer to specks that are clearly traceable to -prepared fibrous substances, the origin of many rieties of such impurities is usually not difficult trace. Second, what effect the sulphate of umina or alum exercises upon the paper apart om precipitating resin-alumina—that is, supposing excess of these agents to be used? As a rule, I d that excess—and in some cases very large cess—is used, and the most diverse accounts are ren as to the reason of this and its supposed tion. Some say it cleans the fibres, but I rather ink the time for cleaning the fibres is quite gone the time the alumina is usually introduced. arch and clay and colouring matters have all been led in order that they might adhere to the fibre ore the resin soap is introduced to coat them, and w after these and the soap itself have been added, ittle sulphate of alumina can do anything analos to cleaning I cannot guess. I would have it to considered, too, that sulphate of alumina is exmely soluble, and that any such remaining unomposed in the pulp as it goes down to the chine must be diluted along with the pulp, and but the merest traces of it pass away with the ter through the wire. Third, how best to preserve l clarify animal size? I understand that one or makers know all about this, but choose to keep information to themselves, which of course they e a perfect right to do, although it is somewhat trary to the spirit of the age. Fourth, the great s which some rags sustain in the boiling and aching processes, notwithstanding their being of ost pure cellulose. Apparently fine white linen cotton should lose little or nothing by either ocess, yet we find, even allowing for the moisture d gluten, a very considerable reduction. Fifth, ny questions concerning the re-use of machine d other waters, &c.

Such investigations involve much time, and exense, and I am afraid will not be readily underken by competent men, unless paper-makers themlves combine to have the experiments carried to a tisfactory issue. The chemistry of the art is ubtless yet in its infancy; indeed, it is little more than half a century old, and although that period has been one of enterprise and inquiry, it cannot be said that in this, any more than in most other of our leading industries, much progress has been made in the way of elucidating the principles involved in the various operations. The pressure of the increased competition and lower prices of the last few years has, no doubt, led to some inquiry in various departments, with results which may be regarded as a foretaste of what might be expected to flow from an exhaustive study of the subject.

The mechanism of the paper process has undergone a more satisfactory development; ingenious engineers have improved the appliances to such an extent that there is apparently little further to be desired. We do not doubt, however, that many further improvements will be worked out as time goes on. The difference in the two departments—chemical and mechanical—is, that in the former improvements in the application of the agents applied by the chemical manufacturer fall to be worked out by the paper-maker himself; the manufacturing chemist may improve his own process of production and cheapen the product, but he can do nothing more for the consumer. On the other hand, engineers devoting themselves entirely to paper-mill work strive to improve their appliances, and meet the wants of the manufacturer as they arise. In short, in the chemical department of his profession, the paper-maker is left to make his own discoveries and improvements, whereas in the mechanical he has simply to indicate what his wants are, and forthwith unexceptional appliances are provided for him. That the chemical operation of a paper-mill should be as well understood and under as complete control as are the mechanical operations, there is no room to doubt, and as time advances, this will be more fully realised and given effect to.

SPACE OF FOUR DIMENSIONS.

UNDER this title the *Quarterly Journal of Science* publishes a remarkable article, giving a curious illustration of the idea which has recently been developed in Germany, that space has another dimension beyond the length, breadth, and thickness recognised in geometry. F. Zöllner, the Professor of Physical Astronomy at Leipzig, is the author, and he describes some experiments which he made in that city in December, 1877, with Mr. Henry Slade, the American. These experiments were, he says, only the practical application of Gauss's and Kant's theory of space, which these two eminent men imagined might contain more than three dimensions. This conception cannot be easily explained without the use of diagrams and resort to highly abstract conceptions; but Herr Zöllner examined the subject in its simplest form, the knotting of an endless cord, and he observed that "if a single cord has its ends tied together and sealed, an intelligent being, having the power voluntarily to produce on this cord four dimensional bendings and movements, must be able, without loosening the seal, to tie one or more knots in this endless cord." And he proceeds to say that "this experiment has been successfully made within the space of a few minutes in Leipzig, on December 17, 1877, at eleven a.m., in the presence of Mr. Henry Slade, the American. I myself selected one of four sealed cords, and, in order never to lose sight of it before we sat down at the table, I hung it around my neck—the seal in front always within my sight. During the séance I constantly kept the seal—remaining unaltered—before me on the table. Mr. Slade's hands remained all the time in sight; with the left he often touched his forehead, complaining of painful sensations. The portion of the string hanging down rested on my lap—out of my sight, it is true—but Mr. Slade's hands always remained visible to me. I particularly noticed that Mr. Slade's hands were not withdrawn or changed in position. He himself appeared to be perfectly passive, so that we cannot advance the assertion of his having tied those knots by his conscious will, but only that they, under these detailed circumstances, were formed in his presence without visible contact, and in a room illuminated by bright daylight." There were four knots in the cord, and the professor describes very minutely how they were sealed. Several other scientific men were present. He concludes thus:—"The four knots in the above-mentioned cord, with the seal unbroken, this day still lie before me. I can send this cord to any man for examination. I might send it by turn to all the learned societies of the world, so as to convince them that not a subjective phantasma is here in question, but an objective and lasting effect produced in the material world, which no human intelligence with the conceptions of space so far current is able to explain. If, nevertheless, the foundations of this fact, deduced by me on the ground of an enlarged conception of space, should be denied, only one other kind of explanation would remain, arising from a moral mode of consideration that at present, it is true, is quite customary. This explanation would consist in the presumption that I myself and the honourable men and citizens of Leipzig, in whose presence several of these cords were sealed, were either common impostors, or were not in possession of our sound senses sufficient to perceive if Mr. Slade himself, before the cords were sealed, had tied them in knots. The discussion, however, of such an hypothesis would no longer belong to the dominion of science, but would fall under the category of social decency." On the result of his inquiry the German professor comes to the opinion that Mr. Slade "was innocently condemned in London, a victim of his accusers' and his judge's limited knowledge."

MASKS FOR VIGNETTES.

THE following methods of making vignette masks are mentioned in the *British Journal of Photography* as those adopted by Herr Düby. The first method is somewhat elaborate. He cuts a number of ovals—say eight—out of black and white pasteboard alternately, and, beginning with the smallest (a white one) he increases the size of each by a centimetre until the requisite number is cut. He then takes up the smallest oval and fixes the exact centre of it to the end of a stick; one centimetre behind he places the black one next in size, then at the same distance behind that again the third oval, and so on. When they are all arranged the opposite end of the stick to that bearing oval No. 1 is fixed in a horizontal position to the wall or a board, and a rather powerful negative of the series of ovals is taken of any size that may be desired, care being taken to focus so that none of the edges of the ovals are sharp. A glass plate is then rubbed with ox-gall, and over it a mixture of the following composition:—Ten grammes of good gelatine dissolved in 100 grammes of water, to which two or three drops of a saturated solution of potassic trichromate had been added for each gramme of the gelatine, is poured, care being taken to avoid air-bubbles, the mixture being assisted to spread by a glass rod. The addition of a few drops of ammonia to the gelatine is also advisable. The plate is dried in a horizontal position, and, when possible, in a warm room. When dry the plate is exposed under the negative sufficiently long to get a powerful print, and is then thoroughly washed in cold water to which a few drops of nitric acid is latterly added; and, lastly, the plate is tanned in a four per cent. solution of alum. If it be wished to have the gelatine mask without the glass, then before coating the plate with the mixture given above rub it with oil of turpentine and talc, and when the printed, washed, and dyed mask has become dry, cut round the edges of the plate and it may easily be lifted off.

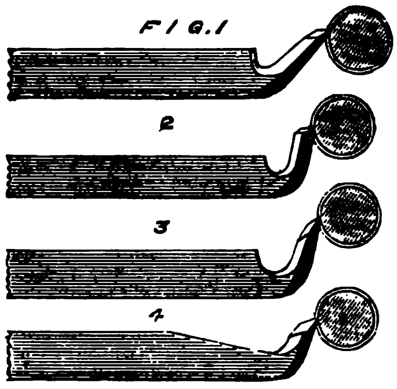
Another way of getting an unbreakable gelatine mask is given by the same gentleman. It is a combination of several other plans, and gives, he says, good results. He takes a clean glass plate and rubs it first with oil of turpentine and then with talc. He has meanwhile made a fifteen per cent solution of very white gelatine, to every litre of which, stirring all the time, fifteen drops of a saturated solution of chrome alum are added, and the still warm mixture is filtered through muslin. If rather too much chrome alum has been added, so that the mixture becomes thick, fluidity may be restored by the addition of a little glacial acetic acid; but it is better if one can do without having recourse to the corrective by using exactly the right quantity at first. The prepared plate is laid in a horizontal position, and the gelatine solution poured equally over it until it forms a film three millimetres in thickness. In the same position it is left to dry. A powerful print on black or dark brown carbon tissue is now made—procured from the negative previously described. The print when sufficiently exposed is dipped for a short time into cold water and then withdrawn, and laid, pigmented film undermost, upon a glass plate and squeegeed thoroughly. It is then dipped for a short time into a solution of white wax in alcohol, and when removed from this solution it is laid upon the now dry gelatine film on the glass plate, squeegeed, and set on one side, under a weight, for hair an hour. The print is then developed as usual, tanned in a four per cent. alum solution, and dried. When dry run a knife round the edge, and the unbreakable mask will come freely off from the glass.

CLOTHES-MOTHS.

THE name clothes-moths, says Prof. C. V. Riley, is applied to several distinct but similar species of minute moths belonging to the family *Tineidæ*, which, in their larval state, are very destructive to woollen goods, fur, skins, feathers, and similar substances. Among them may be mentioned the clothes-moth (*Tinea vestianella*), the carpet-moth (*Tinea tapetzella*), the fur-moth (*T. pellionella*), and the hair-moth (*Tinea crinella*). These Tineidæ have slender bodies and lanceolate, deeply fringed wings that expand 6-10 or 8-10 of an inch. The antennæ and palpi are short and thread-like, and there is a thick orange or brown tuft on the forehead. The colours range from buff to drab and dark gray. The eggs are laid in May and June (the moth dying immediately afterwards), and hatch out in fifteen days. The young worms at once proceed to work, gnawing the substances within their reach and covering themselves with the fragments which they shape into hollow rolls and line with silk. These rolls are by some carried on their backs as they move along, and by others fastened to the substance they are feeding upon: and they are enlarged from time to time by additions to the open extremities, and by portions let into the sides, which are split open for this purpose. In such ambush the worms carry on their work of destruction through the summer; rest, in seeming torpor, during the winter; and change to chrysalids early in the spring. They transform again in twenty days, and issue from their shelter as winged moths, to fly about in the evening till they have paired and are ready to lay eggs. Then follows an invasion of dark closets, chests, and drawers, edges of carpets, folds of curtains, and hanging garments, and the foundation of a new colony is swiftly laid. The early days of June should herald vigorous and exterminating warfare against these subtle pests. Closets, wardrobes, all receptacles for clothing, should be emptied and laid open, their contents thoroughly exposed to light and air, and well brushed and shaken before being replaced. In old houses much infested with moths all cracks in floors, wainscots, shelves, or furniture, should be brushed over with spirits of turpentine. Camphor or tobacco should be placed among all garments, furs, plumes, &c., when laid aside for the summer. To secure cloth linings of carriages from the attacks of moths, sponge them on both sides with a solution of corrosive sublimate of mercury in alcohol, made just strong enough not to leave a white mark on a black feather. Moths may be killed by fumigating the article containing them with tobacco or sulphur, or by putting it, if practicable, into an oven heated to about 150° Fah.

PROF. SWEET ON LATHE TOOLS.*

I HAVE not the least idea that there are, or ever will be, lecturers so gifted, draughtsmen so skilful, or scholars so apt, that any one will be able to learn how to tell good steel from poor; to determine the best form; to temper, grind and set lathe tools by listening to lectures, by looking at pictures, or from the reading of books. However, as there is a great variety of tools in use, as different firms, different workmen, and different writers make, use, and advocate different kinds, our time may not be completely squandered if we draw some comparisons, and try to reconcile the seeming discrepancies. I think it is safe to admit that we cannot make good tools out of poor steel, that we will not get the best results if they are either too hard or too soft, and that they will not cut if they are dull. What is good steel is outside of our present business to inquire; what is too hard and too soft is a matter in a great measure depending on the work, on the strength of the lathe, on the speed of the cut, amount of feed, acuteness of the cutting edge, also a matter about which there is a diversity of opinion by expert workmen. Some say a tool should be as hard as it will stand; others as hard as fire and water will make it; others as soft as it will stand, or all the way down to blue; and they are all right, under certain circumstances. Sometimes it is desirable that a tool should endure the longest possible time with the least amount of wear. Sometimes to do the greatest possible amount of work in the least possible time, and at other times to do the work with the least possible expenditure of power. In the first case hardness is essential; in the second and third cases that temper that will stand with the tool ground to the most acute angle must be the best; the tool that cleaves off the metal will not only remove more stock, but will do it with much less expenditure of power than will the one that crowds it off. It is the general practice, I think, in turning chilled iron rolls, to use a tool with a square corner or 90° angle; and yet J. Morton Poole, of Wilmington, Del., who is one of the most extensive workers in chilled iron in the country, uses cutting edges as sharp as from 78° to 80° on the same work, and his tools are as hard as fire and water will make them. He is able to do this because he uses the best steel—the Crescent Steel Co.'s—because a roll is a very rigid piece to operate upon, and because his lathes are about twice the strength other people use for similar work. In all kinds of work the angle of the tools used by different workmen for the same purpose vary as much as from 45° to 80°. The English, as a general thing, use tools less acute than many American workmen. The more delicate the cutting edges, the softer, as a general rule, will need to be the temper; and the standard expression some workmen use, that they had rather a tool would break than dull, is not always the best economy, for in special tools difficult to forge, and requiring special fitting, one had better grind twice than break one once. There is much said by different workmen about the proper bend, kink, twist, angle, set, rake, clearance, relief, &c., and I venture to say that whenever you find a tool of any shape working well, you will find it is sharp, that is, with an acute cutting edge, and of necessity it must be of good steel and of good temper to stand it. Some say a tool should be level with the centre, others that it should be above the centre. The fact is that so far as the tool itself and the work being operated upon are concerned, it makes no difference whether the tool stands level with the centre, whether it comes down from the top, up from the bottom, or in from the back side, the piece being round is alike on all sides, and so far as that is concerned it makes no difference where the tool is, but owing to different mechanical construction in different lathes it may make considerable difference. If a lathe is absolutely rigid, then a tool that will work well in a planer will work equally well in the lathe if the body of the tool be level, and the cutting edge exactly level with the lathe centre. Some writers claim to discover a great difference between a tool working on a flat surface and one working in a lathe, and if the tool is so blunt as to crowd off the metal, there may be something to count on; but if the tool cuts, whether the metal approaches or leaves the cutting edge in a straight or circular direction, is a matter too fine for the cutting edge of a good tool to notice. But if the cross-slide and tool-post are not rigid, or have slack motion, then a tool properly fitted to work level may draw into the soft places in the metal, and crowd out where it is harder, and so work badly; and for a lathe in this condition it is better to have a tool fitted to work above the centre of the piece, then the pressure of the cut is driving the tool towards the operator, taking up all slack motion. Again, the design of the lathe may have something to do with the best shape or position of the tool. If the lathe is of English style, flat top-bed, and all the parts of the slide packed one above the other so as to best resist strains in a true vertical direction, then a tool level with the centre, or one throwing the strains in a vertical direction, may be the best. But if the lathe is of New England style, where the support to the tool is most rigid in a diagonal direction, then a tool so located that the strain is in the direction of greatest resistance that is best, and this is true of the New England lathes; and it may be that while the users of such lathes insist that they know a tool works better above the centre than level with it, they are right in that case, but partly wrong in considering it the tool rather than the lathe, though the tool itself will spring less and less as the strain comes nearer endwise of it There is still another advantage in having the tool work above the centre. The user of such a tool, see Fig. 1, is more likely to grind it sharp (acute) than he is one in the form shown in Fig. 2, which he is equally sure to grind dull, rather than as it ought to be as shown in Fig. 3. One using a tool forged as shown in Fig. 4 is more likely to grind it properly, but such a tool, though just as strong in the body as the one in Fig. 3, is not as stiff. That is, it would sustain as great a load, or nearly as much; it would stand a greater blow, but would spring by a given load nearly twice as far as the one shown in Fig. 3. One objection to using a tool made to work above the centre is this, that for every change in the diameter of the piece there has to be a change made in the height of the tool, and it is this that calls for a more perfect tool-post than has yet been supplied. The point that governs the proper position of a tool is the back side and not the cutting edge. That is, it is said a tool will work best on a planer when the under side is made at an angle of 3° with the work. If so, then a tool to work best in a lathe should be placed so that the back side should form an angle of 3° with a tangent line. This will, however, vary on different materials.



There has been much ingenuity expended in devising tool-holders for using small cutting bits, and in every case where the inventors have been successful, it has been when they confined themselves to the production of a tool for one special purpose, and in every case, so far as I know, the attempt to make a universal combination has proved a failure. Smith and Coventry, of Manchester, England, make a holder for round steel which, as a round-nose tool, is a complete success. The threading tool made by Page and Lockwood, of West Meriden, the cutting off tool of Slate, of Hartford, and the gun barrel turning tool used by the Remington Armoury, are all great conveniences and money-saving devices. But two features in the business work against the introduction of these tools. When a workman has spent from fifteen to thirty minutes fitting up a special tool, he is likely to use it with extreme care; whereas if he has one at hand which is exactly what he wants, he is quite sure to use it with a great deal of indifference. Hence the patent tools are worn out and slaughtered recklessly, and seem from this cause to be less efficacious.

It is not a very large shop where dollars are spent daily in dressing tools and fitting them for use, and the proprietors or managers look on with indifference, or take it as a matter of course; whereas the same parties, if called upon to send a dollar a month to the makers of the special tools which save them ten times the cost, would think it a piece of extravagance, and more than likely ask the foreman if he could not make them himself, or scheme to devise some way in which to evade the patent.

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* From the *Polytechnic Review*.

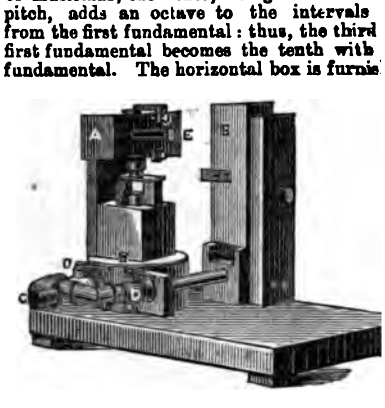
PROJECTING LISSAJOUS' FIGURES ON THE SCREEN.*

BY DR. J. DIXON MANN.

AS is well known the vibrations of tuning forks, when used for the production of Lissajous' figures, are kept up, either by the constant application of the violin bow, or by the aid of an electro-magnet—the former method requiring the presence of two assistants, and the latter adding materially to the complexity of the apparatus and not unfrequently failing to produce the desired result. The difficulty is overcome in the present appa the substitution of harmonium reeds for th forks, the entire instrument being easily c by one operator.

The apparatus consists of a base board are planted the two reed boxes, A and B. A, is placed horizontally in such a manner capable of slight rotation in the horizont and also of adjustment in height, by mean support to which it is attached being provi a slot and set screw. The box, B, is perm attached to the base board in the vertical The boxes are so placed that a pencil of ligh directly on E would be reflected to B, about from its top; they are furnished with screws for the attachments of the reeds. T are entirely open on the sides facing eac their margins being covered with soft le which the reed plates bed, making a sufficie tight joint. Wind is supplied through t tube, C, which gives off a branch to eac stopcock, D D', being inserted in each bran reeds are similar to those used in the cons of harmoniums; they are mounted on bra which fit the reed boxes. The tongue of is furnished, at its free end, with a small of microscopic covering-glass (E), silvered by process—a piece of cork or pith being in between the tongue and the reflector, so as the latter from the frame of the reed; the then tuned in the usual manner. It is not that the reeds should be in absolute tune, a certain limits, their relative vibrations ca justed by means of the stopcock—an adva great value, believed to be solely possessed apparatus.

The reed in the vertical box gives the fun ratio of vibrations from which the inter built up. Two fundamental reeds are us changeably, one giving the double or eig of musicians, the other, being an octave pitch, adds an octave to the intervals from the first fundamental: thus, the third first fundamental becomes the tenth with fundamental. The horizontal box is furnis



a set of reeds giving all the intervals up to the including the unison. The horizontal re changed for the production of the different the fundamental reed being retained.

It was found, when the wind was all pass directly from the bellows to the ree that the tongues of the reeds were simpl past the openings in the reed plates and th tained, no vibration taking place. To obv a free space of half an inch was allowed the supply pipe and the reed box, so as to cushion of air capable of yielding to the ela the tongue. The supply pipe is contract termination to about one-third the size of in the reed box through which the wind ent

The apparatus is used as follows:—T board being firmly clamped to a rigid tab the fundamental reeds is clamped in fron box, B; another reed, giving the desired in similarly clamped to the box, A; an ela about half an inch in diameter, is attach end to the pipe, C, and at the other to an bellows. A fine pencil of light is now t the mirror, E, which is then adjusted by ro the box, A, until the light strikes the m the vertical reed, from whence it is reflecte screen of tracing paper placed a short away; a condenser, interposed between th and the mirror, E, focuses the spot of ligh screen. On the bellows being put in mo figure appears, and can be brought to stand in any phase of development, looped o by careful manipulation of one or other of t The figures are more distinctly seen on th the screen away from the apparatus, being in total darkness. It is essential to fect production of the figures, especially resulting from the more discordant interv the entire apparatus should be as rigid as and free from any vibration other than duced by the tongues of the reeds, and also wind supply should be perfectly steady.

NOTE.—My attention having been draw Baxendell to a paper in the proceedings Royal Society, April 12th, 1877, by McLeod and Lieut. Clark, "On Some Fig hibiting the Motion of Vibrating Bodies, &c.," I think it right to state that my apparatus was constructed in its present complete form in January, 1872, and exhibited to a number of scientific gentlemen in February, 1872; and further, independently of this fact, that the apparatus of Professor McLeod and Lieut. Clark (so far as is conveyed by the description in the above-mentioned paper) does not affect the originality of my *schema*.

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* A paper read before the Literary and Philosophical Society of Manchester.

AMATEUR'S LATHE.

THE following description of the amateur's lathe, constructed by the students of Cornell University (U.S.), is given by *Engineering*, from information furnished by Prof. J. E. Sweet:—

The lathe, which has a 4ft. bed, turns 10in. in diameter, 6in. in diameter over the slide, and 27in. long. While it appears to stand upon four feet like other lathes, the leg at the foot-stock end is pivoted to the bed, as shown in Figs. 13 and 14, which admits of free play between the two for a limited distance, so that when the lathe is set upon an uneven floor, the bed is exempt from torsional strain. The foot motion is what is known as the grasshopper motion, with the rock shaft set high, giving a natural direction to the foot of the operator, which combined with the slow down and quick up-stroke, and the quick change from up to down and the slow change from down to up, makes a treadle that enables an operator to do more work with the same amount of fatigue than probably it is possible to do on any other.

The rock shaft is pivoted to the legs of the lathe on knife-edge joints with reverse knife edges to keep them in place, as shown in Fig. 12, not so much to avoid friction as to avoid the necessity of oiling them, which always, by the accumulation of dirt, makes that part of a lathe unsightly. The connecting-rod is slotted, as will be seen, to give free action between crank and treadle, and the working joint in this case is a knife-edge joint also. With this arrangement, if the foot is removed while the lathe is in motion, the momentum of the parts carries the treadle higher than that due to the crank, and advantage is taken of this feature to introduce a stop motion to the treadle. A spring catch, shown at A, Fig. 2, is so placed as to catch upon the pin, B, Fig. 1, when the treadle rises about ¼in. above its highest position due to the crank. To release the treadle from the catch it is only necessary to place the foot below it and with the ankle touch the spring at C.

The triangular spider crank carrying the bearing is firmly secured to the headstock bed, and both bearings for the shaft finished at once with a long reamer; thus liberal wearing surface and absolute alignment are secured. This shaft, as well as the crank, is allowed ¼in. end play, thus securing polished wearing surfaces instead of grooved ones, which, sooner or later, result from confining bearings between tight shoulders.

Probably the most noticeable feature is the internal back gear within the cone. While such an arrangement is not in itself entirely new, it is in this form a very compact and strong device. The spider with the journals for carrying the three planets, as well as the planets and pinions, are all of cast steel; setting the planets at an angle gives a better hold of the spider on the shaft, and does away with the overhang of the internal gear. The advantages of an internal back gear are that it is compact; neither dirt nor the belt can get in the teeth of the wheels, and with the arrangement for changing from slow to fast and from fast to slow, shown in Figs. 5 and 6, only one operation has to be performed.

The main shaft of tempered steel with a hole through for removing the centre, or to admit small rods for turning screws and other small work from the end, has reverse cone bearings in which the lost motion is taken up by screwing the cap, D, Fig. 3, which draws the box through, and tightens both bearings at once. The step, as will be noticed by reference to Fig. 7, has placed between the hardened ends of the shaft and follower two hardened steel washers, whose outside diameters and central hole are larger than the surfaces they run between. These pieces are free to change their position to a limited extent, and by so doing a polishing action is maintained, and streaking and cutting prevented.

The lead screw passing through the bed and so close to the feed spindle, rendered it difficult to use the feed belt so common in American lathes, so the friction feed, consisting of a steel disc working in either of the V-grooves, shown at E, Fig. 3, furnishes a feed quickly changed, and one that is effectual. The arm carrying this steel disc or friction feed, and the arm carrying the intermediate wheel for screw-cutting being cast in one piece swings around the same centre as the lead screw, and is made fast by the pinch screw handle, F, Fig. 2. By the swinging of this lever either the friction feed or the intermediate gear wheel may be thrown in, and the very act of throwing the one in throws the other out. A drawer at the back of the lathe under the shelf contains the change wheels for screw-cutting.

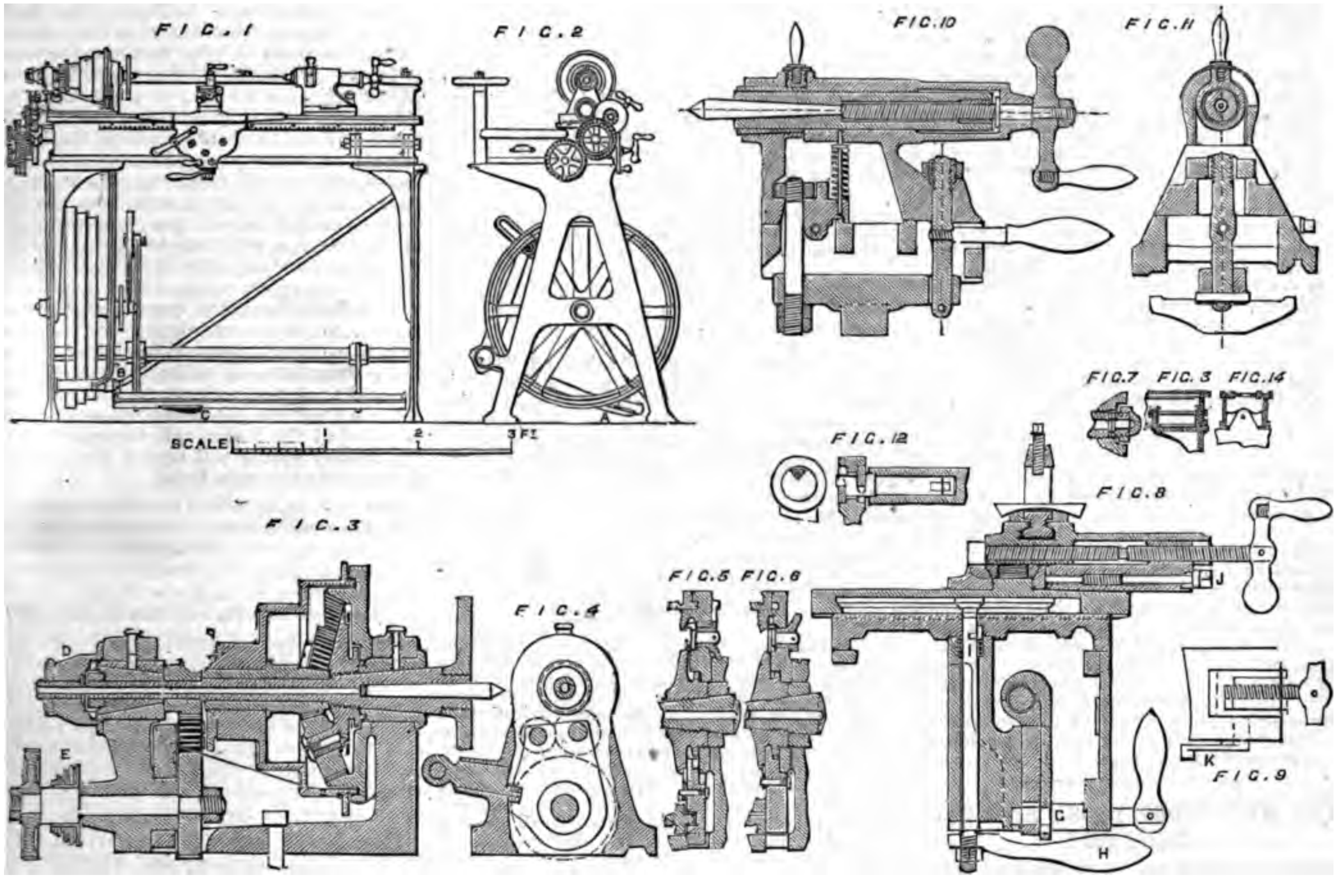
The nut working upon the lead screw is an open one, operated by the two eccentrics on the rock shaft, G, Fig. 8. As the screw is used for the feed in ordinary turning as well as for screw-cutting, the nut is made unusually long—namely, 8in. on a ⅞in. screw. The slide rest or carriage is wholly guided by a single V at the front, and runs upon a flat way at the back. This at first sight would appear to be only half a good plan, but the carriage is quite twice the usual length, and as one long guide is far better than two of half the length, and the carriage when moved by the screw or the hand is always moved by that side, nine-tenths of the pressure due to the work comes on that side. Thus, theoretically the arrangement cannot be far from correct, and practically it cannot be a very difficult one to carry out.

The cross slide is removable to give place to an ordinary rest for hand-tool work; the change is quickly effected by give a turn to the handle, H; the spring at I always holding the bolt up, so that the rests can be changed by the use of one hand only.

The crosshead slide is pivoted, so that it may be swung around for turning balls, and is graduated so that it may be so set accurately at any angle from 60° one way, to 90° the other, and made fast by the screw, J. The traverse screw has right and left-hand threads; this gives a transverse motion to the screw half as great as that given to the slide, and permits the use of equal length sliding surfaces.

Fig. 9 shows the device employed for withdrawing the tool for screw-cutting; by turning the handle, K, the short throw crank on the rock shaft moves the nut, L, about 3-16in., drawing back the screw with slide, tool-post, &c., turning the lever back places the tool in its original position. This device is specially useful for other purposes besides screw-cutting.

The spherical ring and gib to the tool-post furnishes a ready and secure means of raising and lowering the point of the tool. The foot-stock is secured to the bed by a fixed handle rather than by



the use of a loose wrench. The cone clamp for receiving the spindle is an excellent device, and the feather that prevents the spindle from revolving, it will be seen, is a pin held in place by a string. The metal forming one side of the feather way being cut away just at the inner end forming an inclined plane, permits the spindle to revolve when brought back to its limit, thus preventing the wedging of the screw. The foot-stock is arranged to set over for turning tapers, and is operated by a single screw.

The movable joint cutting through the sloping sides of the stock which are dressed off together, renders the effect visible, so that if the lathe is left offset the next person using the lathe can scarcely fail to notice it.

The lathe we have been describing was shown at the Philadelphia Exhibition, and we are indebted to Professor John E. Sweet, of the Cornell University, for particulars of it. Regarding it Professor Sweet says: "The using the lead screw for a feed when turning is an objection, and using a long nut is but a partial cure. The design is characterised by simplicity in every respect. In the lathe exhibited there was not the faintest attempt at ornamentation or finish, and when compared to the other lathes it appeared tame; while the working parts were true, there was much of the work that was not first-class. It was built wholly by the students in the course of mechanical engineering.'

HUGHES' TRIPLEXICON LANTERN.

At the Inventors' Institute, St. Martin's-place, on Thursday evening, March 28, there was a paper read by Mr. W. C. Hughes of the properties of his newly-patented triplexicon lamp, and its adaptability to lighting public and private places. Sir Antonio Brady (President of the Institute) introduced the lecturer.

Mr. W. C. Hughes having dealt in his introductory passages with the history of lamp-lighting from the earliest times up to the introduction of the Argand, Moderator, and the arrangement of the duplex wicks, then proceeded to explain and exhibit the qualities of his own triplexicon or three-wick lamps. One lamp, inclosed in a glass globe, and fitted with an ornamental chain for suspension, gave a brilliant light, although (as stated) it was not perfect, the silvered reflector belonging to it unfortunately not being completed. There seemed to be no doubt that this lamp is eminently adapted for halls, chambers, country churches, shipboard, and other places where gas is not obtainable. The triplexicon magic lantern was then brought into juxtaposition with other lanterns (notably a duplex), the light of either lantern being thrown side by side upon a white screen, when the decided superiority of the three-wick lantern was seen and acknowledged by all present. The lecturer exhibited a number of photographs with his lantern on the screen, which came out with a clearness that left nothing to be desired, and fully justified the statement made by Sir Antonio Brady, at the close of the proceedings, that the light was almost equal to the oxyhydrogen light. The arrangement of the three wicks, the two outer ones being slightly curved, and throwing their flames at an angle into conjunction with the flame of the centre wick, whereby perfect combustion is obtained, was clearly explained and illustrated to the satisfaction of the audience. The other special features of Mr. Hughes' invention—viz., the annealed circular glass chamber, the metal cap surmounting the glass chamber, through which the heat ascends into a movable chimney formed of Russian iron—were fully dealt with. The superiority of the annealed circular glass chamber was illustrated in the course of the lecture by one of the glass plates used in the duplex lamp being shattered by the heat of the two wicks — the lecturer having previously tested a similar plate in his three-wick lamp with a similar result, the plate not standing the heat more than three minutes. This is one of the miseries of magic lantern entertainments with which we have all been familiar; but which, with the new circular chamber, will doubtless soon be a thing of the past.

The Chairman congratulated Mr. Hughes upon the great success of his new light, comparing it, as already said, with the brightness of the oxyhydrogen light. A vote of thanks to the lecturer, proposed by Dr. Croft, was heartily responded to by the audience.

Mr. Varley, speaking with a thorough acquaintance of the subject, and with recollections of the many difficulties involved in combinations of several wicks, said there could be no doubt the difficulty had been surmounted by the clever arrangements of Mr. Hughes. He confessed he had been agreeably surprised and delighted by the clearness and luminosity of the triplexicon light, and predicted a great success for the lecturer.

WHY NUTS WORK LOOSE AND BOLTS DROP OUT.

The following answer to an important question in machine construction is given by "J. R.," in the *Scientific American*:—

"Can you explain why it is that nuts come off, which they will do when subject to rapid motion or vibration, though they may be a tight fit upon the bolts and screwed tightly home with the wrench? Why, indeed, should it take two nuts to lock one bolt?"

The tendency of a nut to unwind and recede from the pressure upon its radial face is proportionate to the pitch of the thread and the diameter of the bolt, and the finer the thread upon a given diameter of bolt, or the larger the diameter of bolt with a given pitch of thread, the less is the tendency of the nut to move back. In the case of ordinary bolts and nuts a given diameter of bolt is given a standard pitch of thread, and these pitches are not so fine as to prevent the nuts from unscrewing in many cases unless checknuts are used.

It would appear that if the nut thread fits reasonably tight upon the bolt, and the nut is screwed well home, it should remain there, but there are palpable explanations why it does not do so. Of these the principal are the errors which ensue from the alteration of form which takes place in the screw-cutting tools during the hardening process. As a rule all steel increases in dimensions from being hardened. What the amount of increase or expansion is we have at present no very definite knowledge, because it varies considerably; although it is probably equal under equal conditions. Suppose, then, that a tap is made of the correct diameter to a vernier gauge, and that it increases in diameter and in length (as it almost invariably does) during the hardening, the pitch, the thickness, the depth, and the diameter of the thread will be altered and "out of true."

Unless both the tap and the die are tempered to precisely the same shade of colour, the amount of the contraction will vary. As a result of these at present irremediable errors taps are made to suit existing solid dies, or adjustable dies are set to suit the taps, and though the nut may fit closely to the bolt so as to be just movable by hand, or under a moderate pressure of a wrench, yet the sides of the thread do not fit properly, nor can they be made to do so under any ordinary conditions. The result is that under vibration the threads give way on the contact sides, for vibration is a number of minute blows. Under reciprocating motion the result is precisely similar, for the whole pressure upon the nut is supported by that part of the surface of the thread which is in contact, which compresses or recedes. Any machinist who desires to test this matter may do so by taking a nut that fits very tightly upon a bolt, and striking upon the sides, he will find it will lose the fit to the bolt.

SCIENTIFIC SOCIETIES.

ROYAL MICROSCOPICAL SOCIETY.

At the meeting on April 3rd, H. J. Slack, Esq., President, in the chair, numerous presents to the society were announced, and two new Fellows elected. A paper was read by Mr. J. W. Stephenson "On a New Immersion Object-glass," which had been designed by him to obviate the difficulty often experienced in the accurate arrangement of the adjusting collars of high angled objectives. This glass had a focal distance of 1-9, and a balsam angle of 113°; it was stated to bear very deep eyepieces, and to have a very flat field. The great difficulty of obtaining an "immersion" fluid having the same refractive index as crown glass had at length been overcome by the adoption of oil of cedar wood diluted with 1·5 part of oil of fennel seed. The objective was exhibited in the room at the close of the meeting.

A paper was read by Mr. Frank Crisp, "On the Present Condition of Microscopy in England," in which, as regarded a knowledge of the optical and mathematical principles of the instrument, unfavourable comparisons were drawn between the workers at home and abroad, and a greater degree of attention to the construction of the various portions of the instrument was urged upon English microscopists. After the meeting, Dr. Millar exhibited a small piece of a most beautiful sponge, Acarnus innominatus (Gray), Mr. Curties some stained vegetable tissues, and Professor Cleve some diatoms mounted to illustrate his pamphlet.

Plating Iron with Platinum.—M. Dode, of Paris, the well-known discoverer of the platinum mirrors, has invented and patented a process for coating iron with platinum. The iron first receives a coating composed of lead and copper, and then the platinum is applied. The first coating is prepared by mixing 22 parts of borate of lead and 4½ parts of cupric oxide in oil of turpentine, and is applied by means of a fine brush. The platinum coating is prepared by converting ten parts of platinum into chloride and mixed with five parts of ether and permitted to evaporate in the air. The residuum is mixed with a viscid combination of 20 parts borate of lead, 11 parts red lead, and some oil of lavender, and 50 parts of amylalcohol added to the whole. In this mixture the object to be platinised is dipped, allowed to dry in the air, and then heated to a moderate temperature.

Steam Tramways.—On the Continent the adoption of steam tramway engines instead of horses is becoming very general. Rouen, Cassel, Barcelona, Bilbao, Lisbon, Oporto, the Hague, and other important towns are all following the example set by Paris, which has working in its streets engines which are noiseless, smokeless, and free from any objectionable features calculated to obstruct or in any way interfere with the ordinary traffic. As shown in the reports of tramway companies, and the remarks of the chairmen at the annual meetings, the proprietors are fully alive to the importance of the subject, and are strongly inclined to take the necessary steps to replace horses by mechanical power. But as public opinion had to be educated in the first instance as regards the tramway itself, so also must it be enlightened respecting the traction; meantime, nothing will be gained by forcing legislation. No one doubts that the use of steam traction in the streets is not remote, but there is no question that, before introducing it into the metropolis, provincial towns, and country districts waiting to be thus opened up, offer, in the first instance, the widest and most encouraging scope for its application. As feeders to existing railway lines, and as branches connecting agricultural areas with the centres of commerce from which they are at present excluded, steam-worked tramways will be a most important and industrial aid.

SCIENTIFIC NEWS.

The Astronomer Royal has received a telegram from M. Prosper Henry announcing the discovery at Paris, on April 7, of a minor planet of the eleventh magnitude in R.A. 12 hours 44 minutes, N.P.D. 94° 37′, with a daily motion of one minute north.

At the meeting of the Edinburgh and Leith Engineers' Society last week, Prof. Jenkin called attention to the results of some experiments on friction made by himself and Mr. J. A. Ewing. The coefficient of friction at very low speeds is not independent of the velocity. It is well known that the friction between two bodies is greater when they are relatively at rest than when they are in motion; and experiment has now shown that the coefficient of friction does at very low speeds increase by about 20 per cent. in certain selected cases where the friction of rest and motion are sensibly different. The change is first perceptible at velocities of a two-hundredth of a foot per second, and the lowest speed examined was one five-thousandth of a foot per second.

The Pennsylvania Railroad Co., at the request of the astronomers of the United States, have determined to offer facilities for visitors to Denver, Colorado, the most suitable *point de départ* for those desirous of obtaining a good view of the solar eclipse of July 29 next. The round trip can be made from New York, Philadelphia, or Baltimore, via Pittsburg, by several routes, at a fare of 73dols. from the first-named station, and a few dollars less from the other ports of arrival. In each case, however, a letter of identification will have to be obtained from the superintendent of the U.S. Naval Observatory, Washington, which letter will be forwarded to the respective consuls at the port of arrival, to be countersigned by them, and handed to the visitors. This letter will pass the instruments, and other professional paraphernalia of the visitors, free of duty and charges at all the principal ports on the eastern seaboard of the States, and on presentation to the railway agents will secure the round-trip ticket at the fare mentioned.

The melo-piano, which was described on page 548 of our last volume, is attracting the attention of our contemporaries, and in one of them Mr. E. J. Reed, M.P., gives an account of it as a novelty seen at a Paris factory. Messrs. Kirkman, we believe, hold the English patent.

An improved charcoal pencil has been patented. It is made by compressing sawdust of lime, willow, poplar, &c., into moulds, drying them in the air, and charring in retorts. The sticks are then cased in paper. This method is said to remove the scratchy pieces found in ordinary charcoal pencils, and facilitates the mixing of the sawdust with gelatine, linseed oil, or lime-water for special purposes.

In an Italian magazine devoted to electricity Prof. L. Ponci describes a battery which is said to be new and of great simplicity. It consists of a glass jar and a porous vessel, the latter filled with a solution of ferrous chloride, and having an iron plate as a pole. The outer solution is of ferric chloride, with a carbon plate as a pole. Both solutions should be made up to a strength of 35° Beaumé. The electro-motive force is said to be nine-tenths of a Daniell cell.

Mr. Sowerby, writing to the *Gardeners' Chronicle*, gives some interesting facts as to the rapid growth of plants under forcing conditions. At the gardens of the Royal Botanic Society the water was let into the tank of the Victoria regia on February 10, and several varieties of Nymphœa, Nelumbium, Pistia, &c., planted. At the end of March the surface of the water was quite covered, and although only six plants of Pistia stratiotes were put in, a good barrow-load (some thousand or so plants) had been cleared off. Seeds of the Victoria left in the mud have germinated, and the water is dotted over with the leaves of the young plants. Seeds of this plant have been sent out to Zanzibar, with the view of introducing the queen of water-lilies to the African lakes.

A new tramway locomotive was tried at Portsmouth at the end of last month, in the presence of General Hutchinson. The peculiar feature constituting its most remarkable improvement is a fan arrangement, by which all the products of combustion are drawn off and discharged from the rear of the engine beneath the passenger car, whether the engine is running chimney or "tender" first. A condenser carries sufficient water to reduce all the steam during a run of two hours, the exhaust passing through a series of pipes in contiguous water compartments until it reaches a tank, whence it is forced into the boiler. The feed is so set that the water-level during a run of an hour and a half was lowered only half an inch, while the oke fire was neither fed nor stoked. At the tart steam was blowing off at 140lb., fell at ist below 100lb., but quickly rose to 125lb. and 30lb., between which it was maintained hroughout nearly the whole trial, 110lb. being he state of the gauge at the finish, with suffiient fire to last 15 minutes, and a condenser pable of working for another hour. Neither noke, steam, nor fumes were perceptible from e chimney, General Hutchinson riding for a rt of the journey with his head near the nnel for the express purpose of detecting any cape.

The Gilbert elevated railway, New York, will e opened in a month. Between the Battery d Central Park there will be thirteen stations. ains will be run at intervals all night, and ere will be workmen's trains. Eighty coaches, ch capable of seating 52 passengers, will be t on, the trains consisting of from one to two aches, and drawn by locomotives weighing out 14 tons.

The Lords of the Committee of Council on ucation have directed that a special loan hibition of furniture, cabinet work, and ornantal woodwork used in the interior of ellings, shall be held in the Bethnal-green seum during the summer months, comncing on 1st May. This will occupy the ce rendered available on the ground floor of museum by the removal to Paris of the nce of Wales' Indian presents, till lately wn there. Their lordships understand that manufacture of household furniture is gely carried on in the east of London, hence y believe that the proposed exhibition will of special interest in that district. The een has been pleased to direct that a selection m the furniture of the royal palaces shall be luded in this exhibition.

tistics of railway accidents in Russia last r have lately been published. It appears t the number of victims of accidents rose to 42, of whom 484 were killed and 958 wounded. the extent of the railway system is 19,300 sts (a verst is equal to about three-quarters a mile), this gives an average of 75 victims 1,000 versts, which is considerably over that previous years. The accidents were espey frequent on the Nicholas and Moscow- t lines, which alone had 7·6 per cent. of the ire number of accidents. Next in order k the lines of St. Petersburg, Varsovia, a, and Kiew-Brest. The frequency of idents in 1877 is probably explained in great t by the exceptional increase of traffic due war. This is confirmed by the fact that the ter number of the accidents took place in month of August, when the railways were worked with transport of the Guards to the t of war, and by the considerable proportion great catastrophes, de-railments, and colns, causing the accidents. In the course the last six years there have been, on an ge, thirty such accidents per annum; in 7 the number rose to 62 (32 de-railments 30 collisions). The 1,442 persons injured ccident are classed as follows:—Employés, ; workmen occupied on the lines, 340; gers, 182; other persons, 313.

scientific work on the Tasmanian aborigines ntly been published by MM. de Quatreand Hamy. It forms the sixth volume r "Crania Ethnica." This race, which, 642, when Tasman discovered the island, is ed to have numbered about 7,000, is now to be extinct. The progress towards ction may be dated from about 70 years , when the first penal settlement was formed the island. The material the authors had upon in their researches were portraits, phs, busts, 54 skulls, and six skeletons. Tasmanians seem to have been a special race, and one remarkably homogeneous, though the languages were often so distinct as to be incomprehensible by different tribes. The average capacity of cranium is 1,420 cubic centimetres, which would place the Tasmanians considerably above the Nubian negroes, though the latter are socially much superior. This feature—volume of brain—must not be too rigidly connected with intellectual development. M. Hamy further shows that the Tasmanian cranium had not those supposed signs of inferiority which have been too much insisted on. For an abstract of these researches see *Comptes Rendus*, March 25.

Steam traction has been suppressed on the tramway lines of the south of Paris. While this company are replacing the steam motors that have worked for eighteen months, by horses, the opposite policy is being adopted in the north part of the city. The line from l'Etoile to Courbevoie will be worked with the Brown engines (of Winterthur) made by MM. Corpel and Bourdon, of Paris. The line from St. Denis, by St. Ouen, to the Western Railway Station, is to be worked with Mekarski engines (compressed air), and, lastly, the line of St. Denis la Chapelle adopts the locomotives of M. Vaessen.

Last year, M. Ernst Mayer, a professor in connection with the Austrian navy, proposed an instrument for measuring the direction of submarine currents, containing a magnetic needle pivoted on the axis of a water-vane, and capable of being fixed at a given moment, so as to show the angle of the vane with the magnetic meridian at the depth when the fixture was made. Such an instrument has been constructed and tried by the Naval Academy. (Its details are given in a recent number of the *Revue Maritime et Coloniale*). In calm water it gave very satisfactory results as regards sensibility and precision. In a heavy sea the compass was apt to be fixed before the desired moment; but this evil was afterwards remedied. The instrument is thought capable of several improvements. Thus, it is contemplated to adapt to it a clockwork motion to liberate and stop the compass (and a registering apparatus of velocity of the current, which is attached) at certain instants, as desired. In its present form, the compass is fixed by the act of pulling up.

According to a report to a Russian journal, all the maritime powers of Europe, with the exception of Turkey and Denmark, have adopted the Whitehead torpedo, and given orders to the inventor. England here occupies the first place, Russia the second. (Another authority states, however, that Denmark lately ordered 50 of the torpedoes, while Spain and Holland had not yet ordered any.) The torpedoes delivered to Russia have been found to run at the rate of 22 knots the first 600ft., and 17 knots the 2,500ft. following. In those made for England, a velocity of 26 knots has been attained. Mr. Whitehead made experiments a short time ago with regard to reports that the velocity of his torpedoes varied with the temperature of the water in which they move, so that in the North Sea they did not reach the velocity they had at Fiume. It was found that the same quantity of compressed air develops in cold water an action much less than in warm water. Thus, it is not a matter of indifference whether the torpedo acts in water at 22deg. or in water at 2deg. or 3deg. C.

The question has recently been investigated by M. Pollacci, whether grapes separated from the plant undergo an after-ripening for some time, as is the case with apples and pears. Several kinds of unripe grapes were cut off with scissors, and three portions formed of each kind. One portion was then taken, and its quantity of sugar and acid determined immediately. Of the two other portions one was placed in shade, the other in sunshine, and after ten or twelve days the same data were procured. It appeared that there was, indeed, a small increase of sugar and decrease of acid, and the differences were greater in the case of the grapes exposed in sunlight than with those kept in shade.

The leather prepared by Dr. Knapp's process of tanning with iron oxide salts has recently been examined by M. Muntz, chemist to the Conservatoire des Arts et Metiers in Paris. His report is unfavourable. In a specimen of sole leather he found 12·84 per cent. of iron oxide, which, however, was not combined with the skin, for by washing with weakly acidulated water it could be completely removed. The proportion of water was 21·3 per cent., and there was besides 2·11 per cent. of free fatty matter, along with a considerable amount combined with iron oxide. To produce 100 parts by weight of this leather, 47·9 parts of dry pure skin are necessary—thus, with iron tanning there is pretty much the same increase of weight as by the ordinary process. This new leather, M. Muntz says, is simply natural skin, in which iron oxide is mechanically deposited in combination with fatty matter. Tanning with metallic salts can only have a future when the metallic oxides are combined with the skin tissue—if not directly, then with the aid of mordants.

It has been arranged that eight groups of conferences and congresses shall be held during the course of the Paris Exhibition. In these will be treated questions relating to the origin, production, progress, &c., of the various products collected in the Champ du Mars. A credit of 100,000 francs has been opened to defray the necessary expenses. These meetings will be held in the halls of the Palace of the Trocadéro, under direction and control of a special committee.

M. Duval-Jouve has been elected correspondent of the French Academy for the Botanical Section, in room of the late M. Hofmeister.

A prize offered during several years by the Berlin *Verein für Gewerbefleiss*, for an elucidation of the causes of mill fires, was lately presented to Prof. R. Weber, who has brought out facts that are of much significance, not only to millers, but to miners. The experiments he performed before the committee showed that all sorts of flour, in dust-clouds of a certain density, are inflammable; also that floury bran dust and many dust-like substances of other kinds, furnish such inflammable clouds. So that some of the explosions in mines, that have been supposed to be due to fire-damp, may really have been caused by clouds of coal-dust. A thorough investigation of such phenomena is obviously very important.

A curious optical phenomenon was recently observed on the coast of Florida, at Key West. The temperature of the sea was about 9 degrees under that of the lower atmospheric layer, and this difference produced on the surface a condensed layer of vapour, on which the sun's rays fell obliquely. The upper limit of this layer, which was only a few metres in thickness, was confounded at a distance with the surface of the water, so that vessels seemed to pass into the sea; their hulls gradually disappeared, while their masts and rigging stood out distinctly against the sky. A correspondent of *La Nature* describes the phenomenon of a vertical luminous column above the rising sun, as observed by him recently at Logelbach (Alsace). It measured 2° to 2·5°, and was of a cindery red at the horizon, changing to orange red at the upper part. Its brightness varied little from 6.30 to 7 a.m., during which time it was transported horizontally from 4° to 5°. A minute after the sun rose the column shrank to a rudimentary form.

In studying the absorption of ultra-violet rays by various compounds M. Soret has found that the salts of ammonia behave differently in this respect according to the mode of their preparation. Thus, ammonia from gas-works gives considerable absorption; whereas the absorption is nil in other cases. It appears from this that the product from gas-works is not pure, and should be examined for the foreign substance it contains.

Another Gatling.—An American inventor named Bailey, of Indianopolis, United States, has sent to England, and proposes placing at the disposal of our War-office, the most wonderful specimen of a Gatling gun which has ever been produced. This formidable engine of destruction is guaranteed to fire from 1,000 to 1,500 shots per minute, directed so as to sweep a whole line without alteration. It is also entirely self-loading.

LETTERS TO THE EDITOR.

[We do not hold ourselves responsible for the opinions of our correspondents. The Editor respectfully requests that all communications should be drawn up as briefly as possible.]

All communications should be addressed to the Editor of the English Mechanic, 31, *Tavistock-street, Covent-garden W.C.*

All Cheques and Post-office Orders to be made Payable to J. Passmore Edwards.

*** *In order to facilitate reference, Correspondents, when speaking of any Letter previously inserted, will oblige by mentioning the number of the Letter, as well as the page on which it appears.*

"I would have everyone write what he knows, and as much as he knows, but no more; and that not in this only, but in all other subjects: For such a person may have some particular knowledge and experience of the nature of such a person or such a fountain, that as to other things, knows no more than what everybody does, and yet, to keep a clutter with this little pittance of his, will undertake to write the whole body of physicks: a vice from whence great inconveniences derive their original."—*Montaigne's Essays.*

"CAN THE LEOPARD CHANGE HIS SPOTS?" — LONGITUDE — TIME OF NEW MOON — MAGNITUDE OF A LUNAR ECLIPSE — COMPANION TO POLARIS—SPACE OF FOUR DIMENSIONS—A STAR-TLING DISCOVERY—THE SELENOGRAPHICAL CLUB — PSYCHO—THE BRITISH WORKMAN—TIME OF FALL OF THE EARTH TO THE SUN—ADJUSTING A SUNDIAL—TESTS FOR TELESCOPES.

[14190.]—I am indebted to your correspondent, "Float," for having kindly forwarded me (through you, Sir) a copy of the *Bristol Mercury and Daily Post*, containing a report of the lecture on "Sunspots in relation to Indian Famines," on the announcement of which I commented in letter 13904 (on p. 500 of your last volume). Verily Mr. Blanford has not written in vain. Let any one read the notoriously inspired article in the *Times* for June 7, 1877, and the openly-signed one in the *XIXth Century*, for November last, and compare them with these last utterances of the Bristol lecturer. He, the report tells us, "observed that he was very glad that the chairman had, so to speak, commenced the lecture for him by drawing a very wide and proper distinction between the interest which must attach to the alleged connection between sunspots and famines, and the extreme importance which might result from the future establishment of that connection. *He was very anxious at the outset that they should understand that he was not pleading for any such connection*" ! ! ! The coolness of this is arctic. To any one who remembers what was blatantly proclaimed by the Physical Observatory clique prior to the appearance of Mr. Blanford in print, the words which I have italicised must be pregnant with meaning. So the lecturer does not plead for a connection, the asserted existence of which was the very raison d'être of the projected Solar Physical Observatory. The country was to open its purse and shut its eyes and see what the director of such an observatory would send it; distinctly on the ground that observations of sunspots (already, be it remarked, made daily at Greenwich, Kew, Oxford, &c.), would enable the weather to be predicted. And now we come down to the statement made at Bristol on March 25. After this it is needless to criticise the lecture at any length. I miss De la Rue, Stewart, and Loewy, but, of course we have Mr. Meldrum; who, as I have before remarked in these columns, fills exactly the same rôle with the Sunspot party that Judge Edmunds does in "Spiritual" literature. One point, however, I must advert to. "For the last three years," the audience were told, "there have been no spots upon the Sun." This is undeniable—but how about the co-existing weather? For weeks together during 1877 the surface of the Sun was absolutely quiescent: and, this being so, if Mr. G. J. Symons should be a reader of the English Mechanic, it would be interesting to learn from him exactly how much last year's Rainfall was in *defect?* It is quite sufficient merely to refer here to the perfect calm and thoroughly normal and seasonable weather which has accompanied, and is accompanying, the present utter and entire absence of Spots on the Sun's disc. One piece of comfort, I may say in conclusion, appears to me to be derivable from the perusal of the lecture on which I have been commenting. It is this: that increasing popular enlightenment on the subject has compelled the advocates of Sunspottery to be very much more cautious in their utterances than they used to be. It is simply impossible to contravene such a mass of damaging antagonistic facts as those adduced by Mr. Blanford in his famous communication to the *Times* of Dec. 4 last; so it is found that the public must be let down gently. Is not this a hopeful sign that a miserable piece of humbug is on the eve of collapse?*

In reply to "Polaris" (query 32467, p. 77), no attempt was, or could be, made by the navigators of old to fix the Longitude of any new land they might discover within many degrees. They can only have worked from what sailors call their "dead reckoning:" that is to say, by noting the direction in which they had been steering, and roughly the number of miles sailed daily; and this would give them a very rude approximation to the number of miles sailed east or west from their starting point.

I am sorry that I am unable to answer "J. C." (query 32499, p. 78), from the fact that I do not possess Ferguson's *Astronomy*, either in the edition of 1811 or any other. The times of New Moon in February, May, and October, 1876, are quite correctly copied into *Whitaker* from the *Nautical Almanac* of that year. The 15′ 19″, 3′ 14″, and 6′ 22″ are quite beyond me though, inasmuch as they represent angles! Surely "J. O." does not mean 15min. 19sec. *of time?*

I am afraid that no reply could be intelligible to "Amateur" (query 32509, p. 78) which would not involve the engraving of a diagram; inasmuch as the magnitude of a Lunar Eclipse is derived from certain quantities obtained in computing its phases. Possibly, however, the *principle* on which such magnitude is calculated may be made comprehensible if we suppose that—from the data in the *Nautical Almanac*—we have drawn a circle representing the Earth's Shadow, and across the proper part of this circle a line representing the Moon's Path. Then from the centre of the circle we let fall a perpendicular on this last-mentioned line, and say that

$$\frac{\text{Radius of Shadow + Moon's semidiameter} - \text{perpendicular}}{\text{Moon's diameter.}} = \text{Magnitude of the Eclipse.}$$

Should "Amateur" have access to your XIIth Volume, he will find graphical methods of projecting a Lunar Eclipse, on p. 444 and 493, whence the magnitude of the Eclipse may be measured by the scale employed in its projection. I have no particular inclination to wade through the mass of figures involved in the calculation of a Lunar Eclipse; but should "Amateur" possess a knowledge of trigonometry, I might give him a sketch of the process employed, in connection with any particular Eclipse of his own selection.

Two or three years ago, M. de Boë, of Antwerp, announced the discovery of two minute comites to Polaris, in addition to the one with which observers have so long been familiar. Search was of course made for these objects by various astronomers (myself among the number), but without any result that I have been able to discover; save in some three or four cases. In the month of September, 1876, Mr. H. J. Slack, F.G.S., of Ashdown Cottage, near Forest Row, in the county of Sussex, detected the two small bodies discovered by M. de Boë, and his observation was repeated and confirmed by Mr. Slack (*Astronomical Register*, Vol. XIV., p. 268). A little later another resident in Mr. Slack's county, Mr. C. L. Prince, F.R.A.S., also picked up these comites. He used a 6·8in. refractor; Mr. Slack employing a 6¼in. With—Browning reflector. Prior to this, apparently, one of your own correspondents would seem to have detected two companions to Polaris with a 4in. Wray achromatic (English Mechanic, Vol XXIII., letter 11250, p. 509); and subsequently a boy 13 years of age, the nephew of a Belgian nobleman, who was wholly ignorant of Polaris and its history, found both M. de Boë's companion stars with a 4·25in. Steinheil telescope; referring them accurately to the positions assigned to them by their original discoverer (*Astronomical Register*, Vol. XV., p. 224). Lastly they appear to have been seen at Ghent by Dr. Von Monckover (English Mechanic, Vol. XXV., Reply 28208, page 215.) So far the evidence would seem to point strongly in favour of the objective existence of these little stars; but now comes the remarkable part of the story. Towards the end of February last, that keen-sighted and altogether admirable double-star observer, Mr. S. W. Burnham, of Chicago, turned the great 18½in. Alvan Clark Equatoreal of the Dearborn Observatory on to Polaris, and subjected it to the most rigid possible scrutiny. He employed eyepieces of the most varying power up to 900, but with an entirely negative result. "It is," he says, "absolutely certain that the supposed new companions have no existence whatever." This opens a question of very great interest. Here are (at least) six people in different countries, with different forms of telescope of various powers and aperture, who all see two exceedingly small stars in the same definite positions with reference to their primary; and yet we now learn, on the very highest authority, that it is absolutely certain that these objects *have no existence whatever!* It is a matter which deserves the most rigid investigation and complete discussion: and, as a preliminary question towards its elucidation, I should like to ask whether M. de Boë still sees his comites to Polaris—or not?

"Nemo mortalium omnibus horis sapit;" and I rather fancy that Herr Zöllner, the Professor of Physical Astronomy at Leipzig, must require the attention of his friends, if we may judge from an article in the current number of the *Quarterly Journal of Science*. From it it would appear that Professor Zöllner had a séance last December with the Mister ("or Doctor") Slade, who disappeared so suddenly from England when it was decided that the Vagrant Act applied to his little performances. As a result of this séance, the Professor comes to the astonishing conclusion that one of Slade's tricks (that of knotting an endless cord) proves the existence of space of four dimensions!!! I wonder what the late Sir William Rowan Hamilton, the inventor of Quaternions, would have said to this? The naïveté of the whole communication would be amusing were it not deplorable. Notably is it exhibited in the offer of the Professor to send the knotted cord to any man for examination. This really reminds one of the mediæval clown, who, producing a rusty sword, exclaimed that "this is the sword with which Balaam smote his ass;" but upon being reminded by one of his audience that Balaam only *wished* for a sword, promptly rejoined, "Oh, yes! this is the very sword he wished for." After this we need not be surprised to hear that the German Professor opines that Slade "was innocently condemned in London—a victim of his accusers' and his judge's limited knowledge." How uncomfortable Professor Lankester and Dr. Donkin must feel, to be sure!

There is an astonishing mistake in your article, "Mr. Proctor on the Star Depths," on p. 84, where our famous English Astronomer is made to say that "only one star's actual distance was known, and that was 280,000 miles (!) from our earth." I wonder how long the Earth would continue in her present orbit under these circumstances?

Since writing letter 14087 (p. 13) I have acquired some additional information with reference to the Selenographical Club, not only from the paragraph in your "Scientific News," on p. 90, but from a friend, to whom I am indebted for a sight of the first number of the Club's *Selenographical Journal*. There is an admirable feature in this, in the form of outline diagrams to scale of the two craters, Fracastorius and Plato, recommended for observation by the members of the Society during April. These must greatly facilitate the accurate delineation of these objects. The *Journal* itself contains short paragraphs on them, a review of Lohrmann's "Mondcharte," some correspondence, Notes on the craters Heriod, Gassendi, and Messier, and (what is printed as) an "Ephermeris of the appearance of the Lunar disc during the month." The Selenographical Club commences hopefully, and should be joined by all who take an interest in the topography of the Lunar surface. I shall certainly belong to it myself.

After reading the letter (14174) of "W. C. P.," on p. 93, I can only adhere to the opinion expressed by me in letter 12965 (Vol. XXV., p. 483). While it is quite true that a clean glass cylinder, interior to the one supporting "Psycho," might, *when once pushed up*, be rotated without detection by the spectators, I must repeat and maintain that I have watched the figure in a way which rendered the introduction either of a second cylinder, or of a glass rod or rods, impossible. It must be a poor opera glass indeed that would not show the *top* of such thing as it ascended.

May I explain, very shortly, in reply to lett 14179 (p. 94), that my object in narrating my pe sonal experience with the British Workman w simply to corroborate what had been vehement denied when stated by Sir Edmund Beckett? I a not concerned to defend Doctors who continue attend patients after they are well, and I think th the conduct of a Barrister who takes a fee and brief in a case which he *knows* he cannot attend is beneath contempt, and cannot be denounced t strongly; but two wrongs do not make e right in any system of ethical arithmetic wi which I am acquainted, and I rather fail to how such cases form a reply to Sir Edmund Beckett allegations. As for social inequalities, if every [illegible] of land in England were put into hotch-pot to-nig and equally divided among the adult males, April 5th, 1880, we should find plenty [illegible] [illegible] considerable acreage and thousands without a [illegible] square foot of their own. Assuredly, too, the upper rank of life are no more idle and l than are all working men the models and which their self-appointed leaders and represent them to be, and the charge of " [illegible] and luxury" against them as a class is an [illegible] one. Nevertheless (as might only reasonably expected from his great and acknowledged abilit "Sigma," apologises for his clients in a mann which affords a most refreshing contrast to t balderdash which appears in certain Organs r; and if his letter should fail quite to rebut mund Beckett's charges it can only be because re unanswerable.

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* Since writing the above I observe by the newspapers that, during the Indian Debate of Tuesday night, Doctor Lyon Playfair asserted definitely, and as an ascertained fact, that "the minimum rainfall was at the time when there were no spots on the sun." One is loth to regard the ignorance thus displayed as wilful; but it is certainly wholly indefensible in any person presuming to instruct the House of Commons upon the subject.

course "W. G. P." (letter 14182, p. 95) is Looking again over my calculation I see only employed a wrong logarithm of one of tors! This does not, though, affect the truth conclusion that Mr. Pinnington's assumed fall has no existence; and the sole effect of relessness was to bring out a result a *little* to his erroneous one than the more correct "W. G. P." Moral: Always repeat calcu- made on the backs of letters, &c., when g to save the post.

Constant Reader" (query 32546, p. 101) can re to adjust his Sundial on the 15th of this , the Sun will be on the Meridian sensibly at Noon. The same condition of things will n June 14th, September 1st, and December If, however, your correspondent knows his ude, and can obtain Greenwich Mean Time he nearest post-office at 10a.m., he can, by g for the equation of time, set his Sundial day when the Sun may be shining. Thus, e, for example, he lives at Torquay, and wishes his dial on the 30th of this month. Now y is 14 minutes West, or slow, of Greenwich, t at the instant when the 10 o'clock post- ignal comes down his watch ought to show m. a.m. Then looking at the *Nautical* *ac* (or *Whitaker*) we find that the Equation s on April 30 is − 2m. 54s. If then your tant Reader" will have his dial bedded in wet , and carefully levelled with a spirit level, ll at 11h. 57m. 6s. a.m., Local time (not *vich* time), turn his dial round until the shadow gnomon shows accurate Noon, it will be in nent, and should be left for the cement to have given an imaginary Longitude, but, s mutandis, all that I have said will apply to your correspondent, which he must ascertain nself.

n only suppose that "H. G. H." (query p. 102) must have bought a chance number ENGLISH MECHANIC. Over and over and ain have tests been given in your columns scopes of all sorts, sizes, and descriptions, for one, have neither the time nor the inclina- repeat them for people who will not search dices.

low of the Royal Astronomical Society.

HE LUNAR CRATER PLATO.

(*Continued from Vol. XXVI., p.* 625.)

1.]—1878, April 16, 6.0, moon's age 13·85

, October 24, 10.0, moon's age 13·84 days. rver in 1855, the Rev. T. W. Webb, who furnished the following extract from his

55, October 24, 10 to 11 hours, 9 hours before on totally eclipsed, 9d. 1h. after max. S.E. n, 3d. 21h. before max. S.W. libration. Air definition sharp, but not perfectly steady; chromatic, 3 7-10in. aperture, power 112 (the eing less intelligible and more confused with The sketch is very rough, and probably mis- s to minute details, for these faint shadow- ere at the very limits of visibility; what, r, was quite certain were: 1st, a white spot aps 1·5″ or 2″ in the centre, not brilliant, but distinct, and brighter than anything else in in; 2nd, an expanded light sector, with ill- curved sides, whose blunted apex lay about e way from the white spot to the east [part ring; 3rd, a sort of elbow of a light tint r or approaching the north-west edge of the 4th, a projection, as it sometimes seemed, e S.W. edge of the ring into the plain, with cure prolongation towards the east, ill made t not reaching the bright sector. North of tre a very faint cloud of lighter hue seemed a north-east direction. The grey hue was in an inlet or bay at the east end, by the nder the ring, and at the south end of the sector."

Webb adds:—"I repeatedly afterwards saw e conspicuous of these details, but never so ly in all respects."

ese details were observed between 22 and 23 go, it would be well to obtain a drawing of r of Plato, if possible, on the evening of the April, in order to determine its present n.

April 17, 6.0, moon's age 14·85 days.

January 7, 13.40, moon's age 14·83 days.

inator near Vasco de Gama.

summit of the wall mostly more luminous e other part of the lunar surface imme- adjoining the crater, with some points more r luminous than the rest.

r of a general dark inky grey colour.

pses of the streak occasionally obtained; it t so distinct as on 1860, January 6. 10.35.

small central speck scarcely if at all seen.

, April 18, 6 0, moon's age 15·85 days.

, July 23, 11.15, moon's age 15·87 days.

Terminator some little distance west of the Mare Crisium, grazing Condorcet its western edge.

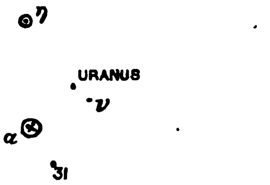
Floor-tint a very diluted inky grey, the tint of the floor rather uneven, but mostly as recorded, the light cloud in the eastern portion exceedingly well marked. It is quite unmistakeable to-night, also the central speck, and occasionally I see a streak both north and south of the speck, the speck itself being brighter than either portion. Some considerable distance north-west of Pluto, not far from the border of the Mare Frigoris, is a bright and lurid spot; crossing this spot is a streak from Anaxagoras, which also crosses the north-west rim of Plato a little westward of the short lateral mountain chain on the north-west margin of Plato. This streak is seen very distinctly and strongly for a short distance from the margin, and can occasionally be traced across the floor. I do not remember having seen the floor of Plato approximating so closely to the appearance given by B. and M. (1st edition of Map) as I do to-night, yet not exactly as they have delineated it.

There is a system of streaks very apparent crossing Plato in the neighbourhood of the whitish cloud on the east part of the floor, which does not originate at Anaxagoras. This system, wherever be its origin, meets with the streaks from Anaxgoras in this locality. **W. R. Birt.**

Buckhurst-hill, April 2.

THE PLANET URANUS.

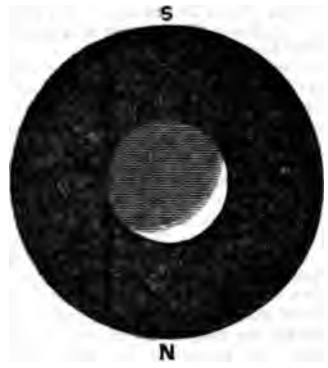
[14192.]—It may interest some of your readers to know that Uranus is now plainly visible to the naked eye, shining as a 5th magnitude star. The following diagram will enable any one to pick it up



easily. A is Regulus in the "Lion," η is a 3rd mag. star above Regulus in the handle of the "sickle," which forms the front of the "lion;" 31 is a conspicuous 4th mag. star, and ν and Uranus will be seen as faint 5th mag. stars in the place indicated in the diagram. **Sale.**

VENUS.

[14193.]—I have been having some very beautiful day views of the planet Venus during the last few weeks. On Saturday, the 30th March, at 11.15 a.m., I was greatly struck by perceiving with remarkable distinctness the whole of the unillumined disc, and, on showing it to some friends, they fancied they were looking at the moon as she appears when a few days old. The unillumined portion of the disc appeared of a warm neutral tint. The accompanying drawing will give a fair idea of this beautiful sight, and may draw the attention of our amateur astronomers to an object at present well worth picking up. The view is, as seen through my 4in. object-glass, with a power of about 90.



Samuel Mills, M.A.

The Rectory, Droylsden.

THE DARK SIDE OF VENUS.

[14194.]—Referring to "F. R. A. S.'s" letter (14134), my original memorandum is, "rather paler and browner than the bright twilight sky, but coming out only at intervals, and much overpowered by the splendid lights of the planets." Many thanks on many occasions. **T. W. Webb.**

TRANSIT OF MERCURY—THANKS.

[14195.]—With reference to the approaching transit of Mercury, might I suggest that a few "hints" on the subject — as to what to observe and how to observe it—from our good friend "F. R. A. S.," or some other competent authority, would be very useful and acceptable to many of your astronomical readers.

Scores of telescopes will (weather permitting) be turned on the sun on the afternoon of May 6th, and one cannot help thinking that the efforts of so many observers ought to produce some evidence of importance in connection with the various phenomena attendant on the transit, which have been often, to say truth, somewhat discordantly described. What is needed is, that some direction should be given to these efforts—a few words as to what one may be on the look-out for, as to what points one's attention may with advantage be more especially directed to, &c.

I am sorry I am not competent to carry out my own suggestion, but I do not think that "F. R. A. S." would grudge the trouble of writing, or you, Sir, the space for a communication which would, I think, be really useful to many.

I wish to return my best thanks to Mr. Herbert Sadler, for his very full and interesting answer on the double star Σ 1964, on p. 100. **Mac.**

EARTH FALLING TO SUN.

[14196.]—In connection with letter 14182 I can only say that the formula given by "W. G. P." is, in my opinion, quite correct. The integration presents no difficulty. It can, however, be easily deduced from the formula which embodies Kepler's third law. Imagine the eccentricity of an ellipse, whose major axis is $2a$, to continually approach unity. The periodic time of this ellipse will in the limit be twice the time of falling through the distance $2a$, whence $\frac{\pi a^{\frac{3}{2}}}{\sqrt{\mu}}$ = time of falling through the distance $2a$, which is equivalent to the formula in question. In this deduction it must be borne in mind that, although in the revolving body the velocity at aphelion is not zero, it is at that point entirely perpendicular to the radius vector, so that both the revolving and falling body agree in having at the commencement of the motion the velocity in the direction of the sun evanescent.

I may as well take the opportunity of correcting one or two clerical errors in letter 14157. About the middle of the letter I wrote fourth column for third column, and vice versâ. I have also omitted the numerical result for 1910·42, This result is really given, but there is a displacement of the deviations one rank upwards, and the omission of a small one about the middle. The conclusion is that 22 of the modern apparitions are connected instead of 21, as appears from the table. **W. C. E.**

THE METEOR, APRIL 2nd.

[14197.]—I was fortunate enough to get a good observation of the splendid meteor that visited us on Tuesday evening. It was nearly, if not quite, equal in size and brilliancy to the one we had in November last (see ENGLISH MECHANIC, Vol. XXVI., page 286), but differed from it in some particulars. The only notice I have seen of it in the daily papers was in the *Times* of the 4th inst., and the account therein was inaccurate, as it stated "the meteor remained stationary for a second or two between Orion's belt and Sirius," whereas the meteor never approached Orion at all. Perhaps the following particulars, as observed by me, may interest some of "ours."

Time 7h. 50m. When my eye first caught the meteor it was approaching from the N.E. It had just left Ursa Major, and was proceeding towards the N.W. It passed through Draco, over the Dragon's head, and on towards Cassiopeia, close to which constellation it burst. There was no noise when it exploded, nor did it emit any sparks. It had no tail, and disappeared as a globe of fire; in colour bluish white, of intense brilliancy, so much so that the entire neighbourhood was illuminated to such an extent that I believe it would have been possible to read a newspaper. I was engaged at the time making a few telescopic observations, and the light was sufficiently powerful to enable me to see distinctly the crevices in the wall bounding my garden. The time occupied in the transit of the meteor from Ursa Major to the place of its disappearance was about seven seconds.

E. Mawe Smith.

MR. PROCTOR'S LECTURE AT LIVERPOOL.

[14198.]—Being laid up I was unable, as I had intended, to be present at Mr. Proctor's last lecture in connection with the Liverpool School of Science. The account in your impression of this date gives rather meagre details on the following points, which, *causâ progressionis*, should at least be cleared up by Mr. P., or some one who heard the lecture.

1. The exact standpoint, whence Mr. Proctor thinks he sees the following facts.

2. The stars which, from that fulcrum, appear to be perfectly still and quiet.

3. How it comes that spectrum analysis can demonstrate a thing which we have no knowledge of, except that it has travelled a distance whereof the measurement is not ascertained exactly, owing to defective instruments, &c.

4. The particular stellar investigations which go to disprove the notion, "that our solar system being developed from a gas will not return to the same state unless extraordinary precautions are taken to prevent it."

5. Never, being rather a long day, why should we be asked to come to the hasty conclusion that telescopes cannot be invented powerful enough to get to outlying systems far beyond our own?

6. Lastly, why he would have us agree that the profundity of the heavens was illimitable, and would never be fathomed—though he admits the actual distance of one star was at least known to somebody? **Thos. A. Pullman,**
Professor of Languages.
Dunedin, New Zealand.

[14199.]—The last number contains an extraordinary review of Mr. Proctor's last lecture, delivered at the Liverpool School of Science. The information there given for popular edification (of course the majority of readers of the English Mechanic will know better) is, that the only known distance of one star is 280,000 miles from the earth! Now, the moon is put down at 238,828 miles, so it is a little over that. Mr. Proctor could not have said this. Of course Alpha Centauri is the star meant, the distance of which Mr. Proctor gives, in "Other Worlds," as twenty millions of millions of miles from us. Also, is it true that the sun, at the distance of the nearest star, would shine as a star of the second magnitude?

The next statement seems very unsatisfactory—that in spectrum analysis the comparisons are made by the "shades of colour," when it is known that, if it were not for the lines in the spectrum, the delicate measurements could not be made. Also, it is unsatisfactory to report a lecturer as saying that "the notion that our solar system has been developed from a gas had been entirely upset by stellar investigations," and then leaving the reader without telling him what the new idea is; presumably it is the meteoric origin that is meant, vide "Other Worlds." Injustice is done to Mr. Proctor's ever correct and valued information.

Theo. Izod.

[The report was forwarded by a correspondent, who volunteered his services in connection with the matter.—Ed.]

MOTIONS IN THE LEVELS OF TRANSIT INSTRUMENTS.

[14200.]—It gave me great pleasure to see in the English Mechanic of March 15th a report of the discussion at the meeting of the Royal Astronomical Society on Mr. Plummer's paper on "Azimuth Errors of Transit Instruments."

Twelve years ago I came to the conclusion that the true tidal motions and some minor perturbations should be indicated by the plumb line and level, and I fixed a level nearly due N. and S. in the upper story of a house, which had been built about 35 to 40 years before, expecting that such an edifice would be to some extent an unstable structure, and that consequently any force that would tend to alter the direction of a plumb-line would act upon the upper story of such a building, and cause level indications to be magnified.

I found that the level gave daily, and, indeed, almost hourly, varying indications; generally the motion of the air-bubble was very minute, but sometimes startlingly great (very near ¼in.), and I have seen large variations followed by exceptionally high tides in the Mersey. I carried on the experiment in this simple manner for several years, but as I have always intended to make a special delicate apparatus which will aim at both magnifying the motions in levels and also at indicating how much of the motion is due to the moon's, and how much is due to the sun's and other influences, I took no notes, and can only say now that specially great disturbances were experienced one year, about the 3rd or 5th of April, and generally great disturbances about end of March and beginning of October. (I am writing from memory.)

The theory that I had formed, and which led me to make the experiment, is hinted at in my letters (March 9th, 1877, p. 621, "The Tides"; April 13th, p. 109, "Terrestrial Centre of Gravity"), and I have since written letters, which have not been printed, in which I had anticipated Mr. Plummer's experience, that "the azimuth errors of his transit instrument would be positive in summer and negative in winter" from theoretical considerations.

Chester, April 1st. **G. Pinnington.**

[We print part of this letter in response to Mr. Pinnington's appeal to "do him justice," but we omit the rest, simply because we believe enough has been said about the matter, and neither now nor at any previous period for reasons of the kind insinuated in the suppressed portions of his communication.—Ed.]

THE LAST LETTERS OF "THE HARMONIOUS BLACKSMITH."

[14201.]—By the kindness of "Fiddler"—to whom we return our sincere thanks for the opportunity afforded us—we are enabled to publish two letters written to him by our late lamented correspondent, "The Harmonious Blacksmith." Both are on subjects with which he was familiar, on which he wrote freely in our earlier volumes. "Fiddler" intimates that he has several other letters in his possession from Mr. Savage. Should they deal with subjects of interest we should be glad to publish them as opportunity offers. We give the first of the letters sent us below, and shall publish the second one next week:—

Strings of Musical Instruments.

As my carnal appetite, fortunately, does not—however little of my original "savage" nature may have been eliminated by Christian civilisation—extend to a desire to substitute human for porcine babies (yclept sucking pigs), it can hardly be needful for me further to investigate the most effective (not to say satisfactory) methods of making this "change at nurse," which I fear will be unpopular with the mothers of the former; at least in a country in which females of the genus homo are so prejudiced as they ordinarily are here. Were I addressing a fellow (female) savage in Gipp's Land, the inquiry would be quite legitimate, for I have read one of them (the aforesaid savage females) philosophically killed and eat ten out of twelve of her children. The veracious narrator of this gratifying fact (?) added, "her husband was always ready and willing to help her," but omitted to specify the nature of the assistance he afforded. It's not bad policy to leave something to the imagination of the reader. In No. — of our journal you will find some of my facts and, I hope, interesting speculations concerning cannibalism and its probable social and commercial consequences when formerly prevalent in North Britain. There can be little doubt it once was.

With regard to the tenacity of that material which has been termed "pussy's bowels," I am not acquainted with any practical reason why strings composed thereof, whose weight per foot-length is double, may not be constructed capable of enduring double the tensile strain which strings half their weight are capable of sustaining. This has long obtained in pianoforte wire, which has been so greatly improved by Messrs. Horsfall and W. Smith (now of the firm of Smith and Houghton, Warrington), that we find wire, whose weight per foot is more than double that formerly used to produce the same sound, not only bears sufficient tension to cause it to vibrate synchronously with the same length of wire only half its weight, but to bear the yet greater tensile force needed when its length is increased from 20 to 50 per cent. Probably it is impossible to increase the tenacity of gut strings in anything like this proportion.

Animal membrane may be one of the most elastic materials of which very light musical strings can be made; but even this differs very considerably in its ability to resist tension. The ordinary sheep's entrails (who has been fattened for human food) is not nearly so tenacious as the gut of the mountain sheep of Sicily and Southern Italy. Hence the great superiority of so-called Roman strings, when genuine (they are not so invariably). Probably strings yet more tenacious than these would be manufactured for sale, if the demand for them existed.

Gut is not the only material of which light music strings have been made, not to mention vegetable fibres (none of which that I am acquainted with are so good for use as catgut). Silk, both as it is obtained from the grub, in the form familiar to anglers, as "silk-worm gut," and spun, has been long employed. The tenacity of silk, in proportion to its weight, exceeds any catgut that I am familiar with. I may remind you my late friend, J. J. Hawkins, made a silk fiddle-string, which bore sufficient tension to raise its pitch to B, one-fifth above your first string, although of the same length. If I remember correctly this string was not twisted, or but very slightly twisted, and the filaments of which it was composed were cemented by caoutchouc. Of course you are aware the torsion necessarily detracts from the tensile strength of all cords which (when twisted) cannot remain equal to that of the sum of the fibres of which they are composed.

Concerning the bowing of metal strings: If I rightly remember, the viol d'amour was at least partly strung with wire. Its tone, as usual, was but thin and unsatisfactory. Few sounds I have heard from thin steel wire were anything else when bowed, but this does not seem to result from any want of elasticity. I have no reason to suppose steel wire (especially if very hard drawn or hardened by heat and quenching, and tempered like watch springs) is less elastic than catgut; on the contrary, I believe it to be much more elastic. That a given force applied to it by a bow does not move it through as large a space as the same force applied by the same means moves a gut string, is no proof the latter is more elastic than the former, but only that, from the comparative lightness of the gut, a given force is able to move it further than it can move the heavier material, besides which the tensile force required to strain the heavy wire to pitch is so much greater that it must of necessity require a greater force to deflect it to any given extent. This, however, does not necessarily affect the loudness of the sounds produced.

Probably nearly all the sounds we hear when a stringed instrument is performed on are caused by the aërial waves formed by the vibrations of its soundboard. The aërial waves caused by the vibrations of strings, unconnected with any resonant body, are so weak that they are almost inaudible—see Tyndall on "Sound." I rather incline to the theory that the musical string acts on the soundboard just as a drum-stick acts on a drum—*i.e.*, it beats the soundboard. Its beats on alternate depressions and elevations of the soundboard occur at each of the string's vibrations, and as the string is invariably in practice more or less efficiently connected with the soundboard, the latter's vibration must of necessity be synchronous with those of the former which moves it.

The loudness of the sounds depends on the amplitude of the vibrations of the soundboard. This is not dependent entirely on the amplitude of the vibrations of the ventral segment of a string, but rather on the extent that the end of the string, which is attached (by a bridge or otherwise) to the soundboard, moves the latter. Now this, *c.p.*, will depend on the weight of the string; hence a heavy metal string (although the bow does not cause its ventral segment to become so large as it does that of a gut string) may, when bowed with a force in proportion to its weight (by moving the soundboard further than the light gut string is able to do), actually cause more ample aërial waves, and consequently louder sounds. I need hardly add, a violin with thick metal strings could not be performed on. The strings, besides needing to be very differently connected with the soundboard, would be too rigid for the finger to deflect them for stopping.

I have no doubt the timbre of a fiddle's sounds, whose belly was 50 per cent. larger than usual, would be very different from that of the sounds we ordinarily hear. When I first suggested the enlargement of the soundboard it was for the very purpose of causing both the timbre and loudness of the sounds to be different, and—may I add?—better. I fully anticipate we shall obtain sounds of that broader quality which I—it may be my bad taste—desire. Preferring, as I do, the quality of the sounds of the tenor violin (when that instrument is bowed *à la* John Alvey Turner) to that of the sounds of the ordinary fiddle, even when he bowed the latter, you need not be very much surprised if I did propose to make the fiddle into a tenor, or even a yet larger instrument.

You say such a fiddle would need longer as well as thicker strings. Query—why? Surely you can hardly have forgotten that increasing the length of a string of given thickness, employed to cause a sound of given pitch, necessitates the application to it of proportionally greater tensile force. Now every increase of tensile force must, *c.p.*, induce greater rigidity. After we (tentatively) arrive at the desirable proportion of length to diameter, so far from any increase in its length rendering it easier to cause a musical string to vibrate satisfactorily, it has the very reverse effect. The additional tensile force it needs to cause it to vibrate rapidly enough to produce a sound of the required pitch renders the string too stiff, at least for anything but a bow instrument, or one in which revolving plectra or rapidly repeating hammers prevent the string from ceasing to vibrate.

I can conceive no modification of or addition to a fiddle which shall cause its sounds to appear equally loud in a room full of furniture, human beings, and other "sticks," as they appear to us when the instrument is played on in an empty room, by which I don't mean a room without a *single* person in it because all in it have been unwise enough to have been married. It seems to me quite impossible the aërial waves can (when broken up and impeded by furniture and the audience) affect the hearers so powerfully as they do when allowed (in consequence of the absence of those obstructions) to spread freely. This defect, if it be one, is not in the fiddle, nor yet in the fiddler, but is an inherent consequence of atmospheric acoustical conditions.

The mechanical bow instrument referred to you was not a pianoforte—at least, it was not a hammer instrument—but a harpsichord. In this the unisonous strings are fully 7 16in. apart; consequently that distance affords space for inserting the little brass pulley, about 5-16in. diameter, between them, which presses the bow, or rather the endless rosined band which is a substitute for a bow in all so-called celestinas, to the two unisonous strings. This mechanism, generally attributed to Walker, the old astronomical lecturer, and patented by him A.D.

1774, is quite inapplicable to the pianoforte, because its unisonous strings are necessarily so near each other, to enable the hammer to strike them properly, that there is not sufficient space between them for the insertion of the brass pulley which presses the bow to them. The reason the A and B and other strings between G and C do not vibrate so as to cause audible sounds is simply because the dampers are not lifted off those strings until their corresponding keys are depressed. I thought I had fully explained this in my article in No. — of the English Mechanic.

The harpischord celestina action, which has been applied with modification to Dr. Clegget's, Groil's, Todd's eupheonon, Goldsworthy Gurney's, and several other so-called bow instruments, answer well to the finger, but when used with the thin strings of an ordinary ancient harpischord the quality of the sounds elicited is but thin and poor. This reproach does not apply to its employment with thick steel strings, but it is far inferior, in my judgment, in every respect, excepting simplicity, to Mott's sostinente pianoforte mechanism. In the latter the steel musical strings are not bowed or rubbed; doing this seems invariably more or less to induce the quality of tone yclept "rasping." In Mott's construction the strings are simply pulled by the silk loops attached to them at intervals which succeed each other so rapidly that each individual pull is indistinguishable. There can be no doubt the resin on the fiddle bow also acts on a musical string by pulling it at indistinguishably frequent intervals just as the teeth of a fine saw would do could we apply it without destroying a gut string, but then the bow also (may I take the liberty to say?) also rasps the string. Need I add the tone (at least, of steel wire, not to say also that of cutgut), excepting when the bow is in the hands of a maestro like Paganini, or the late J. A. Turner, somewhat partaketh of ye nature of ye rasp?

I may just add the tetrachordon pianoforte, so called, is a modern simplification of Mott's sostinente pianoforte mechanism, but, unlike his instruments, it is not a valuable addition to an ordinary pianoforte—i e., it has no hammers. Not having heard it, I can give you no information concerning the timbre or power of its sounds, but you can hear it at —, where the owner of the English patent right has it on them.—Yours truly,

A. Savage.

P.S.—Possibly you may remember Bottesini's performance of soprano melodies, entirely in harmonics, on the double bass. I fear no stopped notes on any violin, however proportioned, will ever rival the quality of his harmonic sounds some 18 years ago; their quality had much deteriorated when I last heard him, about five years since, having become much thinner, and more like those of Piatti's cello, or the oboe. Now, if we aim at the sun, we may, although our range be but short, yet hit the eagle, so if we aim at producing a fiddle whose tones resemble Bottesini's harmonics, although failing to rival them, we may hope for some amendment on the but too frequent thin quality we hear.

THE MATHEMATICAL SIMPLICITY AND SYMMETRY OF THE STRUCTURE OF THE DIATONIC SCALE ILLUSTRATED BY A PROCESS OF MEASUREMENT — TRUTH OF THE HYPHARMONIC SERIES OF RATIOS.

[14202.]—I have read with much interest the letters of Mr. Frederick J. Jackson and others on the mathematical relations of the several tones of the musical scale to each other. The controversy has received fresh interest by the discussion which has been going on between Mr. Jackson and Mr. Colin Brown as to the right to consider rah a tone of the major scale. Mr. Jackson has taken great pains to endeavour to prove that there is a grave second (rah) as well as the major second (ray) in the major scale, thus making that one tone both major and minor. Why should Mr. Jackson introduce a tone of the minor scale into what he wishes us to consider the true and mathematically correct major scale? I should not be surprised if Mr. Jackson confounded the major scale of nature with the so-called natural scale, fixed in C for the convenience of musicians; but he is too thorough a musician to err in that way, and has done as much as most men to set the public, musical and non-musical, right in that particular. But I am surprised that he, knowing the ratios of the tones of the scale, should make so grave a mistake as to assert that there is a major and also a minor second (or an acute and a grave second) in the major scale. Mr. Jackson, I think, takes a laborious method of getting the true tones of the scale. The full major scale, or scale comprising an octave, is composed, in my opinion, of three scales, the tones in each of which bear the same relation to their tonic and to each other. This is, perhaps, obscure as written. The three scales are founded on the tonic, fourth and fifth—the fundamentals of the natural chords. The fourth and fifth form with the tonic perfect consonances. This shows that they have a more important place in the scale as a whole than the other tones. They are also the only bases in the scale. This is another proof of their importance in the scale, and their pre-eminence over the other notes. From these three tones all the notes of the scale can be evolved by a short and simple process, which has often been used by Mr. Jackson and other contributors to the English Mechanic. Taking the tonic doh, the base of the first subsidiary scale, by using the factors $\frac{5}{4}$ and $\frac{3}{2}$ the third and fifth of the scale, me and soh are gotten. Taking the second bass, or base of the second scale, fah, and using the same factors to get the third and fifth, we have fah, lah, doh—the first, third, and fifth of the subsidiary scale, and the fourth, sixth, and octave of the scale. By the same process we evolve the seventh and second out of the fifth—soh, te, ray. Thus out of the three basses and perfect consonances we can get the complete diatonic major scale, with every interval and tone mathematically correct, and by simple arithmetic, involving no calculations that a schoolboy could not make. Perhaps Mr. Jackson will see that a "perfectly exact simplicity is the ruling principle of the structure, or, in other words, of the evolution of the notes of the musical scale."

Picton, Nova Scotia. **D. Fraser.**

UNFERMENTED BREAD.

[14203.]—The subject of unfermented bread has, perhaps, hardly received as much consideration as it deserves. A few practical remarks upon it may not be unacceptable to such of "ours"—and they seem to be many—as have a chemical turn.

Wheat flour contains, we will suppose, about 5 per cent. of sugar. In ordinary bread-making, with yeast, this undergoes the vinous fermentation, passing off as alcohol and carbonic acid. Is it not a pity that one-twentieth part of the vast amount of flour so consumed in this country should be lost nutriment? The process with pure hydrochloric acid and bicarbonate of soda seems unexceptionable; because, when the proportions of those re-agents are accurately adjusted, they have no product but common salt. Bread so made consists merely of flour, salt, and water. But it is not necessary to use enough soda and acid to salt the bread. A lesser quantity will suffice to make it light, and a portion of salt may be added in the water. I find that 46 grains of soda are enough to raise a pound of flour; and, for my own taste, I add about the same weight of salt to the water employed. This is equivalent to some 78 grains of salt per pound of flour.

We rebelled against the bakers ten years ago. It was my custom when we got into a bad vein of bread, or, in other words, when the baker had laid in a stock of inferior flour, to go and complain. I was always met with the assurance that the flour was first-rate; but I also found that the quality of the bread improved materially a day or two after each expostulation. A notable instance this, supposing the flour to have remained the same, of the influence of mind over matter; the mind, my own; the matter the bad flour. However, one unlucky day, the baker paid no heed to my grumble, and we started a domestic bakery at once.

To make what we call a two-pound loaf, which actually weighs five or six ounces more, my cook takes 1¾lb. of flour, and mixes with it 80 grains of bicarbonate of soda, by rubbing the soda with a little flour in a mortar to break down the lumps, and then passing the whole through a brass-wire sieve. Sixteen fluid ounces of water, containing about 106 minims of hydrochloric acid and 75 grains of salt, are then mixed with the flour, and the resulting dough is immediately put into a quick oven, and baked for an hour. If left longer in the oven the crust becomes hard.

In practice it saves much time to keep the soda ready weighed in papers, and to have a stoppered bottle containing acid, salt, and water, in such proportions that a fluid ounce may be equivalent to 80 grains of soda. It is convenient, also, to graduate a 32oz. bottle into 8oz divisions, for the purpose of holding the mixture of acid solution and water. With these appliances it does not take five minutes to make a batch of bread. This kind of bread does very well if baked in enamelled-iron pans; but they are not indispensable.

There are several advantages belonging to this process. You know what your bread is made of. It is not liable to be sour, which bakers' bread almost always is. After 10 years' trial my household care for no other bread; and our friends consider it a treat to get a slice. You are independent of a supply of yeast, and can bake whenever the oven is hot, as there is no "setting" of the bread to be waited for. I astonished some travellers by giving them hot rolls, one morning, at half past five.

It may be asked, is it not less trouble to use baking powder? It is; but baking powders, used constantly, are equivalent to the habitual introduction of alkali into the system, which is injurious to health.

Our chemical friends will not need to be told that the pure acid is intended, as the common sort contains iron and perhaps arsenic. When I get a fresh supply of acid, I test its strength; but I usually find that about 53 minims will saturate 40 grains of Howard's bicarbonate of soda. **A Physician.**

LOCOMOTIVES.

[11204.]—I have lately become a subscriber to your valuable paper, and have been looking through some back volumes. I have been very much interested in the correspondence under the above heading, especially as I take a great interest in the locomotive. Perhaps I should state that I am not connected with any railway, nor am I an engineer of any kind. In the letters on express and other engines I think too much has been put forward on behalf of the G. N., G. W., and Midland, and not sufficient notice taken of other lines which might have claimed some attention from the readers of the Mechanic.

The Furness, M. S. and L., L. and Y., and N. S, have engines which are worthy of notice. The Furness Railway has (or had not in 1875) any engines with driving wheels of larger diameter than 5ft. 6in. four-coupled. The M. S. and L. express engines have wheels of only 6ft. diameter, and last year introduced engines with a leading bogie, and with the addition of a "cab." These engines (both the 6-wheeled and bogies) are four-coupled, and have outside frames. Respecting the bogie class, in my opinion a finer engine never ran, though I cannot speak with the force of a practical man. I am told that the bogie engines answer well. These engines run the G. N. trains from Manchester to Retford and back, and it is well known what excellent time the trains keep, notwithstanding the extra mileage they have to perform in excess of other routes. The L. and Y. was alluded to in the former letters, but in such a disparaging way that I think it is only fair some one should come to the rescue, though it is late in the day. I believe it is in Vol. XXIV. that a correspondent speaks as if the improvements had only then (1876) been effected in the locomotive department. He is surely in error, for in 1868 they brought out some new engines with a flush boiler, having a valve only, and placed over the firebox. Some passenger engines of this type came out in 1869, Nos. 79, 49, 55, 85, and 86, with outside cylinders; these I saw at the time. Then, in 1871, passenger engines were built with inside cylinders, and this pattern has been adhered to, with the addition of a "cab" about 1874, and last year a dome on the centre of the barrel. In 1873 some 4-coupled 6ft. 6in., from the L. and N. W., were added. Then in 1876 came the engines that were originally ordered for the G. N. with 4-coupled leading drivers of 5ft. 6in., and although the men do not like these engines for the manual labour they entail in working them, yet the engines do their work well, and take fast and slow trains in turn. These engines are numbered in the East Lanc. section—viz., 605, 611, 632, 635, 647, 652, and 659, and this leads me to correct a correspondent, and also "A Salford L. and N. W. Driver," who, in writing on these engines, mentioned 562, which they evidently meant for 652, as the former No. is among goods engines.

I must admit the L. and Y. has a great many varieties of locos., perhaps more than any other company; but it has often appeared to me that a copy has been taken from this line, and another from that, and so on, until a great number of different styles (I can count above a dozen) appear, besides the L. and N. W. and G. N. models. Putting all this aside, the Lanc. and York. Railway is one that will hold its own with the other lines, and though it has been spoken of as a local line it is really something more, as a glance at the railway map will show.

I hope this letter—longer than I intended it to be—may help to enlarge the interest in locomotives in the readers of the Mechanic, and that other railways than the Great Northern and Midland may be brought into prominent notice.

Manchester. **R. N. H.**

P.S.—If correspondents would send, and the Editor would kindly illustrate, remarkable locomotives from time to time, it would increase the interest, and be an additional attraction.

MICROSCOPICAL OBJECTS.

[14205.]—A new and novel mode of producing one of the most beautiful objects for the microscope, and particularly for the binocular, is as follows:—Get a tin cell, and after fixing it to a glass slip put into it a solution of sulphate of copper and gelatine. Let it stand for some time, when the tin cell will produce a kind of galvanic action, and the result will be the most beautiful and wonderful formations of metallic copper ever seen; they are like the most beautiful golden ferns of the most gorgeous shape. I have also tried experiments with other salts, and with the same result. If any of our readers want any further information I shall only be too happy to give it, and I am quite sure no cabinet will seem complete without one or two of these slides when they have been seen. **Randolph Richardson.**

ON THE ANGULAR APERTURE OF MICROSCOPIC OBJECTIVES.

[14206.]—The letters of Mr. Wenham on the angular aperture of microscopic object-glasses, in the English Mechanic of the 8th and 29th ult., contain several points on which we are prepared to remark; but, before doing so we would ask that gentleman kindly to answer one question—Why should the angle of an adjusting objective be measured when the lenses are at the closest, and not when adjusted for uncovered objects? As the adjustment is simply a remedy for aberration produced by glass covers of varying thickness, and as the thicker covers require a closer approximation of the lenses, one would suppose the measurement taken when the objective is adjusted for the uncovered object to be the correct one. **Richd. Nickols**
Martin M. Bull.

Jersey, April 4.

SHIP CLEANING APPARATUS.

[14207.]—Experiments have just been made at the Royal Dockyard, Chatham, with an invention for cleaning ships' bottoms whilst afloat, the one selected being the invention of Mr. H. J. Cole, engineer, of London. The experiments were carried out under the superintendence of the inventor, and in the presence of Admiral Superintendent Fellowes, C.B., Staff-Capt. Batt, Capt. Richards, of the Medway Steam Reserve, the Chief Constructor, and other officials, on board the Northampton ironclad in the repairing basin, and some considerable portion of the ship's bottom was scrubbed, each time the brush passed leaving the zinc sheathing quite bright. It was afterwards, by the wish of the Admiral Superintendent removed on board H.M.S. Superb (she being in dry dock), the object of this being to see its action as it were under water. Here it was made to pass many times from the keel to the hammock-rail and back again. This was accomplished by about six or seven blue jackets, aided by a winch, the whole being controlled from inboard the vessel. This apparatus consists of, first, a keel-traveller, having on one side two "Vaucanson" or ladder chains made fast. It also acts as a distance piece to keep the chains the proper distance apart. The keel traveller is hauled down to the keel by means of two ropes being made fast to the opposite side to the chains; the ropes are consequently brought up and made fast to the opposite side of the ship to the one being operated upon, the loose ends of the chains being inboard on the side being cleaned. The brush or brushes are about 4ft. long, and are mounted in segments on a cylinder, which, by its own buoyancy, floats. The cylinder is mounted on a spindle and frame, and on each end of the spindle and between the sides of the frame is keyed a pinion whose teeth engage into the links of the ladder chain, which is passed between the sides of the frame under rollers and over the pinions. It follows if the brush is hauled up or down a rotary motion is given by the pinion and chain. The brush is made to press hard or soft against the ship by adjusting legs. Each end of the brush frame is connected to the other by arms, to which are attached on the top side a rope for hauling up purposes, on the under side one for hauling down purposes. This one is also passed through a wheel guard on the keel traveller, and the loose end brought up the ship's side under the brush and over a suitable pulley on the hammock berthing, and wound round one barrel of a winch. The first or hauling up rope is also brought up the same side and over a pulley, and wound the opposite way round the other barrel of winch, so that when the winch is being turned one rope is being paid out and the other is being wound in. The ends of the chains which are in board are also over pulleys and have hung or attached to them by a peculiar hook weights which keep them taut, and also act as a spring allowing the brush to travel over the wall or over the bilge portion and always keeping it well up to its work. It will be understood from the foregoing this apparatus works athwart ship, and not as of old fore and aft. Once down and up polishes the zinc. To clean a fresh place the pulleys on hammock berthing are slid along the necessary distance, the ropes holding the keel traveller are loosened, and the traveller hauled along the keel. They are then made fast again. The winch turned as before and a fresh place is cleaned. **W. H. G.**

PARALLEL VICES.

[14208.]—I send you two forms of parallel vice which have been recently devised, and which may interest your readers. The first, which is the invention of Herr H. Baecker, of Remschied, Germany, is intended as an improvement upon the present method of screwing and unscrewing vices, the ordinary straight mandrel, with its sliding handle, not only requiring a considerable amount of physical power, but occupying much time, besides unsteadying the hand of the operator where the work has to be shifted frequently. Herr Baecker obviates these defects by applying a toothed gearing to the mandrel, which is actuated by means of a worm attached to a handle placed in a position convenient for the operator.

Fig. 1 renders the construction sufficiently clear, but it is obvious that the arrangement of the details may be variously modified; for instance, the toothed wheels may be placed between the jaws of the vice, and the mandrel instead of extending backwards may project in front. As shown, the mandrel has a toothed wheel secured to it, which gears into a larger wheel, the latter being actuated by a worm connected to the handle, which is thus placed in a position very convenient for the hand of the operator. A slight exertion of physical force will release the work, which can be adjusted by the operator's right hand, the steadiness or delivery of touch of which is not upset by the necessity under other conditions of using it to screw up the jaws.

FIG. 1

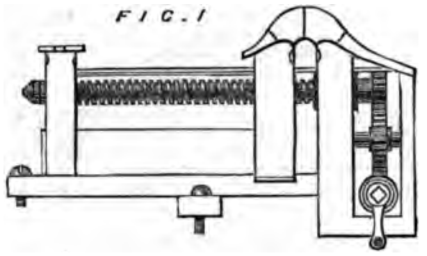
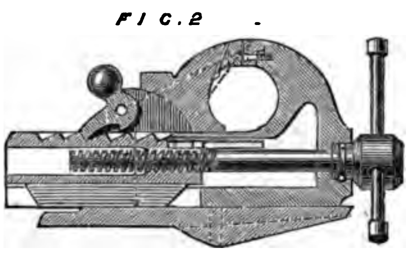


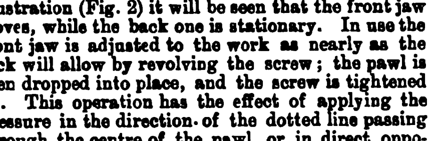
FIG. 2



The other vice has been patented by Mr. J. Lynde, of Philadelphia, and has several features which will commend it to the attention of mechanics. In all vices, and especially in parallels, it is essential that the pressure of the grip may be brought as near to the resistance as possible, while means of quick and accurate adjustment are provided. These qualities Mr. Lynde claims for his vice. In the accompanying illustration (Fig. 2) it will be seen that the front jaw moves, while the back one is stationary. In use the front jaw is adjusted to the work as nearly as the rack will allow by revolving the screw; the pawl is then dropped into place, and the screw is tightened up. This operation has the effect of applying the pressure in the direction of the dotted line passing through the centre of the pawl, or in direct opposition to the resistance, whereas, if the pressure is to be applied in the direction of the other dotted line, a tipping strain is brought on the jaw, which thus acts as a lever tending to wrench the base or bar. The maker's claim of stiffness seems to hold good, and the quickness with which the vice can be operated leaves little to be desired. As regards the latter point, however, it would seem impossible to devise a more rapid method of adjusting the jaws than that employed in Stephen's and Hall's patents, but it may be doubted whether those vices are not exceptionally liable to rapid wear and chance injury. I submit these remarks, however, for the criticism of your readers, amongst whom I believe there are many skilled amateurs as well as professional mechanics. **Oberhof.**

TYPO-ZINCOGRAPHY v. COLLOTYPIC PRINTING.

[14209.]—On p. 577 of the last volume I described a process for obtaining blocks for surface printing by etching zinc with an acid. The design to be engraved can be obtained either by photography or by lithographic transfers from paper, stone, steel, and copper-plate line engravings, or type. When obtained these blocks can be printed in an ordinary typographic press, and require no special knowledge or skill in their manipulation, the only technical knowledge wanted being in their production, which is done, of course, by duly qualified operators.



Since my description appeared I have noticed one or two letters in which the correspondents decry typo-zincography on account of the alleged difficulty in the original production of the blocks, and recommend various of the gelatine processes, because of the comparative facility with which the printing surface is obtained. Certainly that is obtained more easily, but then it has to be printed in a lithographic
press, which at once does away wi
chief advantages claimed for the zinc
of being printed with type. Then, agai
requires considerable manipulative ski
be got by apprenticeship, and would
in an ordinary lithographic printer.
all these gelatine processes are th
patents, and the proprietors insist o
copies themselves, so that not many
care to venture on attempting thei
these processes depend on photograph
duction, and if you want to reproduc
line engraving by their agency, you
obtain a proof in the usual way, then
tive of the proof, and finally photog
gelatine surface, all these preliminari
and causing an extra expense. Whil
graphy, as I have before stated, a tr
obtained in a very short time and at
The prices for engraving zinc blocks
to 8d. the square inch—this is, of cour
drawing or photographing. The latter
I think, about 2d. a square inch ext
be seen at once how much cheaper i
engraving or heliotypy, the former
1s. 6d. to 3s. 6d. per inch, and the l
per 100 proofs. The artist may dra
paper or stone, which is but little m
him then sketching in pen and ink.
send his transfer to the zincotyper, wh
the very moderate cost I have na
blocks can then be sent to the pul
printed as they desire. In Leitch's
very ingenious mechanical apparatus,
be enlarged, reduced, or distorted.
diagram shows the result of such tr
the original design, B is a correspond
C may be supposed to be a lateral, a
extension, while E is a type of any
sided figure, which can be obtained b
of the original square. These
obviously unsuitable for cartographi
but they introduce a striking nove
marks, show cards, &c. The reducti
ment proper by this apparatus sav
taking a negative; but for obtainin
existent drawings, maps, &c., reco
graphy is necessary.

I am by no means wishing to throw
on the gelatine processes, for most
can be got from some of them, but t
any means applicable to the same c
blocks are intended for. It is also un
they will not yield long numbers-
exceeded—and the last proof always
derable falling off in vigour and de
pared with the first. Most of these
cesses depend on the fact that bichrom
when exposed to light, becomes hard
the direct ratio of its exposure. Th
film, properly printed under a negat
blacks should be quite horny, a
white of a soft and absorbent nat
sponge is then passed over the surf
parts unacted on by light to swell slig
graphic roller saturated with ink is
the film (and it should be noticed th
first importance that the ink should b
and regular; amateurs will find a d
here), when it will be seen that the
the gelatine in the ratio of its horni
bility, the soft parts that retain wat
the ink to remain thereon. When s
up a sheet of paper is laid over it,
pulled in the lithographic press. It ta
as long to print one of these as it doe
The heliotype has hitherto been the
the collotypic processes. In this a f
from the coarsest gelatine, with a
chrome alum, the latter serving to
tine tough and insoluble, but does
property of absorbing water before e
The film is made on a sheet of leve
but is stripped off before printing in
sharper contact with the negative.
the back is sunned behind ground g
hard and durable, and the film is
down on a flat zinc plate, and is pr
In all the other processes of this
remains on the plate-glass during t
manipulations, and has to be cem
litho stone or slate slab to be pr
lithographic press—an operation w
well imagined, requires considerabl
stone is liable to fracture, how muc
a brittle glass plate be? The Albe
Waterhouse's method are the most
latter processes, and they are so
not to require more than a passing

There is one great disadvantage
all these gelatine methods of p
printing, and that is, that they can
If the exposure has been too long
will be clogged up and print dirty
been too short, the fine lines will n
These imperfections must either re
be destroyed and a fresh one printe
whole day's exposure in winter, th

ry, the feelings of the operator may be well In a zinc plate, however, one can imperfections with a scraper, and draw in k with a fine camel-air brush, just as is stone, and a wrongly exposed plate may endered passable. **Ernest A. Nuth.**

PURIFYING WATER.

]—In answer to "S. M. P." (letter 14153) to inform him that different waters, like diseases, require different treatment to em, and that all waters, no matter how ey may be, can be made quite pure for or other domestic purposes without dis- providing the proper materials be used, ient time allowed the reagents to act; but amples of water I have found distillation quickest and cheapest mode of purifying ll filters in use that I am aware of only water from solid impurities mechanically in the water. The following is a descrip- ilter that I have often used, which purifies from organic impurities held in solution from suspended solids. Take any suitable h a perforated false bottom, and cover it er of animal charcoal, on the top of that ayer of iron filings, borings, or turnings, he better, mixed with charcoal dust; on f the filings place a layer of fine clean and, and you will have a perfect filter. foul water to filter slowly through the er, and you will produce a remarkably ing water. Before placing the iron filings er they must be well washed in a hot f soda or potash, to remove oil and other , then rinse them with clean water; the uld be mixed with an equal measure of fine If the water is very foul it must be filter very slowly. The deeper the bed of is the quicker they will act.

ve is a simple, cheap, and very efficient rior to any other filter that I know of, and advantage of being free to every one who make it. I have not taken out a patent I am not aware of any other person having think I am the only person who has ever should like if "S. M. P." or some other r would try it with different waters, and experience and opinions. A very good e efficiency of any filter is to add some he water before passing it through the then testing the filtered water to see if passes through unchanged; if it does, lter only acts mechanically.

ition of permanganates to water will not cteria, but the addition of hydrochloric If you have to purify water containing ou must first add hydrochloric acid to the it is slightly acid to test paper; that will e whole of the animalcula, then add suffi- water to neutralise the acid, then pre- e lime with oxalate of ammonia, and filter he iron filter described above. The foulest er, treated as above, is rendered quite pure r drinking.

mention that I have made it a practice e last 27 years to boil all my drinking t is the safest plan for a man moving from place. You cannot always carry a filter icals about with you, but you can always to get boiled water; people talk about it pid and tasteless, but I am used to it, and

Wm. Burns.

DISTILLATION OF COAL.

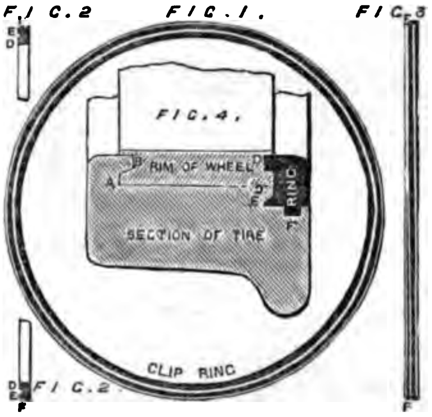
.]—In your journal of March 29, 1878, I reference is made to my Cantor lectures rbon." The views there expressed on the of Coal Formation" were adopted by me, onversation with my friend, Dr. Mills, who d them. **Fred. S. Barff.**

ie University College Kensington, W.,
April 9, 1878.

TIRE FASTENING.

]—I send a diagram and description of s patent tire fastening, which I have lately e. It has has given great satisfaction Caledonian and other railways.

veral other systems of tire fastening, it is for a tire to leave the wheel even if to several pieces, and I may mention that I an experimental waggon, which has run with the tires purposely cut into two, r, and five pieces. The following explana- the diagram will make the construction clear:—Fig. 1 is an elevation of the clip ring the two tongues upon it marked in ig. 2 gives a section of the ring in black. view of the ring showing the screw thread eriphery, also marked in black. Fig. 4 is section of rim, tire, and clip ring, showing in black. The fillet of the tire, Fig. 4, d at A for the purpose of receiving a tongue ponding size, which is formed in the wheel centre by recessing the rim at B. Two tongues, marked D and E respectively, are formed on one side of the clip ring by recessing it at C, and upon its outer circumference a screw thread is cut, indicated by the letter F. To receive this a corresponding thread is cut in the tire, and to receive the tongue, D, a groove is turned in the rim of the wheel centre; likewise for the tongue, E, a corresponding groove in the tire, as shown in the drawing, Fig. 4. In making up these wheels the centre is dropped into the tire after the latter has been slightly heated; the ring is then screwed into position, and thus the rim and tire are firmly bound together at every point throughout the entire circumference.

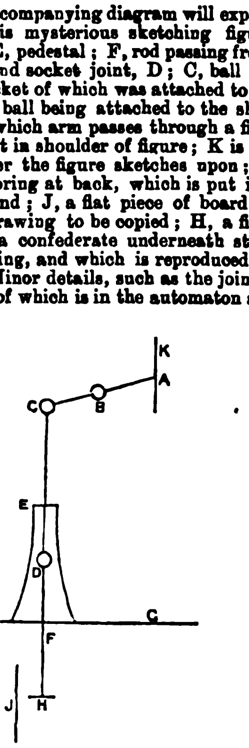


The advantage claimed for this fastening is, that it entirely does away with rivets through the tire and set screws, and dispenses with a number of attachments, such as bolts and nuts.

April 3rd. **C. E. S.**

ZOE.

[14213.]—The accompanying diagram will explain the working of this mysterious sketching figure. G, floor of stage; E, pedestal; F, rod passing freely through the ball and socket joint, D; C, ball and socket joint, the socket of which was attached to the end of rod, F, the ball being attached to the short or sketching arm, which arm passes through a fixed ball and socket joint in shoulder of figure; K is the sheet of curved paper the figure sketches upon; A, the pencil with a spring at back, which is put into the automaton's hand; J, a flat piece of board on which is laid the drawing to be copied; H, a fixed pencil with which a confederate underneath stage goes over the drawing, and which is reproduced by the figure at K. Minor details, such as the joining of the rod, F, part of which is in the automaton and part in pedestal, and which are joined after the figure is placed on the pedestal, and the arrangement for lifting the pencil from the paper when required need not be described, as a little ingenuity on the part of any one wishing to make such a figure will readily suggest them. **W. C. P.**



BRUSH MAKING.

[14214.]—I send this little account of brush-making, hoping that it may interest your readers. The wood, after being seasoned in the air for some little time, is cut into logs about 4ft. long. These, if very stout, are split down with wedges. One of the halves then goes to the large circular saw, which is about 3ft. in diameter, and is cut again, so making the log at last into quarters. The quarters are cut into octagon form. The pieces of wood, when cut so far, are about 3 or 4in. in diameter; they are then left out in the air for a few days in the dry. They are then brought to the second circular saw, which is about 2ft. 6in. in diameter, when they are cut across in lengths of about 14in. according to the kind of brush that they are intended for. These, after being piled up, are taken to the lathes, where they are truly centred and turned, and are afterwards bored with a centre bit chucked in the lathe. To make the hole for the handle. The brush head, in order to be bored at the proper angle, is brought up to the centre bit with a sliding table. But previously to this the double brush-head has to go again to the second circular saw to be cut in two, so making the one double head into two. These have now to have the sides of the edges bevelled off with the plane. The brush head now goes to the last-maker's knife, where the ends corresponding to the bevel taken off by the plane is also taken off, so as for there to be a bevel all round the edge of the brush head higher on the inside of the brush head than on the outside. The brush head now goes to the boring lathe. The man either sits or stands on a tripod stool; the lathe has a breastplate for the workers to lean against. The bit runs at a very high speed, and as he sits on the stool pulls the head towards him. After this the head has to go to another lathe, to have the hole drilled for the nail that is to hold the brush handle. The head now goes to what is called a pan-hand—that is a person that puts in the bristles or hairs, who sits before a large pan of boiling pitch, with a table scooped out for him to sit nearer the pan. There is an apron that is nailed to this table and is to be tied round the waist. They also sit on a stool, only much higher. The workers have a bundle of hairs and a lump of whiting near them, which is used to keep the pitch from sticking to their fingers. They now catch up a little bundle of the hair or bass, whichever it might happen to be. They now very quickly twist a piece of common string of about 4in. round the end of the little bundle of hair. It is twisted round very tightly, and, holding the end of the string by the thumb, they dip it in the pitch, which is then inserted into one of the holes made in the brush-head. Then, with a dexterous turn of the brush-head, holding the little bundle of hair in the hand quite still meanwhile, the hair is pushed in something like a spiral twist. After all the holes have been filled, it is then taken to a large pair of shears, where a wooden guide is inserted in the side of the brush. It is then cut, so as to make the hairs all of one height. The brush is then allowed to dry, and then the back is sand-papered off. The smaller kinds of brushes are made by women, who sit before a vice with the end of the jaws facing them. They then insert one of the corners of the pieces of wood which is already bored taper, and yet drilled right through, which is about 9in. long, and from 2 to 4in. in width, and ⅜in. in thickness. The women have a leather glove to come over the back and the inside of the hand, leaving the thumb and fingers free. This glove is for the left hand, which has a lot of brass wire wound round it. The end of the wire is first doubled up and inserted in one of the holes. A little bundle of hair is caught up with the right, and tapped on the bench to make the hairs level. The brass wire that has come through the hole is passed round the bundle of hair, and is then nearly pulled through, but cannot come through because of the taper hole, and so on until the brush is finished and the hair cut level by the same means as explained before. After that the back has to be put on, which is either blinded, nailed, or screwed. Blinded is where some fine brads are driven in, and the heads of the brads are filed wedge shape, and the back driven, on which previously a little glue has been smeared on the head and back of the brush. The machinery of the place with which I am acquainted consists of 8-horse engine and boiler. It has to drive four drilling and four turning lathes, also two circular saws, besides other appliances, as well as a lathe to carry emery wheels for sharpening the jaws.

Telescope Tele.

MOLECULAR VIBRATION THEORY OF THE TELEPHONE.

[14215.]—I have read with much interest Dr. Ferguson's valuable paper on the telephone, as well as the letters of your numerous correspondents on the subject. I cannot, however, bring myself to accept the molecular vibration theory, even on the authority of so good a physicist as Dr. Ferguson, not because it is in itself impossible, but because, to my mind, there is as yet no evidence to disprove the much simpler explanation of ordinary disc vibration. The difficulty to be faced is, I suppose, that the amplitude of the vibrations is too small to be detected by ordinary mechanical means—that, even with the discs in contact with the magnets, faint sounds may be heard, and that the magnet itself is capable of producing sounds without any disc whatever.

With regard to the imperceptibility of the vibration, I may note that Lord Rayleigh (R. S. Proc., XXVI., 248), has calculated the maximum amplitude of the sound-wave of a whistle in air at a distance where it was just distinctly audible, and found it less than a ten-millionth of a centimetre, while he gives it as his opinion that, on a still night, a sound of the same pitch (2,730 vib. per sec.), whose amplitude was only a hundred-millionth of a centimetre, would still be audible. These calculations were based on the amount of energy expended on producing the sound, and as it is highly improbable that the whole of this was consumed in producing sound alone, the estimate is certainly too high rather than too low. Now the telephonic vibrations may far exceed these figures, and yet be quite inappreciable by any means of measurement we can apply. All that is necessary is that the motion of the plate should be sufficiently sudden in proportion to its areas to expend its force in producing vibration instead of mere currents in the air; a condition which at once explains why powerful, but comparatively slow, undulations are incapable of sounding the telephone; and why the prongs of a tuning fork produce so little sound with their ample motion.

Of course, with very thick plates we must conceive the vibration as originating in the surface of the plate nearest the magnet, and propagated as a wave through the plate itself, so that the question of *molar* or *molecular* motion becomes in this case rather one of terms than of fact.

With regard to sounds produced by the magnet itself, I need only point out that Joule has shown that magnetisation increases the length of a bar by sometimes as much as 1-27,000th of its length—a motion amply sufficient to account for the sound-waves produced. **Henry R. Procter.**

THE ANHYDRIDES.

[14216.]—THE anhydrides are substances derived from acids by the abstraction of sufficient oxygen and hydrogen to form water—two molecules of a monobasic acid being required to form the corresponding anhydride, thus 2EtCOHO propionic acid = $(CEtO)_2O$ the anhydride, plus water OH_2.

The anhydrides of dibasic and tribasic acids contain the elements of these acids minus a molecule of water, thus succinic acid

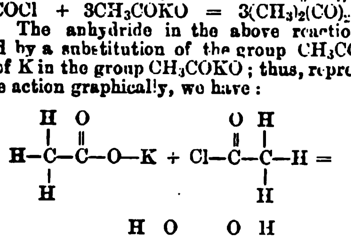
$$\left\{\begin{matrix}COHO\\C_2H_4\\COHO\end{matrix}\right. - OH_2 = \begin{matrix}CO\\C_2H_4O\\CO\end{matrix}$$

There are anhydrides of the monohydric monobasic acids $(C_nH_{2n} + {}_1)_2(CO)_2O$ and $(C_nH_{2n} - {}_7)_2(CO)_2O$, anhydrides of the dihydric monobasic acids $C_2H_{2n} + {}_1)_2(CO)_3$, and anhydrides of the dihydric dibasic acids $C_nH_{2n}(CO)_2O$. The anhydrides of the organic acids are similar in appearance, being oily bodies heavier than water, while the anhydrides of the inorganic acids are dissimilar, assuming various forms, solid and gaseous. The anhydrides of the organic acids unite with water to form the corresponding acids.

The anhydrides of the monohydric monobasic acids of the acetic and benzoic series are acetic $(CO)_2Me_2O$, propionic $(CO)_2Et_2O$, butyric $(CO)_2Pr_2O$, valeric $(CO)_2Bn_2O$, caproic $(CO)_2Hy_2O$, oenanthylic $(CO)_2Cp_2O$, benzoic $(CO)_2Ph_2O$, acetobenzoic $(CO)_2MePhO$, caprylic $(CO)_2Cy_2O$, pelargonic $(CO)_2Pe_2O$, and paleuitic $(CO)_2Pa_2O$. These anhydrides are produced by the action of the chloracids on the potassic salts of the acids. Phosphoric chloride, PCl_5, acting on acetic acid forms the oxychloride thus: $CH_3COHO + PCl_5 = CH_3COCl + POCl_3 + HCl$. Acetic anhydride is formed by the action of CH_3COCl on CH_3COKO, producing

$$\left\{\begin{matrix}COMe\\COMe\end{matrix}\right.O, \text{ or } (CO)_2\,(CH_3)_2O.$$

It may also be obtained by the action of phosphoric oxychloride or potassic acetate, thus: $POCl_3 + 6CH_3COKO = 3KCl + K_3PO_4 + 3(CH_3)_2(CO)_2O$. In this reaction the oxychloride of acetic acid is formed, when it immediately reacts on the excess of the potassic acetate, thus: $POCl_3 + 3CH_3COKO = 3CH_3COCl + K_3PO_4$, and $3CH_3COCl + 3CH_3COKO = 3(CH_3)_2(CO)_2O + 3KCl$. The anhydride in the above reactions is formed by a substitution of the group CH_3CO, instead of K in the group CH_3COKO; thus, representing the action graphically, we have:



the K and the Cl unite and form KCl, and the vacant bond of O is satisfied by that of C, as shown. Acetic anhydride is a colourless liquid having a high refractive power and the odour of acetic acid. It dissolves slowly in water, giving off heat, and forms acetic acid. When exposed to the air it absorbs moisture, thus:

$$\left\{\begin{matrix}C(CH_3)O\\O\\C(CH_3)O\end{matrix}\right. + OH_2 = 2CH_3COHO.$$

The anhydrides of the dihydric monobasic acids are formed by heating the acids; thus $C_2H_4HOCOHO$ gives off OH_2 and becomes $C_2H_4CO_2$, the lactide after being heated. Water dissolves this lactide slowly, forming the acid. Boiling alcohol also dissolves it, from which it crystallises on cooling into rhombic prisms. It absorbs ammonia, and is converted into an amide, thus: $C_2H_4CO_2 + NH_3 = C_2H_5CO_2NH_2$. The anhydrides of the dihydric dibasic acids are formed by the abstraction of water from the acid, either by substances having a strong affinity for water, or by heat: thus succinic acid, $C_2H_4(COHO)_2$, gives off OH_2, and becomes $C_2H_4\,(CO)_2O$, the anhydride. In the same way tartaric, malic, camphoric, and phthalic anhydrides may be obtained from the corresponding acids by heat or by distillation with phosphoric anhydride. When benzoyl chloride, C_6H_5COCl, acts on dry sodic succinate, a mixture of benzoic and succinic anhydrides is the result.

Mixed anhydrides may be obtained by using the benzoic, cuminic, &c., oxychlorides to decompose the dry salts of benzoic, salicylic, cinnamic, cuminic, &c., acids: thus, by decomposing dry sodic cinnamate with benzoyl chloride, benzo-cinnamic anhydride is obtained, thus—$C_8H_7CONaO + C_6H_5COCl = NaCl + \left\{\begin{matrix}C_6H_5\\C_8H_7\end{matrix}\right.(CO)_2O.$ **Hugh Clements.**

KENTISH RAGSTONES AND CRYSTALS.

[14217.]—NOTWITHSTANDING "G. J. H.'s" attack in letter 14155, p. 69, on myself, I am disposed to think that he has done good service by calling attention to my letter (13824, p. 428), challenging its accuracy in letter 13917, p. 503, where he made some statements about primary and secondary forms of crystals, with which I could not agree. These seeming erroneous ideas led me to suppose that crystallography was not "G. J. H.'s" forte, and induced me to ask him to explain more fully what he meant. In letter 14019, p. 579, he entered into a very full and lucid explanation, illustrating his remarks by reference to neatly executed figures. In this letter he dispelled any doubts I had previously entertained as to his abilities in this direction, for "G. J. H." was not sparing either in diagrams or in explanations, which were not always clear; but whether this was the fault of the figures or the composition it would be hard to discover. Certainly it is not so easy to render intelligible drawings of models on plane surfaces as the models themselves.

I did not complain of this haziness of description previously, simply because I wished to be as lenient as possible to a contributor who was so unsparing in his efforts to elucidate the mysteries of crystallography according to his topsy-turvy or cart-before-horse system.

In my original letter I stated that the crystals referred to were found in a quarry near Harrietsham (not Harrietshaw, as printed in error), seven miles along the road from Maidstone to Lenham, and that they were composed of calcic carbonate containing iron.

I observe that "Daghbert," in letter 14187, p. 96, states that his analysis coincides with mine, and that, without presuming to be a mineralogist, he believes that the crystals are the same as I stated. "Daghbert" gives a very accurate description of the appearance of the crystals, as well as the results obtained by various reagents. Although I verified the composition of these crystals by various organic, as well as inorganic, reagents, I did not in my original letter state the modus operandi or extent of that verification, merely because I did not care to be tedious. I stated the conclusions I had arrived at without giving any reasons for arriving at them. I did not know but that the readers of our valuable journal might be well acquainted with the crystals formed on such a well-known stone as the ragstone of Kent. However, it appears that these crystals are practically unknown, as J. H. Collins, an eminent authority on mineralogy, appears to know nothing about them. And "G. J. H.," who is certainly not a novice in his knowledge of minerals, as any one may see by a reference to his last production, is entirely at sea. Had I known that such was the case I should have entered more fully at first into the probable reasons why these crystals (if they do) should assume the form of the pentagonal dodecahedron. "G. J. H." in all his letters takes no notice whatever of the iron which I stated was present in the crystals. He quite gratuitously assumes that the crystals were calc spar, calcic carbonate pure and simple.

He confounds calcic carbonate with a compound containing iron. Now, I agree with him that it is utterly impossible for calcic carbonate to crystallise in the monometric system, yet I do not think the impossibility is quite so obvious when we consider that iron in the form of a sulphide does crystallise in that system. Then, since iron is present in the mineral, why should it not take the initiative, and form the pentagonal dodecahedron rather than the six-sided prism? Can "G. J. H." answer this question? Besides, why should these crystals not be pseudomorphs of calc spar after pyrites, as J. H. Collins suggested? Mr. Collins's theory accounts for the iron present, and for the monometric form, which is a favourite form for pyrites to assume. Now that "Daghbert" has sent Mr. Collins specimens, I hope he will determine what the crystals really are, and so end "G. J. H.'s" suspense. I observe from an article of Mr. Collins's, p. 81, that the pentagonal dodecahedron very closely resembles the six-sided prism. This close resemblance was referred to by me when I asked "G. J. H." could the six-sided prism become so modified as to be undistinguishable from the pentagonal dodecahedron. But "G. J. H." seemed to think that if they were exactly alike it would be easy to distinguish the one from the other. Well, if he lives in London, I shall be glad to show him the only specimen I have at Westminster, any day he names, and orally discuss the matter with him.

"G. J. H." accuses me of going off into collateral subjects in my letter of March 15. I have re-read that letter, and cannot observe any going off. I confined myself strictly to a discussion of the points raised in his previous letter, and "G. J. H." was the first to go off the lines of the controversy. Which of us introduced the crystallography? Who inserted diagrams and entered into tedious detail? Compare the length of his letters with mine, and judge which of us has studied brevity? And now, when he has got entangled in the meshes of crystallography, he thinks it is time to wind up the discussion. "G. J. H." has an inverted idea of crystallography, and has evaded the question I put to him as to primary and secondary forms. While thanking "G. J. H.," on behalf of the readers of the ENGLISH MECHANIC, for so much of his system as he has vouched to give us, I am still sorry that he did not give us a fuller account of it. **Hugh Clements.**

[14218.]—I HAVE received a letter from a correspondent of the ENGLISH MECHANIC ("Daghbert"), who sends me some crystals "of the same kind as Hugh Clements—he obtained his in my company." These crystals are undoubtedly ordinary calcite crystals, short hexagonal prisms with [illegible]hedral summits. They only simulate true pentagonal dodecahedrons, and have no crystallographic relation whatever to the cubical system.

J. H. Collins.

ERRATA.—KETONES, letter 14189, p. 96.—For dead, line 16, read "died"; for eltride, line 44, read "ethide," and for $(C_2H_4)^{11}$, line 46, read [illegible]—HUGH CLEMENTS.

ERRATA. — STRONG TELEPHONE. — In letter 14170, p. 93, the last word but five is a misprint. Instead of "my" it ought to be "a."—JOHN FORTUNE.

The Eddystone.—A Parliamentary paper rec[illegible] issued gives a report from the Corporation [illegible] Trinity-house to the Board of Trade on the practicability of removing the Eddystone rocks, instead of re-building the lighthouse thereon. The Elder Brethren state that the use of the light is not [illegible]fined to warning against an isolated danger, [illegible] the removal of which its functions would cease, [illegible] that the existence of that danger in affording [illegible] platform for the exhibition of a light has be[illegible] not merely the means of giving a good lead [illegible] Plymouth, but of determining position, and of [illegible]viding an essential link in that chain of [illegible] passing lights which, as defining a straight [illegible] up and down the English Channel, may be rega[illegible] as invaluable. Sir Richard Collinson observes [illegible] holding these views, it will be understood, the re[illegible] says, why the Elder Brethren have not given [illegible] very detailed consideration to the practicabili[illegible] removal; but it has been estimated that to [illegible] the safe minimum depth of seven fathoms, [illegible] would be expedient in the unmarked approach [illegible] such a naval station as Plymouth, it would [illegible] necessary to remove about 100,000 yards of [illegible] or 1,750,000 tons, to which would have to be [illegible] the blasting of an inner danger (that of the [illegible] Deeps, at present sufficiently indicated by the [illegible] house), computed at another 250,000 tons, [illegible] in all 2,000,000 tons of rock to be removed, at [illegible] which cannot be estimated approximately at [illegible] than £500,000. To restore the rigidity of the foun[illegible]dation of the existing lighthouse, and to do [illegible] work necessary to raise the light to 130ft. [illegible] high-water spring tides, Mr. Jas. N. Dou[illegible] engineer to the Trinity-house, estimates would [illegible] about £120,000. The cost of the proposed new lighthouse is not stated. The Eddystone Lighthouse may be considered one of the most important [illegible] marks in the English Channel. Situated as it is about nine miles from the land, it is not so liable to be involved in fogs which hang about our shores, and being only three miles within the fairway [illegible] ships bound up or down channel, it is of great va[illegible] to the mariner, especially in these days of steam navigation, when straight courses can be always [illegible] The outlying dangers are so close that it is only [illegible] the thickest fogs that the lighthouse is not [illegible] out in time to avoid the danger. It appears that though this rock is in the way of all vessels navigating the Channel, only two vessels are recorded to have been wrecked upon it, and that was in consequence of sheer carelessness.

REPLIES TO QUERIES.

*** *In their answers, Correspondents are re- ectfully requested to mention, in each instance, e title and number of the query asked.*

[31855.]—**Collodion Transfer (U.Q.).**—I have d very little experience in this style of work, but, so one else has answered the query I will try to so. "Struggling Photo" does not say what rt of the process he wants to know about, and it uld be tedious to describe the whole—so I will ly refer to the transfer of the print from the glass paper. If more information is wanted, let 3. P." ask again. Having got an enlarged transrency—which must be very thin and clear—I ow it to dry. Then a bit of fine paper, which has viously been coated with gelatine, is placed on back in a dish of warm water till moistened. e picture is then laid on a level place, collodion e up, and covered with water; then the gelatine per is carefully laid on, so as to avoid bubbles. e plate is then raised to drain the water off, the per gently rubbed down, and then left to dry. hen quite dry the edge of the paper is lifted with point of a knife, and pulled away from the ss, taking the collodion film with it. If there i y tendency to stick, the plate is put into cold ter for a short time, which helps in the removal. order that the picture may leave the plate with ater ease, it is a good plan to rub over the glass it of white beeswax, and then polish off as much the wax as possible before pouring on the lodion.—OCCASIONAL PHOTO.

31864.]—**The Woodbury Process (U.Q.).**—is process was well described and illustrated by . T. Bolas in one of the Cantor lectures delivered the Society of Arts a short time since, and will, ubtless, shortly be published.—BETULAN.

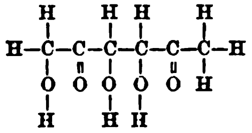
31873 and 32490.]—**Adjusting Rod.**—This tool for the purpose of assisting workmen in "adsting" the equal distribution of the mainspring's rce, in order that the "train" may be impelled ually throughout its entire action, in connection th which the fusee plays an important part, inasch as the mainspring's force is greatest when lly wound up, and least at the point when its tenon is ceasing. If "Ratchet" and "C. P." secure e adjusting-rod to the fusee square, having the rrel and fusee only in the frame, with the chain , and "set up" half a turn, and wind the chain the fusee until the fusee-cap abuts against the "stop," they will find that the adjusting rod will ve a tendency to return by the force of the mainring. The weights upon the rod are for the purpose of producing a certain amount of resistance against the mainspring force, and, by moving them upon the rod, producing a long or a short lever—i.e., distance from the fusee square—the rod will be taken back (the finger should guard the too-sudden motion of it). The result may be that the first turn may pass nicely and just, freely taking over the weight; the second may go over with greater force, the third stronger than the second, and the fourth even yet stronger. If such happens the spring requires letting down about three teeth of the ratchet, and if the reverse takes place the ratchet requires setting up a click or two. In each successive trial the weight of the rod will require re adjusting. To treat the subject more fully would require a special article upon the mainspring and its adjustment.—SECONDS' PRACTICAL WATCHMAKER.

[31899 and 32127.]—**Flute.**—Practise without the long F♮ key. I had Chas. Nicholson's flute in my hands some 30 years ago, and, if my memory serves me, it was not fitted with this long F♮ key. In his "School for the Flute," p. 48, he says: "I never use it." T. Cridland says: "The long C key is of no use to me." This may be a peculiarity. Avoid using oil or glycerine upon the pads of the keys; it will clog them, and obstruct your execution. The best lubricators are—careful study and hard practice.—OLD AMATEUR.

[31930.]—**Purfling Violins.**—The thickness of belly should be 3-16 of an inch, and grooved halfway through. The woods used for purfling are holly for the white, and dyed willow or holly for the black (ebony is too brittle), one black piece glued on each side of white. But do not attempt to make purfling unless you are quite up to such kind of work. It can be obtained at Dawkins's, Charterhouse-street, or Metzler's, Great Marlborough-street, or any large music warehouse, for 1s. 6d. the dozen strips, and two strips are enough for one violin. The ribs should be 1-16 of an inch thick, and equal throughout, and the side linings (of deal) the same, about ¼in. deep.—BOSH FAKER.

[31945.]—**Time of Fall to Sun.**—"W. G. P." may rest satisfied, I think, that his answer to this query, given on p. 44, and referred to on p. 95, is correct, as the formula he gives is demonstrated by Sir I. Newton in the first book of his "Principia," and also by Simpson in the first volume of his "Fluxions." Will "W. G. P.," or any correspondent, favour your readers with the space the earth would pass over during the first second, and also the space it would pass over during the last second of its wonderful journey, due regard being taken of the varying force of gravity?—JAMES SMITH.

[32103.]—**Organic Chemistry.**—The graphic formula, No. 1, page 20, should be written



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instead of the form there given. I did not observe the inaccuracy until it was pointed out by Mr. Grey, in letter 14162, page 71, in which he very clearly shows by graphic formula how the oxidation and hydrogenisation of the aldehydes may take place. I have no fault to find with his view in this respect. But with regard to substitution of the name of carbinol instead of alcohol I think it is useless, as well as highly inconvenient, to multiply the names by which the same compound may be known. For still retaining the popular term alcohol, by which the compounds referred to will be known for ages, we are not thereby prevented from entertaining the opinion that ethylic alcohol is formed from methylic alcohol by substituting one atom of hydrogen by methyl. Referring to the passage which Mr. Grey quoted from Dr. Frankland, letter 14127, page 42, I should like to know what are the facts referred to by him as tending to support his hypothesis. It appears to me that the facts are in an embryonic condition, and that neither Dr. Frankland nor any other chemist will ever discover any difference between methyl or ethyl hydride, simply because they are identically the same subtance. We might with equal reason expect some readers of the ENGLISH MECHANIC to discover that there was a difference between my friend, William John Grey, and "Beacon Lough." I dare say some of them will make that discovery, for they are naturally quick in detecting difference where none exist. Mr. Grey says in the same letter that the ortho, meta, and paradichlorbenzenes are known. From the graphic formulæ it is evident that only these three forms are capable of existence. I only know the boiling point of two varieties, and should like Mr. Grey to tell me that of the third, as well as give me any other information about it that he may possess, and oblige—HUGH CLEMENTS.

[32126.]—**Gas Pipes and Meters.**—"J. C. S. S." will, I hope, pardon me for having overlooked his query of the 15th ultimo, page 564. For lighting up a large building with 1,000 lights, averaging 5 cubic feet of gas per hour, should have a 3in. service pipe from main, which is $3^2 \times \cdot7854 = 7\cdot0686$ cubic inches. A 3in. service pipe, 30yds. from main, with a pressure of 1in. head of water, will deliver by calculation 5,324 cubic feet of gas per hour at the sp. gr. of ·420. As $\overset{P}{\sqrt{50}} = \cdot707 : \overset{Q}{3\cdot764} \times \overset{P}{1\cdot000} =$ 5,324 cubic feet. In regard to the 3in. outlet pipe for length, he must be guided by the size and number of branches taken from it, also either horizontal, ascending, or descending. In descending pressure is lost, and in ascending every 10ft. he gains a tenth of an inch pressure. A gas-meter for 1,000 lights ought to have 3½in. inlet and outlet pipes, as there is a diminution of pressure by the working of the meter. Meters made for a certain number of lights are calculated at 5 cubic feet per hour for each light.—F. R. WAITE.

[32181.]—**Bleaching Paper (U.Q.).**—Write with a solution of caustic potash; it will at once turn white on ordinary blue paper.—W. A. S.

[32234.]—**Filter.**—The price demanded is not out of the way, as charcoal is worth about 30s. a cwt. "Derfla" might take out the charcoal, wash it, and dry it before the fire; but it would be much better if he could lute it up in an iron box and re-burn it.—AQUA.

[32238.]—**Cement for Guttapercha Cells.**—Make the joints by melting the edges of the guttapercha. No cement wanted.—SIMPLE SIMON.

[32244.]—**Stench Closet.**—Yes; it could be made of cardboard, care being taken to cover all the joints air-tight.—J. T. M.

[32252.]—**Top Clack Sticking.**—All the answer that can be given is that the clack sticks probably by some expansion or contraction of the parts. Without a measured drawing it is impossible to give the reason, and perhaps not then.—SWINDON.

[32254.]—**Clockwork.**—"Almoho" can get the spring he desires made in Sheffield, or perhaps he can buy a second-hand one cheap of the gentleman who was going to employ springs for propelling tramcars. I think they could be seen "over the water," but I forget the address—it's some engineer's on the Surrey side.—TEMPLET.

[32255.]—**Magneto-Electric Machine.**—Magnets worn out, perhaps; but what sort of machine is it?—IN DOUBT.

[32266.]—**Patent Leather.**—See p. 387, Vol. XXIII. Also "Ure's Dictionary."—J. T. M.

[32277.]—**Diatoms.**—Adverting to the replies on pp. 73 and 74 respecting the diatom Aulacodiscus, figured by me on p. 22, I was under the impression that the diatom was A. Crux; but Mr. Kitton says it is not, and another correspondent (on p. 45) states he believes it to be identical with A. Kittoni. Mr. Kitton says it is "only a variety of A. Kittoni," and "Bolumbembo" says, "It was at first considered a very beautiful specimen of the A. Kittoni, but, differing in certain particulars, it received the name of A. Africanus." If Mr. Kitton would be so kind as to furnish me with some further remarks of his upon the subject, they would doubtless be acceptable to many of our readers. If the diatom referred to by me is not identical with A. Kittoni, then it would be interesting to know in what respect it differs from that diatom.—E. MAWE SMITH.

[32283.]—**Filters and Purifying Water.**—The only trustworthy method of purifying impure water is to distil it, for however effective a filter may be there are some impurities it cannot remove, while in a short time it becomes itself impure.—AQUA.

[32280.]—**What is a Meter?**—Many thanks to "A Fellow of the Royal Astronomical Society" for the information and advice contained in his letter (14087, Vol. XXVII., page 13), but as I happen to be in a land where the powers that be have recently been so unscientific and benighted as to cram the metric system down our throats, and jam it there by the lever of law, I think it is advisable to do as the boa constrictor does, and arrange things in the most convenient manner possible for bolting. My thanks are also due to "A Barrister," "C. B. M." and "Bex." I have derived much useful information from all their answers, but somehow I think I have not put my query in the proper shape. I wished to get the meter and kilogramme to correspond with the specific gravity of water at its maximum density (temperature 39·2° F.), as compared with water at 62° F. This, by the answers given, would be 1·0017404. A correspondent in the *Engineer* of the 15th of March, 1878, says that a cubic foot of water at 39·2° weighs 62·4521lb., making the specific gravity 1·002101. Nystrom's "Pocket Book" says that one cubic foot of water at 39° weighs 62·388055lb., and at 62° 62·321050lb. = specific gravity 1·001075. Thomson's "Cyclopædia of Chemistry" makes it 1·00034, and somewhere else (I cannot remember where) I have seen it put down at 1·00113. Which of all these results is the correct one? I have tried to find out for myself practically what it is. But alas! the weighing apparatus which I had at my command gave results that were nowhere.—AJUTO.

[32302.]—**Midland New Carriages and the Re-introduction of the Pullman Car Trains.**—In my answer, page 74, reply 32302, which was written upon the 14th of March, I mentioned the reintroduction of the Pullman car trains on the Midland Railway between London (St. Pancras) and Liverpool and Manchester. These trains ran regularly from Monday morning, the 11th, to Tuesday afternoon, the 19th of March, after which date the four Midland companies 1st and 3rd class cars upon each train were discontinued. The result of the 7½ days' working was very satisfactory to the Midland Company, but it had the effect of considerably reducing the receipts obtained by the Pullman Company's "drawing-room cars." As the Midland 1st class cars have been so much improved, and there was "no extra charge" for riding in them, the passengers naturally preferred to travel in the Midland cars, to paying the "Pullman extra charge." The Midland cars have, therefore, been discontinued, and they will not again be used until a further agreement is made with the Pullman Car Company, as required by the original contract.—C. E. S.

[32322.]—**Microscopical Field of View.**—Mr. Lancaster (on p. 74) has omitted to state that the rule should be held 10in. from the eye to obtain the proper size, for if it is nearer it is seen under a greater angle, and, consequently, the size will be too small. I hope he will excuse my pointing this out; but many have fallen into the same error.—ANXIOUS.

[32325.]—**Watch Query.**—"Richard John" should refer to my reply to query 31303; also to "The Watch, and How to Repair it," in the ENGLISH MECHANIC, No. 425, May 16th, 1873. If he follows the instructions there given his doubts will be dispelled.—SECONDS' PRACTICAL WATCHMAKER.

[32342.]—**Electric Bells.**—In diagram on p. 74 the engraver has omitted the line showing connection between No. 2 knob of switch and the small stud under, to which the wire of telephone, which is not connected to earth, is attached. This method of joining up bells, &c., is for stations at some distance from each other; if only a short line, "G. B. C.'s" sketch will be best. I find that ringing bell through telephone, as recommended by W. F. Knox and "Glatton," will somewhat injure the telephone plate.—C. O. G.

[32345.]—**Grain of Violin Wood.**—Putting aside the question of vibration common sense should point out the reason and necessity for building violins with the grain running longitudinally. "Fiddler" might as well ask why the planks of a boat, or his walking or umbrella sticks are not cut across the grain.—BOSH FAKER.

[32361.]—**Induction Coils.**—Many thanks for "Omega's" reply to my question. I was thinking of making a tube of paper strips prepared with paraffin. Would this suit as well as an ebonite tube? I don't see why the paper could not be wound directly on the primary, making the paper about 3-16in. or ¼in. thick. This would avoid any space being lost by the tube not being the exact size to fix primary. Should not the inner diameter of the paper discs be a little smaller than the coil of wire, to allow the inner ends to be joined, and the space filled with melted paraffin? If I made outer diameter of discs 4in., could you give me an idea of what space 3lb. of 36 wire would occupy? I know a great deal would depend on the insulation; say with two sheets of printing paper on each disc.—F. A. M.

[32366.]—**Organ Queries.**—In his reply, Mr. S. Taylor gives two references to "England's Organs"—"St. Stephen's, Walbrook," and "Hinckley Parish Church." The former I know nothing about, but Hinckley parish church cannot be considered one of England's since 1876, as it has been entirely rebuilt and enlarged by Messrs. Halmshaw and Son, of Birmingham, and several improvements made in it—viz., 16ft. pedal open, 16ft. pedal Bourdon, Bourdon in the swell, and all the swell stops taken down to C C (the swell originally was fiddle G); also new cornopean swell, and all new inside of organ. New Cremona in choir, new spotted metal trumpet in great, and all the organ re-voiced, so he can hardly consider that organ England's. The principal things left in the organ are the pipes in the great and choir (trumpet and Cremona excepted), great and choir soundboards, as the action, keys, pedals, and case, which is iron above the impost, and oak below, is entirely new; also the tone of the organ is very greatly improved by re-voicing. That is acknowledged by others that have heard and tried it as well as—H. Nosnevets.

[32371.]—**Speculum Testing.**—I confess I hesitate before I attempt to answer this question, as it is addressed to Mr. Purkis, to whose letters on speculum-working (which appeared in the Mechanic some years ago) I am indebted for a great deal of what I know on this subject. But as we have not had the pleasure of seeing anything from Mr. Purkis for a long time, and as I have been in a similar position to that in which "A Country Reader" now is, I overcome my hesitation. I think a method pointed out by Mr. Purkis (I believe it was introduced by him) will suit the present inquirer. Make a square rod of wood about ¾in. thick and an inch or two longer than the diameter of the speculum; next get a sheet of coarse sand-paper, lay this over the surface of the speculum, rough side up, and take the wooden rod and scour it lengthways on the sand-paper until it has assumed the same curve as the mirror. This ought to have been done immediately after the rough grinding was completed. If the mirror is now polished it will require care to prevent scratching. Upon the curved side of the rod glue a thin card the same length as the rod and half an inch wider than the minor axis of the diagonal plane proposed to be used. Each side of the card must be cut perfectly straight and parallel with the other. The card is the actual test, the wood is simply to hold it in position flat to the surface of the speculum. Now mount the speculum either in its tube or temporarily. After being adjusted, fit an eyepiece giving a power of 200 or more, and direct the speculum to a bright star, and focus as usual for ordinary observation. Bring the star into the centre of the field, place the test rod perpendicularly across the centre of the mirror, the slip of card being next the glass and in close contact with it; then push in the eyepiece a trifle, until the star is enlarged to a broad luminous disc about ½ or ¼ the diameter of the field of the eyepiece. The image of the test-rod will now be seen as a broad black band across the centre of the star disc. If the speculum is parabolical the test-rod will appear to have its sides exactly straight and parallel to each other; if spherical, the rod will seem wider in the middle; and if hyperbolical, narrower in the middle and wider at the extremities. Various tests have appeared in these columns from time to time; if desired, I could give the numbers which contain them. I may add that if it is not convenient to put the speculum into a tube it may be tested by fitting it up temporarily on a board.—Ecnal.

[32378.]—**Trapeze Bar.**—Use two bolts, with eyes on one end, and a nut on the other; fix to rafters. Bar to be about 30in. long; usually made of ash, with ½in. steel rod tapped and nutted on both ends. Two pieces of iron, with two holes in each—one for the rope, and the other to be slipped on the end of bar, and nut screwed up (it must be flat iron).—Telescope Tele.

[32380.]—**Krupp v. Royal Arsenal.**—The number of workmen employed in the steel foundries is 10,500, those in the mines and the iron forges amounting to 5,000. In the steel factory there are 1,648 furnaces of various kinds in full blast, 208 steam boilers, 77 steam-hammers, 294 steam-engines of from 1 to 2,000 horse-power, and 1,083 other machines. In the year 1875 the manufactory consumed 612,000 tons of coal, 4,500,000 cubic metres of water, 7,500,000 cubic metres of gas, supplying 22,482 burners. The means of transport and communication comprise 25 miles of railway, with 14 engines and 537 trucks; 11 miles of narrow-gauge rails, with 10 engines, 210 trucks, 80 horses, and 214 waggons, and 38 miles of telegraphic wires. The number of men employed is 16,200, and they have 3,277 dwelling-houses. The food supply department comprises an hotel, 3 breweries, a mineral water factory, a butcher's shop, and a bakehouse with a steam mill for grinding the corn; the bakehouse turns out 200 tons of bread in a month, and the total monthly receipts for the whole supply department are £13,500. The mining department sees to the working of the 414 shafts which are being worked in Germany, exclusive of those belonging to the Krupp Company in the North of Spain, the minerals from which latter place are conveyed in four steamers, with a total tonnage of 1,700 tons. The practice-ground for the guns made at Essen is at Dülmen, and is nearly five miles long.—E. W., Sutton.

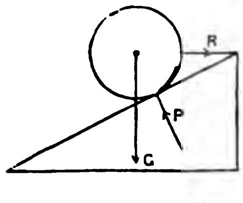
[32392.]—**Netting.**—Buy some old fishing-nets, sometimes to be had of the fishermen, and also to be had at some ironmongers; 1d. the square yard is about the price.—Telescope Tele.

[32397.]—**Stuffing Furniture.**—Tack, and stretch tightly from side to side of chair frame, three pieces of webbing; then do the same from back to front, only interlace with the cross pieces—one over, then one under, and one over again—stretch and tack. Begin the next piece of webbing as before—only, instead of going over, go under, then over, and under; tack and stretch as before. After the webbing comes the canvas. Stretch and tack nicely all round; afterwards place the stuffing—horsehair, wool, or whatever it is—round the seat of the chair, fill in the centre, cover again with canvas, tack down, and sew round the edge of canvas, through hair and all. Put cover on, tack round with small tacks, put in buttons or tufts, and then finish off with putting braid all round, nailing with gilt nails.—Telescope Tele.

[32398.]—**Circulation of Steam.**—The system of dry heating with steam, returning the condensed water to the same boiler that generates it, works well if properly arranged. The pipes must be laid so as to fall to the boiler, exactly as if a drain-pipe was being laid. The return pipe works best into steam space of steam boiler, contrary to some theories. As the pipes when started will be full of air, a small cock fixed at the highest point to let out the air whenever necessary is indispensable. If Mr. Carter attends to the above suggestions he will have the most economical arrangement, and will consume far less steam than the antiquated plans of "Chelt" and "Omega." If he does not succeed it may be the ¾in. pipe. I would prefer 1in.; in fact, the larger the pipes the better it will work, as there is no circulation similar to the hot-water plans. It is simply a steam atmosphere, which, being cooled down by radiation, condenses into water, which water runs back into the boiler if the pipes fall towards it.—Richard Gatenby, Manchester.

[32407.]—**L. and S. W. Bogie (Tender) Engines.**—In reply to "Short Stroke" I beg to say that the length of wheel base of these engines is as follows—namely, wheel base of bogie wheels 6ft. 6in., distance between centre of driving wheel and centre of nearest bogie wheel, 7ft.; length of boiler barrel, 10ft. 4in.; diameter of boiler barrel, 4ft. 2in. outside; length of tubes, 11ft.; length of fire-box outside, 6ft. 6in.; width of firebox outside, 3ft. 10½in.; size of steam ports, 12½ × 1½in. The steam brake arrangement consists of a cylinder fixed at each side of the engine frame between the driving and trailing wheels, and fitted with a piston and rod connected to a crosshead and lever, to which the longer ends of bent levers, slung to the backs of the nearer brake blocks, are connected by links. The shorter ends of the bent levers are connected to the brake blocks upon the opposite sides of the driving and trailing wheels. The brake blocks are carried by wrought-iron hangers slung from pins attached to the engine frame. Copper pipes from the brake cylinders lead to the back of the fire-box, and are there connected to a cock, by which the action of the brake can be regulated, and the steam discharged into the cistern under the foot-plate after being used. There is a screw adjustment for taking up the wear of the front and hind brake blocks.—The New Clock.

[32420.]—**Science Examination.**—(1.) Draw two lines at right angles to one another, making them 30 and 40 units long respectively, complete the parallelogram, then the diagonal of the figure will be as many units long as the magnitude of their resultant is in lb.—viz., = 50 units of length = 50lb. (2.) I should say the forces acting on the cylinder would be the reaction of string acting in direction,



(R) in a horizontal direction, the force of gravity (G) acting perpendicularly downwards through the centre of the cylinder, and the reaction of the plane (P) acting upwards at right angles to the inclination of plane. (3.) Let (f) = acceleration in feet per second, (s) = space described in a certain (t) number of seconds. Then $s = \frac{1}{2} f t^2$ ∴ 10ft. = $\frac{1}{2} f \times 1^2$ ∴ f = 20ft. per second. Then space described in 2 seconds = $\frac{1}{2} f t^2 = 10 \times 4 = 40$ft.—B. Angwin.

[32427.]—**Acoustics.**—To Mr. W. J. Lancaster.—About the simplest and best method of exhibiting Chladni's figures is the following:—Make a mahogany stand, with a base of 5 to 6in. diameter, and from its centre a round pillar, tapering from 2in. diameter at the bottom to 1in. at the top. This must be bored, and have a thread in to take a screw about ¼in. to ⅜in. diameter. This is to hold the plate on to pillar. Now, the plate should be made of glass, about ¼in. thick, and bored in the centre screw to go through into centre pillar, it tightly down in centre. The plate wou be movable, and I would recommend three plates—one a round glass one, meter, and another glass one, 9in. sq plate of brass, about 1-10th of an inch these you will obtain all the figures W. J. Lancaster.

[32435.]—**Boiler Feed.**—I see that given an explanation of this increase o but has not said how this increase is o opinion is this:—Say the steam pressur is = to 6 atmospheres; "now I think in Ever's work on 'Steam'" that pressures occupies 321 times the space t it was generated from did. Now w 1 atmosphere is capable of raising 32ft column, in a vacuum, and the pressu the boiler is 5 atmospheres above the pressure; therefore it would force water 32 × 5 = 160ft. against the pressure. Again, it would raise a colu 32 × 5 × 321 = 51,360ft. against the pressure. By the law of falling bodie gravity × 2 × space = $v^2 = 2gs$; ∴ with which a jet of water issues from boiler = $\sqrt{160 \times 32 \times 2}$ft. per sec and the velocity of a jet of steam = $\sqrt{51}$ = 1,815·7 ft. per second, taking grav you see from this that the steam is orifice with nearly 18 times the velocity and they use this surplus velocity in feed-water in the boiler.—B. Angwin.

[32442.]—**Heating Glue.**—If "C. proper glue-pot—that is, one pot cont and another the glue, inside of the f uses good glue, with a proper quantity there can be no disagreeable smell. I the glue? I fear he does.—Ecnal.

[32444.]—**Fluid for Tubes of Spi** Generally spirits of wine coloured; or, spirits quite colourless, as dyes soon bl Lancaster.

[32448.]—**Hens and Chickens.**— possible to keep hens in a house of g with plenty of air; but they will not la well to be profitable. However, if one deal of kitchen scraps, which would thrown away, they may be utilised by It will only require a little to be exp purchase of other food to make up wh in the house scraps. Care should be tak ing them properly with water, and in house clean and sweet; also in giving t green food in the shape of vegetables fro or grassy turf from the road-side, as p will always be certain of having your e nice, which will compensate for the t with them. Hens naturally require run, and the nearer this condition is ap better. The best and easiest way to ha is the natural way—viz., by a brood her this can be done artificially by means of or some similar contrivance, but t constant and great care, as a devia certain temperature, I believe 102°, eve time, will ruin all, besides, a brood hen no more room than an incubator.—Ec

[32451.]—**Telephone.**—A double lin answer every purpose both for teleph bell. You would require a simple swit bell out of circuit when wire is wanted f The telephone advertised at 5s. ought n because the telephone is a patent, and not be pirated; and besides if you buy t them you are liable to a royalty.— caster.

[32454.]—**Taking Burrs out of Wat** —After burrs are formed a screw ferru to the arbour of the wheel, placed in th while in motion, by means of a drill- thin piece of whalebone, charged with "red stuff," is pressed against the teeth, burrs are removed, and the teeth beco Removing roller and cannon-pinion arranged in the article next to appe Watch, and How to Repair It." L wheels are glossed by means of a polis grain-tin, charged with "red stuff," the placed upon a clean good cork.—Seco tical Watchmaker.

[32456.]—**Finder.**—The best finder telescope should be made up of an achrom lens 1½in. diameter and 16in. focus. T should be made of two planos, each 1½in the one near eye should be ½in. diamet lens being ¾in. diameter, and they must 1in. apart, convex surfaces towards eac the focus of the two lenses a diaphragm should be placed with fine cross hairs web or unspun silk.—W. J. Lancaster.

[32462.]—**Achromatic Objective** Pearce asks for comparative value of En and French combinations. From my e them I should say the former "good," good "for nothing." He would find the powers at present to be 1½, ¾, and ½in. future time, when he has learnt how to add a ¼ or ⅕. With 3 eyepieces, A, B, an then have a good range of powers. I wo the B eyepiece on the Kelner principle.

e course of about 17 years I have had ıry sliding, magnetic, and mechanical find the latter far preferable to any, rotatory: see "Dr. Carpenter on the ınd its Revelations."—G. M. J. N.

ıchromatic Objectives.—An English s may possess an equal definition with quarter, but the lens will have a much le, and the French triplets will have a e still; but for all ordinary work the s work as well as English ones, but for n of diatoms and for delicate investiga- ound lens is far preferable. A rack- ade is very useful, but a good ball and is quite as good in the hands of a . J. LANCASTER.

Telescope.—There is evidently a part ee lost—the part we call the erector. It the second tube, and should be made up es, the one nearest object-lens being and one nearest eye end 1¼in. focus. epiece should also have two lenses, 1in. cus. Send fuller particulars of the tele- will try to help you to make it useable. NCASTER.

Kangaroo Skins.—They are used for ves and also boot uppers, and, when ssed, are beautifully soft for tender feet. useless for an outsider to attempt to do k.—TELESCOPE TELE.

Kangaroo Skins.—Any tanner and dress your kangaroo skins and make leather very suitable for light boots or y make a nice soft leather, very pleasant would be absurd for any, except in the empt to do them himself. It requires pparatus, and the knowledge of two les.—TANNER AND CURRIER.

Legal.—If "Capias" has been in pos- receipt of the rents of the property o him for more than 20 years, and has acknowledgment in writing of the title or right to redeem, either to the or to some person claiming his estate, or of such mortgagor or person, then he the absolute owner of the property, and no liability to subsequent mortgagees. he important question is, therefore, one dgment or no acknowledgment, and to actory answer cannot be given without dge of "Capias's" acts regarding the his cannot be gone into in your columns. pears from his question he has a *primâ* —SPERANS, Lincoln's Inn.

Longitude. — I doubt whether the uld find longitude with any degree of or in 1714 the British Government offered he person who could determine the longi- 1° or 69 miles.—R. T. A. INNES.

Inflammation of the Windpipe.— will meet your difficulty regarding cold s a splendid climate for sufferers from y. Special attention to diet is the only h sufferings. Tea and coffee should not less for a change. Oil your chest and cocoa-nut oil daily. Use yourself, if tepid baths last thing at night. Do not medicine (the less the better); use flesh kin after bath, and when in bed take half f milk, as hot as possible, with a half- of fresh butter in it, once or twice a think in a few months your health will Do not take much food at a time, but ten. Scotch porridge, made of oatmeal, ficial for breakfast. You want natural han rich living.—CHEMICUS.

elephone.—The soft iron core is of ever, the end of the magnet being just hout it. The wire should, of course, be nd be wound on a bobbin about 1in. in nd just thick enough to keep together. the wire on to bobbin, about a quarter of each bobbin.—W. J. LANCASTER.

Photographic.—There have been many h special reference to the recovery of r and gold in back numbers, and you will by looking through them than from one V. J. LANCASTER.

Building Societies.—Before the Act uilding society, it authorised by its rules, st surplus moneys in the purchase of real unless the late Act has altered this the ins. The 37th section is the one that question on this head. By it building e empowered to buy buildings for offices, which to build offices only. I do not this clause, which gives a power of he capital moneys of the society for such part from the provisions of the rules, would take away by implication (on the sugges- by making certain purchases legal it ose not referred to) the right to invest neys in real estate. Answering, therefore, Member's" specific question, I should say opinion (1), it is a legal transaction for society to purchase property out of its ney if sanctioned by the rules. (2) Such is not made illegal by section 37 of the ocieties Act, 1874. (3) It ought certainly amongst the "effects" in the annual et, and the rents should also appear there receipts.—SPERANS, Lincoln's Inn.

[32480.]—**Pianoforte Playing.**—To "AMATEUR MUSICIAN."—After reading your query I fixed the little finger of my right hand so that I could not use it, and sat down to the piano. I found I could play in all keys, scales, octave passages, and arpeggios, the flat keys being easier than the sharp ones. In octave passages I used thumb and third finger easily. In arpeggios extending over 2 octaves I greatly missed the little finger. In scale passages in flat keys the loss was not felt at all, either ascending or descending, but in ascending sharp keys I had to slide the third finger off the leading note on to the tonic in every second octave, and in descending I found 3, 2, 1, X, repeated very comfortably. I then took some of Schumann's moderately easy pieces, and found I got on very well; but on trying hymn tunes I found it necessary to "fudge" the harmonics—*i.e.*, change the position of the parts, where the bass and tenor are not playable by the left hand, and a wide stretch exists between tenor and treble. As a crucial test I took Bach's 7th prelude, and Beethoven's "Moonlight" sonata (No. 14), and, as I anticipated, found it impossible to play them without the little finger. Your problem, then, is this: I, after a lifetime of practice, and with a knowledge of harmony, can play, without the little finger, up to "moderately difficult" music. You are a beginner, and, presumably, lack a knowledge of fingering. Can you, by dint of study and practice, become a moderate performer on the pianoforte? It is quite certain you will never be able to accomplish the works of the masters, or to play anything abounding in chords, and this would be very disappointing in the end. Bacon says "There is no stand or impediment in the wit but may be wrought out by fit studies." But your impediment is, unfortunately, a physical one, and certainly a very serious drawback to pianoforte-playing. As you are so fond of music why not take to an instrument of the violin family—say the viola? This is a beautiful instrument, and good players are always in request where there is an orchestra; it needs no entire right hand (indeed, I have met with good fiddlers quite destitute of a right hand), and, in the grasp of a good player it is a charming duet instrument with the pianoforte, vide "Kalliwoda." For examination purposes I have pleasure in recommending you "A Concise History of Music," by Bonavia Hunt, price, 3s. 6d., published by Bell and Sons, York-street, Covent-garden.—NE SUTOR.

[32483.]—**Mercury.**—Mercury being so heavy, breaks glass or earthenware vessels in transit, hence something stronger and more difficult of breakage must be employed, and nothing is better than iron for this purpose.—W. J. LANCASTER.

[32488.]—**Driving Belt.**—I think a broad leather belt is best.—DORSET MEMBER A.M.S. and M.S.A.

[32489.] — **Photo-Zincography.** — Prepare the polished zinc plate by rubbing it with flour of emery, so as to give it a "tooth" to enable it to retain the sensitising solution, which is prepared as follows:—Soak ¼oz. of gelatine (use Nelson's best, or else clarify it yourself with white of egg) in 1oz. of cold water until it thoroughly swells, then add 3oz. of boiling water to dissolve it. When dissolved pour in 2oz. of a 10 per cent. solution of pure bichromate of potash. To mix it well strain it through flannel, and finally through cotton wool to eliminate air-bubbles—those fatal obstacles to success. Coat the zinc plate with it, pour plenty on, spread it about with the edge of a glass plate, and give it a rapid rotary motion by means of a turn-table or other convenient arrangement, then put it in an inclined position in a warm place to dry, which it will probably do in from three to six hours. When ready print it under a clear well-developed negative, until all the detail is shown on the plate as a faint brown design on a dark-yellow ground. After exposure coat the surface evenly with lithographic ink by means of a roller, then soak it in cold water, and gradually increase the temperature to about 100° F., when the greater part of the ink will detach itself from the clear spaces and float away. Now put the plate into another dish containing water of the same heat, and proceed to develop more completely by lightly rubbing the remaining ink from the finer spaces with a piece of sponge. When all the detail is clearly visible rinse the plate well under the tap, and allow to dry. When quite dry warm it gently to "set" the ink. For any further information see page 74 of the same number your query appeared in. —ERNEST A. NUTH.

[32491.] — **Polishing Pivots and Pinions.**—"Anxious Inquirer" wishes information as to the means of acquiring a knowledge of pivoting and facing a pinion. If he will refer to the ENGLISH MECHANIC, Nos. 448 and 452, Vol. XVII., he will find in the former all he requires concerning pivoting, and in the latter how to be enabled to "face" pinions.—SECONDS' PRACTICAL WATCHMAKER.

[32493.] — **Momentum.** — The momentum of a body = its mass × velocity. Let v = velocity, g = accelerative effect of gravity, and s = feet per second. $v^2 = 2gs$; $\therefore$ the velocity generated in falling 15ft. = $\sqrt{64 \times 15} = 30{\cdot}98$ft. per second. Weight in lbs. = $112 \times 10 = 1{,}120$lb.; $\therefore$ the momentum = $1{,}120 \times 30{\cdot}98 = 34{,}697{\cdot}6$ absolute units. (2nd part.) Weight in lb. of the mass = $112 \times 15 = 1{,}680$, then the velocity required = $34{,}697{\cdot}6 \div 1{,}680 = 20{\cdot}65$ ft. per sec. Now, $v^2 = 2gs = 20{\cdot}65^2 = 64s$; $\therefore s = 6{\cdot}6628$ feet.—B. ANGWIN.

[32496.]—**Eyesight.**—I should like you to try a few experiments with your eyes. First, look at this answer 18in. away with your left eye, if you can read it easily then move the paper further away and note the distance when it is just unreadable, now bring the paper towards your eye until it is just within a readable distance. Calling the former the "far point" and the latter the "near point," give me figures for these; then do same with right eye, being particular to the least difference, far or near, and finally do the same with both eyes, and write another query, with these particulars, and I will tell you what to do.—W. J. LANCASTER.

[32497.]—**Mathematical Instrument.**—Remove the ring which retains the glass in place, then take glass out and lift needle off pivot; then, with a pair of pliers, remove the pivot, and sharpen it. See that you make it quite round and well sharpened. Then, put needle on, and glass and ring in position, and move the needle several degrees, and note whether it comes back to same point every time. If so, it will be all right; if not, the centre in needle will have to be drilled, or if there is an agate centre, it will have to be removed, and a new one fitted in.—W. J. LANCASTER.

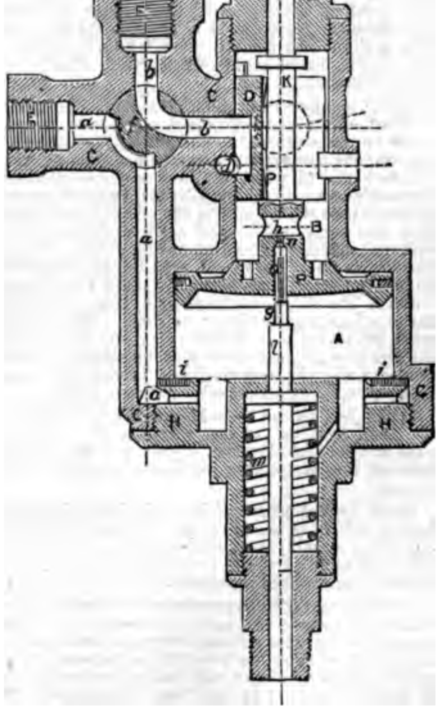
[32504.]—**Gong Buzzing.**—Is your gong cracked? If so, I think you can remedy the buzzing either by widening the crack with a file, or by soldering it up. —ENDYMION.

[32506 and 32520.]—**Emery Wheels.**—Use them dry. If your tool gets too warm just dip it into water. What kind of wheel does "John" use? Mine is Bessemer's patent, and goes by steam. Drive a union wheel, 1in. × 12in. diameter, at 900 revolutions per minute, run it towards you, don't press too hard, keep your bearings well oiled unless they are metaline, and don't stand just behind.—DORSET MEMBER A.M.S. and M.S.A.

[32508.]—**Batteries.**—Neither the bisulphate of mercury nor the bichromate of potash cells are any use for electric bells. The mercury cells may be made so that the carbons and zincs can be lifted out easily, or they may be left in when out of circuit. About the best form of simple arrangement I know of is a little device of my own. It is simply a cell containing a solution of bichromate of potash and sulphuric acid, in regular proportions. The cell is about 4in. long and 2in. deep, and about 1¼in. wide, the two sides being lined with carbon. The cell is in the lower part of a box, and at the back of the box is a board, hinged, and having a spring to keep it up. To the centre of this the zinc plate is attached, and can be lowered into the cell in a moment, so that the bell may be rung at any time, and then the board is loosed, and, of course, rises and carries the zinc out of the cell, and the telephone circuit is then complete. Thus: Zinc in cell gives bell, out of cell gives telephone.—W. J. LANCASTER.

[32509.]—**Magnitude of Lunar Eclipse.**—As this calculation would take up some space and a diagram, the best "Amateur" can do is to get "Loomis' Astronomy" (New York), or the Appendix to the *Nautical Almanac* for 1836 (Murray, London). Should he find any difficulty I would willing calculate an example for him.—R. T. A. INNES.

[32512.]—**Westinghouse Brake.**—This valve consists of a casting *c c c c*, in which are two cylinders, A and B, and also a four-way cock, *f*. It is connected to the main-pipe by a pipe from E, and to the brake cylinder by a pipe from F. The connection



with the auxiliary reservoir is shown by the dotted circle. The bottom of the cylinder, A, is closed by the cover, H, in which a spindle, *l*, is placed, being kept in position by the spring, *m*. A piston, P, works in the cylinder, A. Communication is made between the cylinders, A and B, by the passage, *g n h*, which, when the piston is forced downwards, is closed by the spindle, *l*; the passage, *n*, being kept free from dirt by the needle, *o*, which is fixed to the spindle, *l*. At the top of the piston is a rod, *k*, by which the slide-valve, D, is worked. The cylinder, B, is put in connection with the atmosphere by the opening, *d*. A plug, L, closes the top of cylinder, B, and also serves as a guide to the valve-rod, *k*. The valve, D, is kept up to its work by the spring, *p*, which rests against the valve spindle, *k*. The action of the valve is as follows: The air (compressed) enters from the main pipe at E, passes through the four-way cock, *f*, and by way of the passage, *a*, enters the cylinder, A. The piston, *p*, is forced upward, and also the slide-valve, D, putting the brake cylinder in communication with the atmosphere through the port, *d*. Communication is also made between the two cylinders, A and B, by the passage, *g*, being opened, which permits the compressed air to fill the auxiliary reservoir. The air continues to flow in until the pressure in the main-pipe, cylinders A and B, and auxiliary reservoir is equal. The diagram represents the valve in this position. When it is required to apply the brakes the air in the main-pipe is allowed to escape, whereupon the piston, *p*, descends, for the reason that the pressure in the cylinder, B, is greater than in A; the slide-valve is also moved downwards, shutting off the communication of the brake cylinder with the atmosphere, and putting the brake cylinder in communication with the auxiliary reservoir, whereupon the brake is applied. It is obvious that in the event of anything going wrong with the valves the four-way cock may be turned so as to put the brake cylinder in communication with the main-pipe, thus converting the brake into a simple compressed air brake.—T. G. S.

[32513.]—**Enlarging Carte-de-Visites.**—You want an achromatic lens with large aperture and short focus, and you also require a good light on the carte so as to be easily seen when enlarged full size. The best way to enlarge them is to get transparencies and enlarge them with the lantern. This is the best arrangement you can have. You can then get the picture directly on the canvas.—W. J. LANCASTER.

[32516.]—**G. E. Engines.**—The engines running between Yarmouth and Lowestoft are of several classes—252 and 253, Gooch's tanks, 15in. by 22in., and 6ft. 6in. drivers; outside cylinders; 328 and 356, Sinclair's 4 coupled tender engines, 17in. by 24in., 6ft. 1in. drivers; 150, 153, and 157, Sinclair's tanks, 140 class. There are two fine 4 coupled express engines, 17in. by 24in., 6ft. 3in. driving, running between Yarmouth and London—No. 406 and 416. No. 406 is fitted with Westinghouse brake, and 416 with the vacuum. The Blackwall engines have outside cylinders, 14in. by 20in., and 5ft. 6in. drivers, built by Jones and Potts, many years ago.—A. J., Stratford.

[32517.]—**To Watch Jobbers.**—If "Young Sub." has drilled the pinion deep enough, by turning or filing (with a very smooth file) a piece of tempered steel straight—or but slightly tapered—which passes into the hole drilled about half its depth; cut off the required length, make both ends flat, place the pinion upon a stake in the vice, and with a slight but decided "tap" by a hammer the plug ought to be secure.—SECONDS' PRACTICAL WATCHMAKER.

[32518.]—**Spectroscope Prisms.**—To MR. LANCASTER.—You had better get a piece of glass as dense as you can have it, and of a length suitable to cut up into five prisms; then before cutting up it will be better to polish the hind surfaces all along. One surface need not be polished, but left merely ground; then when polished the prism should be cut into five equal parts, and then cemented in an inverted condition, one next to the other. Thus, if three have their bases level, then the other two will be inverted and placed between 1 and 3 and between 3 and 5. The slit should be made of two knife edges, the one fixed and the other movable. This is best made with two pins and a spring working against the two pins; then a screw must be attached so that it moves the slit backwards and forwards in a perfectly parallel direction.—W. J. LANCASTER.

[32521.]—**Uranus.**—On March 2nd, 1878, the R.A. 9h. 57m. 14·47sec., and as ν Leonis' R A. on same date was 9h. 51m. 42·09sec., it was very likely a mistake of the compositor putting γ for ν.—R. T. A. INNES.

[32527.]—**Telephone.**—It will be better for you to have a switch, so that you can take the bell current out of the circuit; then you will not interfere with the telephones. I would strongly advise you to take the telephones out of the circuit.—W. J. LANCASTER.

[32528.]—**To Photographers.**—Dubroni's apparatus is not a new one, and, unfortunately, it is not a good one, because although very portable, still it is very difficult to get a good picture, because of the mixing of the developer with the bath solution, even if only a spot or two has been left behind. The method of working is to first focus, then remove the ground glass, and clean a plate same size, then pour on collodion, and place at the back of glass rim, having first poured a small quantity of bath solution into glass interior. Now fasten back of camera, and turn the camera so that the lens is on the top; allow it to remain in this position for two minutes, occasionally moving it a little, then place camera in position, and take the photo, then remove the bath solution by means of the indiarubber ball and tube, and swill gently the glass chamber with clean water; then introduce the developing solution, and watch until sufficiently developed, and wash well; then remove plate and fix.—W. J. LANCASTER.

[32530.]—**Hebrew.**—Pronunciation varies with Jews in different parts of the world. I acquired syllabication and reading many years ago from an Oriental Jew in India. About the first inquiry, taking, for example, the word for hook, I should pronounce it *vav*—the *a* having the Continental sound, as in father. Again, the word for alive, or life, would be pronounced *khai*, giving both vowels the Continental sounds (*i* like *ee*). Beginners are usually rather puzzled to distinguish between *kamets* and *kamets-khateph*. In the cases mentioned by "W. G.," the infinitive of *katal* (in *kal*), with suffix pronoun 2 sing. sem., is pronounced *kot-tek* (as "W. G." rightly thinks). The same infinitive, with suffix pronoun 1st person plural, is *kot-te-nu*, with accent on the penultimate. So the infinitive with pronoun 2 sing. mas. is *kot-l'ka* (the other form, *k'tol-ka*). I advise "W. G." to procure two little books by my friend, the late Dr. Tregelles—"Heads of Hebrew Grammar," and "Hebrew Reading Lessons" (Messrs. Bagster). They will greatly, I think, smooth his progress; and then the grammar of Gesenius will become of great use to him.—G. J. W.

[32531.]—**Chemical Bath for Preserving Canned Meat.**—Chloride of calcium would be about the best if you want to raise the temperature above 212°. But I do not see the necessity for so raising it, and if you raise it much above that the cans won't stand it. 212° is quite sufficient to cook the meat, and will create a sufficient pressure in the cans to blow out all the air—that is, supposing you lose no time over your work. It matters very little whether the tins are covered, as of course they are closed. They will get hotter if they are covered, and it depends on what sort of apparatus you use. I should think the most convenient would be a kind of oven with the tins placed on trays; you can then let the steam out one after the other before you take them out of the water. As to the time required a few words with any practical cook would soon settle that.—Os.

[32532.]—**Varnish.**—Canada balsam dissolved in turpentine will make a nearly transparent varnish. By altering the quantity of Canada balsam you can get any amount of "glaze." A few drops of linseed oil added will make the varnish more elastic, but if you do not require to bend the paper this is not necessary. You can also render paper tolerably transparent by means of white wax. The paper should be saturated with the melted wax, and the excess allowed to drain off before a hot fire.—Os.

[32539.]—**Economical Spring Motor.**—"W. W." can have one of the above to give off one horse-power; but it would take a hundred horse-power engine to wind it up.—GEORGE TOLMAN.

[32540.]—**Blistered Hands.**—Your hands will get harder in time. Do not remove the blistered skin, and let the handles of your hammers be as smooth as possible.—Os.

[32542.]—**Photographic Lenses.**—Shortening the tube makes the lenses cover a larger surface, and conversely lengthening tube causes lenses to cover smaller area; but the lenses cannot be so altered. They would not produce a picture at any other distance than the proper one apart.—W. J. LANCASTER.

[32543.]—**Brush Varnish.**—The polish itself will answer every purpose. Make it a little thicker with more shellac.—Os.

[32544.]—**Cooking Stove.**—We have had a large stove in use for some time, and find, if anything, that the meat has a better flavour, and is more juicy when cooked in the stove than when cooked in front of a fire. Let the consumed gas pass into the flue.—W. J. LANCASTER.

[32547.]—**Railway Rates.**—A manufacturer of goods finds it to his advantage to contract for the supply of a large quantity of a certain article, to be supplied in a given time. The manufacturer is thereby relieved of a large amount of uncertainty. He knows exactly what labour to engage, and can avail himself of a favourable state of the various markets. Can he be expected, and is he able to give the same advantage to every casual customer, who gives no notice of what he wants, and for whom he has to keep a stock on hand, sometimes at a loss to himself? Instead of "manufacturer" in the foregoing read "railway company."—Os.

[32551.]—**Selenographical.**—The formations called by Mr. Webb "Gauss" and "Sulpicius Gallus" are respectively so called in my edition of B. and M.'s "Mappa," which is dated 1834. I believe there is another and later edition. Is it in this that "Brickwall's" discrepancy exists? By the bye, in the key map in Mr. Neison's "Moon" the names "Aristillus" and "Autolychus" are interchanged.—MAC.

[32556.]—**Electrical.**—You can certainly make the carbon for batteries (it would cost you a lot of time and money—why not purchase them?) either by compressing or saving them from the gas-retort
scurf. The red varnish is made by
sealing-wax in methylated spirits,
dissolve shellac in methylated spiri
powdered vermilion till it is the re
The size battery for the wire you menti
4½in. round cells. Cost, about 5s.
TOLMAN.

[32568.]—**Iron Depositing.**—To M
—There have been some experiments
magnetic properties of deposited iron.
referring to Vol. XX., p. 103, of the *Ch*
but am not sure whether this is a re
experiments or only to its general depo
remark in my book is due, however, n
any experiments already made, as to my
tion that there is here a field of exp
paratively unworked, and likely to
results to its workers.—SIGMA.

[32573.]—**Glycerine Jelly.**—"High
add 1oz. of gelatine to 2oz. of glycerin
white of egg.—ALBERT SMITH.

[32574.]—**Leclanche Battery.**—"S
make a small hole through his carbo
tightly some platinum wire round it,
have a first-rate connection.—ALBERT

[32574.]—**Leclanche Battery.**—D
hole in the carbon plate, screw a threa
of platinum wire, and screw this i
plate; or get a new plate, quite 2½in. hi
porous cell, and cast a lead cap on t
varnish the cap and plate well down
cell. Do not use a second-hand Leclanche
you boil it in hot water for about a we
of the absorbed solution of sal-ammoni
MAN.

[32576.]—**Dilapidation.**—If a "Poor
wants an answer to his question he mus
position more clearly. As the question
it appears that the lessor could not ma
inside more than once in 7 years; but wi
the lord of the manor has anything to
matter? I am unable at present to see
into the case at all.—SPERANS, Lincoln

[32581.]—**Files.**—"What's in a name
saying, and I think may be applied in
with some truth, for, does "Todlebe
Russian?) know that many Sheffield
make both their "hand-cut" and "
files by machinery? One reason for s
genuine hand-cut files, I should say,
chisel used for file-cutting is sharpen
peculiar manner, and that when machi
the sharpening of the tools is given to i
persons—for, where the chisel is sha
proper hand the files are said to turn
Perhaps, another reason may be foun
that there is such a prejudice about
hand-made tools *versus* machine-made,
machine-made are sent out as hand-
just relieved of their machine-looking e
are (metaphorically) swallowed without
EX-LANCER.

[32584.]—**English and German.**—
tion that the English language is poorer i
than the German is very wide of the
example, the English word "gentleman"
"Ein feiner Herr" (a fine lord) or "ein
lady, dame, from the French, or eve
comfortable, pronounced "coomfortarbl
just as often as their own word "gem
For the English words—"Like, immedi
directly, equal, similar," all of differen
they have only one word, "gleich."
word "jungfrau," means either the "V
a virgin, a spinster, or a young woma
maid is "eine alte jungfrau" (an old yo
In German a girl is neuter, the sun f
the moon masculine. As to the Germ
being better adapted for the telephone,
to know how the instrument would
words as: "Dudelsockspeiffer, Dam
gesellschaft, Oberverwaltungscommis
geschwindigkeit," &c.—E. J. F. S.

[32584.]—**English and German.**—
the circumstance referred to evidencin
the English language, it would appea
prove its richness and capacity of
What constitutes richness except th
accumulation and retaining possessio
the beauties of the English language
faculty of receiving and absorbing
without, and so developing without lim
the use of words except to convey id
thing intended is known? "Telephone"
much as "far-speaker" does, but the G
word is a universal one, entering any la
so giving widespread meaning, while
one is of use only to the German. As
suitability of the words the German
merit, for it would be equally fit for
tube, a speaking trumpet, or a pair
reflectors—in fact, it ought to be give
ance of this order, carrying the voi
distance, not to one which reproduce
fresh acoustic origin.—SIGMA.

[32590].—**Telephone.**—You ca
resistance with pure water. I believe
15in. long, ¾in. diameter, full of wat
resistance to between 6,000 and 8,000
do not know any one that can assist y
you a glass tube of water, with a resi
700 ohms., or could send you a coil of
resistance in it.—GEORGE TOLMAN.

-Induction Coil.—Whatever else may t, it is hopeless to expect a good result nary of cotton-covered wire. The very the thing is to get the primary as con- and powerful as possible, while the thick aces the number of turns and increases ance from the iron as well as that of the —Sigma.

-Boiler Incrustation.—The best pre- o use for removing the scale would, I caustic soda. It would soften the scale, it to come off as a kind of mud, which be blown out, and it would not injure the es. The only acid solvent which could be uriatic acid, but I should consider the da far preferable. A few pounds of this atroduced when the engine was not in use, end of the week, and in a few hours the he scale would come away, or it might other application. Caustic soda will also e scale from forming, and is certainly one t harmless chemicals that could be used pose, but in working at a high pressure I whether it would be carried over. Even I do not see what harm it would do. A substance, such as Irish moss, has a great reventing scale deposit; at least, it pre- om adhering to the boiler, which should be whenever the mud accumulates. An ho had charge of boilers representing 250 orse-power, once told me he found cow's st scale-preventer, which amounts to the g as the Irish moss I have mentioned action in each case being similar.—Os.

-Partial Greyness.—Your dye is all perfectly safe. It should not be allowed e skin, or it will dye that. The hydro- of ammonia and the solution of potash mixed and used first. The silver nitrate dissolved in the water and used after the een applied. Two small-toothed brushes uld be marked Nos. 1 and 2) will be found onvenient for applying the dye, which will be renewed at the roots as the hair grows solution of potash is a solution of caustic d may be obtained at any chemist's. It is tful whether you will succeed in exactly he colour, but if her hair is very dark you ess difficulty. I certainly consider it great to dye the hair, and do not think the h the trouble.—Os.

—Electric Light.—"J. H. B." will time and money if he attempts what he is f. The making of such an apparatus igh electric knowledge of details, which lently unacquainted with. A machine ld do what he requires would burn his up at once, and would leave little other done by his engine.—Sigma.

NSWERED QUERIES.

ers and titles of queries which remain unan- five weeks are inserted in this list, and if still are repeated four weeks afterwards. We trust will look over the list, and send what information the benefit of their fellow-contributors.

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Galvanic Coils.—To Mr. Fennessy.

QUERIES.

[32608.]—**L. and N.W. "Bloomer" Engines.**—Has this class of engine outside or inside cylinders, and is the framing single or double? Is "Miranda" or "Rocket," which have outside cylinders, single drivers, with inside bearings, and outside bearings to the leading and trailing wheels of the same class, and what is the diameter of driving wheel?—R. N. H.

[32609.]—**L. and N.W. "Cornwall."**—Will "W. A.," Crewe Works, please say if the "Cornwall" still runs on eight wheels and if she has outside bearings to the carrying wheels?—R. N. H.

[32610.]—**Great Eastern 7ft. Engine.**—The engine, by Schneider, which was in the Paris exhibition of 1867, and illustrated in the *Engineer* afterwards, was numbered 299, and a correspondent lately gave it in the Mechanic as 87. Which was it?—R. N. H.

[32611.]—**Glass Chandeliers.**—Can any of "ours" inform me what it is that is used to make the joints of the arms of the above? To all appearance it is plaster of Paris, but I have tried this without success. Is there any other ingredient mixed with it or is it something entirely different? This and any other information respecting the same would be very acceptable to—W. R. S.

[32612.]—**Double Star.**—Can some astronomical correspondent give me the distance of the components of γ Leonis? With my 2in. telescope it appears to me a much closer double than Castor, whereas in "Slugg's Observational Astronomy" the distance of Castor is given as 4in., and that of γ Leonis as considerably more. Is not this a mistake?—Argus.

[32613.]—**Telescope.**—I have an ordinary 30in. telescope, magnifying 40 diameters. In dull weather there is a great dificiency of light, owing to the high power. Can I put in an alternative eye lens and field lens of lower power, reducing, say, to 30 diameters, without material sacrifice of definition, or should I have to make new erecting lenses as well?—Argus.

[32614.]—**Sailing Boat.**—Would any of your correspondents kindly inform me how to construct a sailing boat, say 18 or 20 feet long for pleasuring, somewhat similar to Stanley's English explorer's boat, made in pieces to come asunder?—Irishman.

[32615.]—**Phosphorus.**—How am I to put phosphorus into tin or copper? I was told to melt the metal and then wrap the phosphorus in paper and drop it into the hot metal; but it burns away on the top and surely cannot enter into the metal.—Tyneside.

[32616.]—**Agricultural Chemistry.**—1. Is there any easy chemical test for distinguishing carbonate of potash, carbonate of soda, nitrate of potash, nitrate of soda, sulphate of potash, sulphate of soda, all, or nearly all, of which are found effervescing on the surface of certain tracts in these provinces? 2. Is any tolerably simple system known for analysing soils, chemically and mechanically? No great accuracy is required.—J. B. Fuller, Allahabad.

[32617.]—**Cast Monument.**—I am a joiner, and wish to erect a neat little monument with a good deal of mouldings on it. As it will be very expensive to get it cut in stone I intend to make a wooden mould and cast it if any one will inform me what material to use so as to stand the weather and have a nice appearance when finished. Also what it will cost per cubic foot, also what to use to keep the mould from sticking and present a smooth surface when taken out.—J. W.

[32618.]—**Revarnishing Violin.**—Having scraped off the old black varnish from my violin with the assistance of wood naphtha, will any of your kind readers inform me how I shall prepare and revarnish it, and the best kind of varnish to use? It is believed to be a "Klotz."—Amateur.

[32619.]—**Draughty Floors.**—Can any reader inform me what is the best material for filling up cracks between the boards of a room floor? I have tried putty, but when the floor was cleaned it all came out.—John Henry Kay.

[32620.]—**Thermometer.**—I have a thermometer (mercury), the accuracy of which I am desirous of testing. Will one of your numerous correspondents kindly inform me how I can ascertain whether it be correct or not?—H. Hill.

[32621.]—**French Polish.**—Can any of "ours" give me the ingredients for mixing pure white French polish? Also I should like to know what liquid will prevent sealing wax dissolved in spirits from setting so rapidly, and still retain its polish after drying; or what is the method of laying it?—J. E. Thompson.

[32622.]—**Ship Measurement.**—Is there any rule or simple method of measuring the exterior of a vessel, say in a graving dock for instance?—J. E. Thompson.

[32623.]—**Light for the Magic Lantern and Use of Photo Lens in Do.**—I have been working a good deal with a lantern made from the instructions given in your most useful paper, and have obtained very satisfactory results with ordinary lantern pictures, using for light a very good paraffin lamp, which I got from J. Lancaster and Son, Birmingham, from whom I also obtained my lenses. Lately I have been trying some of the new slides, such as the wheel of life, &c., but the result on the screen has not been so satisfactory. I was not much surprised at this as these slides of necessity shut off much of the available light. The point, however, on which I hope some of your correspondents will kindly enlighten me is this:—I have by me a half plate portrait photo lens, which I laid aside some time since on getting a better one. Now can any one kindly inform me if I should likely improve matters by using it for my object lens in the lantern? Which of the lenses in the combination should I use, and should I not have to cut off a piece of the front or nozzle of lantern to suit the altered focus?—W. R. C.

[32624.]—**Refining Oil for Lubricating Purposes.**—In my present business I have a good connection amongst steam-users throughout the United Kingdom, but the time of my men is little more than half occupied, and I am desirous to supplement it with an oil trade. I have plenty of room, and shall be very glad if any of your readers can give me some practical advice as to the requirement of plant for refining purposes, approximate cost of same, and mode of procedure.—D. E. Donald.

[32625.]—**Model Trunk Engine.**—I purpose constructing a model engine of the trunk type. The inside diameter of cylinders, 2¼in.; diameter of trunks, 1⅜in.; stroke, 1¼in.; diameter of cylinder squared—diameter of trunk squared—3¼sq. in., square root of which is 1¾in. nearly, which is the effective diameter of piston. What size should the parts be cut to insure a good result in working? Is there any fixed rule for calculating the same? If so, please state or refer me to any work in which it is to be found. Would also be glad of any information respecting a boiler to work the above, thickness of plate, best working pressure, general dimensions, &c. If correspondent would state what length boat two such cylinders would drive he will greatly oblige—Amateur Trunk.

[32626.]—**French Polishing.**—Can any one tell me how to finish so that it will stand and present a bright appearance?—Cabinet Maker.

[32627.]—**Spoiled Brass Bedstead.**—I have a brass bedstead which has been turned blue in different parts of it—I think it must be with damp. It has come to me wrapped in straw and paper. Can any one tell me what will restore its colour?—Furniture.

[32628.]—**Butter Cleaning and Remaking.**—Will some fellow-reader be good enough to give me some information on this subject? I understand the butter is first melted, but you must not exceed a certain temperature. What is the critical point? On making it up for sale some innocent colouring matter is added, made in Germany. What is it?—Terebene.

[32629.]—**Midland Engines.**—Would it be asking too great a favour of "C. E. S." to give us in the English Mechanic a small side elevation of the Midland new 7ft. bogie engines, and of one of the 800 class as rebuilt by Mr. Johnson, with a statement of their principal dimensions?—High Speed.

[32630.]—**The Phonograph.**—As "Speravi" (32408) has succeeded in making a phonograph, and expresses his willingness to impart information thereon, I should be much obliged by his kindly answering the following questions:—1. What contrivance, if any, does he use for regulating the speed of revolution of the barrel? 2. How many revolutions does it make per minute? 3. What is the length of the barrel? 4. How is the style attached to the diaphragm?—C. H. J.

[32631.]—**Amateur Printing Press.**—I am thinking of purchasing a small press to print about 10 by 8, but before doing so should much like the opinion of "ours." I wish to print circulars, cards, and in fact everything that an amateur can well do. I should like to know if a wooden press would do all I want, as I find that I could get one the required size for about £1, whereas an iron one would cost £5—a very wide difference. Also could I do amateur's copper plate printing, and ditto lithography with any ordinary hand wood or iron press? A few remarks on the best principle of an amateur's press would be very acceptable, as I find there are several on very different principles. Is a self-inking press of much advantage to an amateur? I believe—but am not certain—that I once read either in the Mechanic or elsewhere that wooden presses were not worth having, as the wood skelered and did not afford a level surface to the type, and also that the type sank into the wood. Is this correct? If so, how is it that with an iron press "blankets" or other soft material are used so as to afford a "giving" surface? A few hints as to what a press should be like for the above purposes will be esteemed by—Galvano.

[32632.]—**Artificial Finger.**—I had an accident when a child and lost one of my fingers. Can any one suggest how the loss can be hidden or supplied, as I am engaged in a trade where its loss is sometimes noticed?—Enquiry.

[32633.]—**Making Range Boiler.**—Which is the best form to cut sheet-iron to make range boiler? I have made one square, and from iron ¼in. thick, ¼in. flat head rivets, and set the edge of iron down close with a small set punch, but still it is not cold-water tight, leaking from rivets and joints. Rivets were put in hot.—Iron.

[32634.]—**Regulating Gas Meters.**—Would one who knows please tell me how much to screw up or let out crank of gas meter, say for 10 and 20 lights, 3 and 12 per cent. slow or fast, and oblige—Iron.

[32635.]—**Harmonium.**—Will any one kindly inform me if I can put broad reeds in my harmonium without altering the inner construction? I mean could I take the old reeds out and put broad reeds in their place? If so what would one row cost?—J. R. W.

[32636.]—**Locomotive Gas Engines.**—Have any readers tried gas for locomotive carriages? Why should not a gas engine and one of the new self-acting gas machines be combined? Velocipedes certainly ought to be superseded.—Member Soc. Arts, &c.

[32637.]—**Pain in the Back.**—I have been suffering a long time from a severe pain in my back, striking down my left leg. I suffer most when sitting or in bed. Do not feel much of it when walking. Could any of "ours" tell me of any remedy?—J. Webster Sutton.

[32638.]—**Removing Paint from Steel.**—I shall be glad to know of an easy effectual method for removing a coat of paint from a bicycle, originally all bright, without discolouring the steel or preventing reburnishing.—Fifty-six-inch.

[32639.]—**Pitch of Screws.**—Will some friend give the pitch of Whitworth's standard threads from ¼ to ¾?—Nut.

[32640.]—**Projection.**—I should feel obliged if any of your correspondents would inform me how to describe an ellipse, having given in magnitude and position a pair of its conjugate diameters, not at right angles to each other?—O. W. H.

[32641.]—**Sizing.**—Can any reader tell me if they know of any chemical that can be mixed with animal size for sizing woollen warps so as to prevent it shelling off when dried on hot cylinders? Also of anything to mix with animal size to make it dry more quickly?—Sizer.

[32642.]—**The Telephone.**—Will some one try leaving the disc free, but forming the short arm of a lever, the other and much longer arm resting against a stretched membrane. Will not this increase the sound?

Also will the finest copper wire answer as well as thicker? It is to go round the ceilings, and not to be noticed?—W. L.

[32643.]—**Oxide of Hydrogen.**—Would any readers who are well taught in inorganic chemistry be kind enough to inform me whether there is any possibility of making peroxide of hydrogen on a small scale, and what are the materials used to make such liquid, and their proportions? I have several books upon chemistry, but they do not contain any practical guide for its preparation.—CONSTANT READER.

[32644.]—**Legal Question.**—A, a dealer in furniture, undertook to furnish a house for B. A delivered part of the order to the value of £30 before he discovered he was dealing with a swindler not now to be found. C, the landlord of the house hired by B in which the goods are now deposited, holds the key, but refuses to give them up, although no rent will be due till 24th June next. What is the best way of dealing with this case?—A.

[32645.]—**Paper-hanging.**—Can any correspondent kindly give a remedy to prevent the colours of thin papers running? I have used alum in the paste, but the colours start, and get mottled and stained?—HOPEFUL.

[32646.]—**Matt Sizing.**—Would any subscriber inform me how the matt size is made which is used in preparing ordinary matts in picture frames, and also how the water is applied? In this paper I saw a full description given for matt gilding, and I have tried the water but fail to make the gold assume that peculiar dead appearance. Any hints would be most welcome.—DERBY.

[32647.]—**The Phonograph.**—To "SPERAVI."—Will "Speravi" send a description, and, if possible, a sketch of his phonograph, as I have no doubt that it will prove interesting to many of "ours" besides myself who are anxious to construct one?—ENDYMION.

[32648.]—**Bicycle.**—Will Mr. Striffler give us amateur bicyclists a little more of his valuable information—for instance, as to how the centre of a wheel is made? A small drawing of the different pieces, and how they are put together, would be of great advantage.—AMATEUR.

[32649.]—**Dynamo-Electric Machine.**—Will Mr. Sprague, who described the Weston machine in February last, or some other correspondent, inform me if it is the best make of machine for producing the electric light up to 60 Carcel burners? If it is the best, will Mr. Sprague oblige by giving a longitudinal section, and a few more particulars as to size of wire, &c., to enable me to make a machine for this purpose? Or will some other correspondent describe or tell me where I can get a description of an electro-magnetic machine, simpler and cheaper for electric lighting?—PROMETHEUS.

[32650.]—**Compound Microscope.**—To MR. LANCASTER.—In Vol. XX., p. 466, is given some instruction for making a compound microscope, but as no size is mentioned would you kindly give the proper measurement of tubes forming the body of a full-sized instrument, so that I could at any time add other eyepieces and objectives, as those advertised are, I suppose, of one standard size? Also is there any fixed lens in the body other than those composing the objective and eyepiece?—ENTERPRISE.

[32651.]—**Paste.**—Will any reader tell me of a good paste for sticking plush in relining an old gun case?—DELTA.

[32652.]—**Shutting out Sound.**—I should be glad if some of your correspondents would inform me how best to produce artificial and temporary deafness at will? The telephone is a valuable acquisition; but an aphonic cap or some means of keeping out unwelcome sound, would, I think, be nearly as valuable to a person who wishes to study either mathematics or metaphysics, to allow his fancy to make its highest flight, or to secure rest in sickness. I have tried stuffing my ears with cotton wool, but have not succeeded.—STUDIOSUS.

[32653.]—**Microscopic Photographs and Bank Notes.**—I dare say many of your microscopic correspondents will have seen photographs of Bank of England notes for the microscope. Mr. Dancer, of Manchester, has them marked in his catalogue, the size of them being something less than ¼in. I went to buy some slides of him about 10 months ago, and wanted one of a £20 note, but he had not got one, so I thought I would try if I could take one. I succeeded very well in taking a negative of a £10 note, the negative being 1½in. long by 1in. across, from which I took the microscopic one. I also printed some small ones on albumenised paper, and I gave one to a friend, who, I suppose, thought he would have a bit of fun, and he took it to the Bank of England at Manchester and asked them what he must do with it, but he had to say where he got it, and then they came to see me, and have now got the negative, and also a microscopic slide, which has been sent up to London to the bank manager there, and they do not seem likely to come back again. Will some correspondent say what the Act of Parliament is about it? The bank manager here says that photographs of bank notes, ever so small, are not allowed to be taken.—OXYGEN.

[32654.]—**The Antiquity of Man.**—On the 18th March I attended a lecture by Prof. Duncan on "The Antiquity of Man," which gave a very clear proof that man existed on this earth when the surface was not as it is now, and when various animals existed which are now extinct, but the lecture did not contain any scrap of information which would show what length of time has elapsed since that period. If any of your correspondents would be good enough to give the desired information, either through your columns or point out in what books it is likely to be met with, they would confer a great favour on many others who heard the lecture besides—ISCÁTEL.

[32655.]—**Printing Circulars.**—I am desirous of printing my own circulars, price lists, &c., from manuscript copy. Will any one kindly say if the method mentioned by "Oberhof" (let. 14137) would do, describing the way of inking the plate and apparatus required for printing with, as I wish to make the press, &c., myself if possible? Any hints on the subject will oblige—MEMO

[32656.]—**Conductor.**—I wish to make a conductor for a large plate electric machine, and would like to know if I can do so satisfactorily by making it of wood, and covering this with tinfoil? Would it be better to varnish over the tinfoil? Does Winter's ring answer instead of a conductor? It would, I presume, be more easily made. In what book can I get a practical description of this ring so that I may construct one? What size ought it to be for a 2ft. plate?—SHOCKING.

[32657.]—**Civil Service Examination.**—Will a fellow-student kindly inform me as follows:—The best published work, and price, on above? Is it possible to obtain more information of result than usually given? For instance—who obtained vacancy, number of marks obtained in each subject, and total number, so as to know how one stood, as no particulars are given by C. S. C.?—STUDENT.

[32658.]—**32in. Focus.**—Would Mr. W. J. Lancaster give me a few hints? I bought lately a telescope; it is all brass and very heavy; it is in two pieces; the focus of the object-glass is 32in., diameter 1¼in.; the eye lens is 1in. focus; they both screw into cells; the object-glass is a spectacle lens. I know nothing whatever of stars and such like, but when I look through it the purple and red fringe the edge of the object to a great extent. Would it be worth while to cut it down and get an achromatic, or what is my best plan to adopt with it?—JOHN.

[32659.]—**Naval Crews.**—Can any of your readers tell me the relative number of the crews of our old wooden frigates and our modern ironclads?—NAVY.

[32660.]—**Phonograph.**—Would "Speravi," or any gentleman, answer the following questions:—1. Would the writing in the case of either the phonograph or the phonautograph be larger in proportion to the size of the diaphragm used? For instance, would a drum-head give larger writing than a diaphragm of about 3in. in diameter? 2. Is the principle of the phonograph and phonautograph the same, and might the latter be adapted so as to be used as a phonograph? 3. Could the phonograph be made to speak by having, instead of a cylinder, a slide with a groove in it and tinfoil gummed over it, drawn under the vibrating point at a uniform rate?—W. B. PRIDEAUX.

[32661.]—**Telephone.**—1. What is the right size of wire for connecting telephones in a house? Would No. 36 wire do? 2. Is it necessary to have two soft iron cores, one for each pole of the magnet, in making a telephone with a horseshoe magnet, or will one suffice, and are the soft iron cores spoken so much about hollow or solid pieces of iron? 3. I have followed directions for hardening steel magnets, and I have tried magnetising them with both a single Smee's battery, and with a strong horseshoe magnet 8in. long, but the result is very unsatisfactory; the battery hardly magnetised them at all, and the magnet only made them just strong enough to lift each other. Is the fault in the steel, or in the power used?—W. B. PRIDEAUX.

[32662.]—**Violin.**—Would any of our readers indicate the name of a good easy exercise book for self-practice of a scholar of about six months?—AMATEUR.

[32663.]—**Fresh Water Aquarium.**—I intend to make a small fresh water aquarium. Could any of "ours" answer the following questions? I saw in a number of this paper that the Valisneria spiralis and the Anacharis alsinastrum are good plants for compensating the water for loss of oxygen. 1. Where can I find them? 2. How am I to know them? Into a tank containing about eight cubic feet of water I intend to introduce two gold fish, two silver fish, two trout, six minnows, two eels, two sticklebacks, one perch, one tench, and one miller's thumb, or flat-headed loach. These three last-mentioned are uncommon here (Strathbogie, Aberdeenshire). 1. Where can I find them? 2. Will all these fish live together in the space noted?—W. A. R.

[32664.]—**Artificer.**—1. What examination have you to pass to become an artificer? 2. Whether you have to find your own rig or not, and about price? 3. Which is the most desirable, the navy or merchant service?—H. BINGHAM.

[32665.]—**Siphon.**—Would some correspondent of the ENGLISH MECHANIC kindly inform me whether any kind of siphon exists which starts into operation itself on the fluid reaching a point lower than the upper portion of its bend?—AULOS.

[32666.]—**Heart.**—Is there such a thing as partial paralysis of the heart's action? What are its symptoms? What its remedy?—W. BARNARD.

[32667.]—**Telephone.**—Will Mr. Lancaster or some other person oblige by informing me whether the magnets ought to be hardened after magnetising or before? Also would magnets about 5 × ½ inch be as good as smaller one, say 4 × ⅜, and what weight and size of wire to use for the bobbins of the large ones? Would drilling a hole in the end of a magnet affect it?—A. B.

[32668.]—**S. W. and G. N. Bogie Engines.**—I have noticed that when the new S. W. bogie express engines start—with a long train and nearly full steam on—they roll very much from side to side, which I believe is caused by the alternate action of the pistons and the engines not having sufficient breadth of bearing on the bogie. I have also seen the G. N. 8ft. single engines start, under similar conditions, as steady as possible. Will "The New Clock" and "L. L." give a description of the bogies of these engines, with the amount of lateral play allowed? A sketch would oblige. Will "The New Clock" also give the distance between centres of cylinders and height of centre line of boiler from rails of the S. W. engines referred to.—SHORT STROKE.

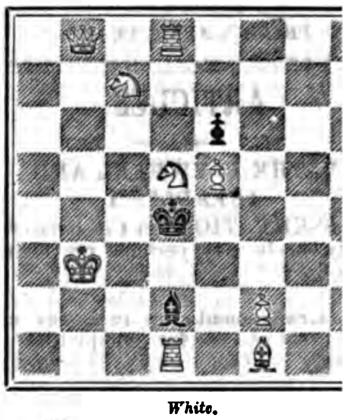
[32669.]—**Musical.**—My business requiring the use of pitch-pipes accurately tuned to a given number of vibrations, I am anxious to possess an instrument for computing them in order to arrive at the desired pitch. I am aware of several methods having been invented. I now want advice as to the choice of one, giving preference to the simplest in construction consistent with accuracy. Would the attempt to make one be likely to prove too much for a bit of a mechanic?—TONOMETER.

A Use for Tin Cans.—It is stated that a Philadelphia manufacturer makes a speciality of sash weights, and it is said that he employs labourers with carts to collect during the morning every article of worn-out tin-plate or sheet iron in whatever shape used for domestic purposes that had been thrown out upon the street. This scrap is made into sash weights of a higher specific gravity than ordinary iron. The metal obtained is very hard. The kind of furnace used for this purpose is not described.

CHESS.

ALL Communications intended for this d
must be addressed to J. PIERCE, Copthill House

PROBLEM CCCCXVIII.—BY W. R. BL
Black.



White.

White to play and mate in two moves.

SOLUTION TO 416.

White.	*Black.*
1. Q to K Kt. 4.	1. Anything.
2. Mates.	

In 417 the White Bishop at K B sq. should b
Knight.

NOTICES TO CORRESPONDENTS.

J. G. F.—The second solution you will find is qu
Unfortunately 1. R takes Q B P; if 1. Q
2. R takes Kt. (ch); and 3. Kt. mates. We
to this effect, but the letter was returned, a
was insufficient. Your solutions of 415 and
correct.

J. THURSBY AND A. F. S.—Thanks for the probl

G. A. L.—Your solution of 416 is right.

ARCANUM.—1. P to Q 7 will not do in 416, as t
mate if 1. Kt takes P.

USEFUL AND SCIENTIFIC N(

Purifying Water.—At the last meeti
Royal Society, Professor Frankland pre
communication from Mr. G. Bischof on "Pu
Organic Matter in Portable Water," in wh
described some of the effects of spongy
organic matter. Last year experiments w
by allowing water to filter through spong
to meat, and it has been found that after s
the meat remained fresh. Another test w
by preparing a hay infusion, which was k
showed abundance of organic life. The infu
filtered through spongy iron with layers of p
sand and gravel, and then was kept in cont
meat for many weeks. The meat showed
of putrescence. In some of the experiment
air was supplied, which, Mr. Bischof poi
proves conclusively that bacteria or their g
not revived when supplied with oxygen
filtration, and he urged that this is a
importance, as it demonstrate that by
through spongy iron putrefaction of organi
is not only suspended for a time but that
entirely until reinstated by some putrefacti
foreign to the water. The peculiar action
iron is believed to be thus explained. If
inserted into a body of spongy iron which
in contact with water for some time gas bu
seen to escape. These are found to contai
and hydrogen, and experiments lead to the
sion that the carbon is due to the decompo
organic matter.

The Railway Servants.—The Amal
Society of Railway Servants have issued
interesting pamphlet, embodying an a
Parliament and the public in support of th
mendations contained in the report of th
Commission on Railway Accidents, especi
which relates to compensating railway ser
injuries sustained. The main recommend
the commission were to give the Board
power to enforce the extension of stati
sidings, to enforce the adoption of the b
interlocking systems, to restrict the speed
to require the construction of continuo
boards, to impose certain conditions on c
opening new lines, to require companies t
foot-bridges or subways at stations, and to
lodge to be maintained at public crossings
recommendations related to provision f
pensating railway servants, but on this m
society have drafted a bill, which they hope
duce into Parliament, in order to "ext
regulate the liability of railway companies
compensation for personal injuries susta
persons in their service." The pamphlet
much matter of interest to the travelling p
well as to railway servants.

Inglish Mechanic
AND
OF SCIENCE AND ART.

RIDAY, APRIL 19, 1878.

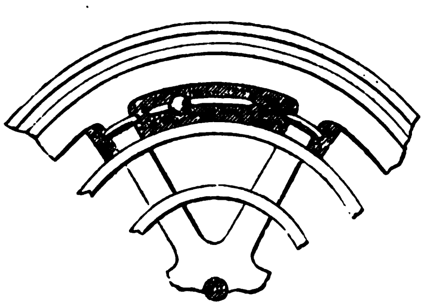
ARTICLES.

THE FLYWHEEL AND TREADLE.—I.

IRTATION on the liveliness of
eels may perhaps prove but a
ct to the majority of readers,
ry good reason that their own
angements act in a way which
le cause for complaint. But
be some who will sympathise
feeling of lingering dissatisfac-
cannot be quite dispelled until
tain of having secured the very
which the means at hand can
o command. This feeling has
an intention to test by actual
t certain theories I have long
e improvement of treadle-hang-
, the fact that my own require-
re sufficiently and comfortably
educed the old intention to very
roportions, until the appearance
" article (ENGLISH MECHANIC,
and the subsequent correspon-
ted by it. But this revived the
notions, and led me to experi-
n them; and as the result shows
tionable increase of power, and
nd) an improvement in the tread
ink it may be worth while to
plan to the criticism of those who
be interested on this subject.

be evident, from the foregoing,
I sent the notes on flywheel
ce to "J. L.," I had not the
dea that they would be used as
ard of what the best performance
e flywheel might be made. My
knows that he is perfectly wel-
any notes of mine, and that I
l otherwise than flattered when
them worth his editing. But I
aware that the proportions of
were not of the most favourable
e the flywheel, being only 80lb.
n, could not rank among the
' My notes, therefore, were only
o prove how much might be done
mproving flywheel performance
weighting alone, even when the
s of the treadle were not of the
ect kind; and I now refer to
s only for the sake of comparing
which two different arrange-
the treadle may exercise on the
heel. Although the "single-
t is very good as far as it goes,
must necessarily be insufficient
s the two most important condi-
al work—viz., the regularly re-
ead of the foot at each revolution,
etarding influence of the work
ght. But, as the "single tread"
ir test for liveliness, I may men-
whereas the old hanging of the
e only from 25 to 30 revolutions,
nging gave at once an average of
this with very rough-and-ready
where the centres of the rocking
somewhat shaky—being fixed
ooden battens clamped to the
dards, and where short bits of
strong brass wire loops at each
he place of the regular pitmen.
ave also excellent results under
be called the "docility test"—
orking the treadle at extremely
d with flywheel and mandrel pulley connected for the fastest speed. Under this test the mandrel was kept alive at even pace, with only eight treads to the minute; and I hardly know a severer test for the handy docility of a flywheel.

But not considering these tests satisfactory on the point of *power*, the following was adopted:—The treadle being hung in the old way, an automatic cut was started on a piece of iron, and gradually deepened and quickened until the flywheel was pulled up and could not get over its dead points. After giving the wheel every chance, even to a little assistance by hand, everything was left in exactly the same condition as to depth and speeding of cut; but the treadle was taken down, rigged up with its extempore fittings, and re-hung on its new centres. The wheel now not only took up the cut under which it had broken down before, but on quickening the feed of the tool again, the wheel contrived to get over its dead points three or four times after the driving band began to slip on the mandrel pulley. This experiment was, of course, made without back gear; but I cannot see that it would be possible to devise a more stringent test for the influence of treadle-hanging alone, as every other condition remained exactly the same in both cases. So far as the rocking shaft of the treadle is concerned, the difference consists in hanging it only 1½ or 2in. below the level of the centres of the flywheel shaft, instead of some 4 or 5in. from the ground. But as the chief object of this is to establish a certain relation between the pull of the pitman and the position of the counterpoise on the wheel, and as the modification in the form of the treadle which is necessary must be arranged with reference to this object, the mere adoption of the higher position for the rocking shaft would not insure improved results, unless arranged with regard to the principle involved.



So, as the treadle question has now been fairly started in the columns of the ENGLISH MECHANIC, it may be the best plan to enter into the subject thoroughly, making this epistle a contribution towards its exhaustion, as well as the description of a particular arrangement. But, before leaving the particular for the general, it may be well to observe that this plan of hanging the treadle some 14in. from the ground introduces a rather different rise and fall for the foot, which might prove an insurmountable objection to many old turners. As the treadle is usually hung, it oscillates in an arc whose chord is vertical; so that the rise and fall of the foot is practically vertical. The hanging now proposed changes this vertical motion into one that carries the foot slightly (2½in. or 3in.) *forward* in its fall. To secure such a motion was part of my idea, because it seems to be the more natural movement for the foot. Let any one stand on one leg, and lifting the foot of the other about 12in. from the ground, thrust it down again with force. In nine cases out of ten the foot will be observed to fall 3in. or 4in. in advance of the other; and the same tendency may be noticed in the position which the foot will instinctively adopt when about to crush anything on the ground—so long, of course, as the *heel* is not used. But the third part of a century will make habit very strong, and as something very close on that period has passed since my first acquaintance with the treadle, I freely confess that when I began to practise on my theoretical improvement the feeling was too novel to prove very attractive. Still, the great increase of power resulting from a position of the pitman, which could not be very readily secured without making this change in the motion of the treadle, induced me to give the plan a fair trial in regular practice; and now, having broken the old habit, I would not resume it on any account. The slight forward fall seems to give much freer and more independent play to the several joints concerned in treading—viz., the hip, the knee, and the ankle; while it is certainly more favourable for the exertion of the considerable muscular force which is now and then required. The only position in which I still find the old arrangement preferable to the new is when standing with the whole body (below, as well as above the waist) facing the mandrel, and wishing to tread with the right leg. There must then be a dishing motion, which is not pleasant. But for using the left leg, while leaning with the right hip against the lathe-bed, as also in every case where the operator wants to stand very close to the lathe, the inward fall of the treadle is very convenient, for there is hardly any risk of its falling on the toes of the standing leg, and throwing the hooks of the pitmen off the cranks—an accident which must be familiar to most old treadle-turners. The practical pros and con.s of this particular case having been fully stated, so far as a month's experiment on all kinds of material, and at all rates of speed, have suggested them, I will proceed to explain why the general principles of treadle action seem to me to recommend this method of hanging.

As I start on the assumption that to secure the best action from any foot flywheel it is absolutely essential to weight it with a counterpoise properly adjusted, both for balance and for position on the wheel, a few words may be desirable on this point. I am aware that this proposition is sometimes disputed, and have heard it argued that it is the source of vibration and roll, and that it causes the centres to wear oval, and the wheel to run untrue; and of course the practice may do all this if improperly carried out. But the abuse of a good thing is no argument against its use; and a proper counterpoise is so entirely in accordance with the principles of mechanical science that it would be almost waste of words to argue in its favour. At any rate practice approves the plan, and even the smaller flywheels used for steam-engines are constantly loaded; the rim being cast with a cell into which the lead is run. Yet calculating the effective range of a crank at about ⅚th of each half revolution, and remembering that the steam-engine gives the advantage of both thrust and pull, the conditions under which the steam-engine wheel works are far more favourable than those of the treadle flywheel. Setting aside the comparatively light weight of the latter in consideration of its lighter duties, the effective range of the crank can now be only as about 5 to 11; and through the full half of each revolution the wheel has to carry on the cut at even speed, and lift the full weight of the treadle as well, by the impetus of centrifugal force alone. The lathe flywheel is rarely run at a speed where centrifugal force can make the influence of a proper counterpoise injurious in any way; and I can state that, having (only a few weeks since) taken down a flywheel which certainly had not been shifted for 10 years, I could not detect a trace of uneven wear in the female centres of the crank shaft

The male centres were unquestionably worn; but this was only on the top, where they had to bear the weight of the wheel and the force of the tread. When this was corrected, and the wheel rehung, it ran without a suspicion of shake on its centres, and as true as a die. Springs or similar contrivances for relieving the weight of the treadle, can at most work but half a cure at the cost of waste of force at every tread. For unless the simple and effective hook of the pitman be superseded by the complication of a collar, weight enough must be left on the treadle to drop it to its lowest point at each revolution of the crank; or, if that revolved without the pressure of the foot to send the treadle down too, the hooks would necessarily be pulled off. Such springs are therefore simply obstructive in their action, while the counterpoise will not only do its duty effectively to the last ounce of the treadle's weight, but becomes, under the moderate influence of centrifugal force, a decided aid to the power of the flywheel when running.

One of the commonest difficulties in weighting a flywheel properly is that some spoke is relied upon for attaching the weight; and it is of course a mere chance whether there be a spoke in the right place or not. This difficulty may generally be met by using two weights of the right proportions on two separate spokes. But by far the best plan in the long run in such a case is to clamp an iron plate (say $\frac{3}{16}$in. thick) with a slot in it, to the two spokes between which the weight should lie. The weight can then be attached to this plate by means of a single (mushroom or cheese) bolt passing through it and the slot. In this way both the amount and the position of the weight can be arranged with the greatest ease and accuracy; and if anything should ever render it desirable to vary or shift the counterpoise, it can be done in a moment by simply loosening a single nut. I have found this arrangement so useful in experimenting, that I think it is worth an illustration, although almost too simple really to need this. P is the slotted plate, clamped to the spokes by two pieces of $\frac{1}{4}$in. rod, screwed at each end for small nuts, and then bent into the required staple form for clamping the plate to the spokes. These nuts are not shown, as they would be at the back of the wheel; as also would be the counterpoise fixed by the bolt, the head of which is seen in the slot.

D. H. G.

(*To be continued.*)

THEORY OF THE STEAM-ENGINE.*

THE "notes" on the theory of the steam-engine, issued by Prof. Cotterill, about seven years ago, for the assistance of students and others interested in steam-engineering, were so much to the purpose, and met with so favourable a reception from professional men, that the present volume, in which the "notes" have been expanded until they cover nearly 350 pages, will be welcomed, we think, as perhaps the best treatise on the theory of the steam-engine extant. The object of the author is to place before his readers the process of the conversion of heat into work in steam-engines, and consequently he does not encumber his pages with any questions relating to the form and dimensions of the mechanism through which the work is applied, nor of the boilers in which the steam is generated, and the heat of fuel rendered available for use as a motive power. Prof. Thurston's paper on the "Perfect Steam-engine," which we noticed on page 518 of our last volume, has done something to attract the attention of steam-users to the advantages likely to accrue from a better understanding of the heat-engine as a motor, and Prof. Cotterill's recently issued treatise will afford them all the information upon the subject. It is not to be supposed that users of steam are likely to study the theory of the engines they employ, and, as a matter of fact, only a very small percentage of them know much more about them than the stokers they employ; but, in the hands of the engine-makers, the volume will not only be of value in pointing out the direction in which true progress is to be made, but it will be of assistance, from a commercial point of view, by enabling them to quote an undoubted authority in support of their arguments for the use of superior engines instead of the nominally cheap but in reality very expensive types too frequently made at the present day. In his first chapter, Prof. Cotterill explains the physical properties of steam as determined by Regnault's experiments; and in the second he introduces the principle of the mutual equivalence of heat and work. The theory of the steam-engine is commenced in the third chapter by a preliminary investigation dealing with the principal phenomena, and leaving the minor details, which, in practice, complicate the question, to be dealt with subsequently. Assuming the expansion curve to be a perfect hyperbola, and it is known to be so approximately, and the heat lost by radiation and by transmission to the exhaust to be known, Prof. Cotterill calculates what should be the performance of an expansive engine supplied with dry steam under different conditions, the results being exhibited in some interesting tables, which help to put the question clearly before the reader. Calling the loss from the two sources above mentioned "exhaust waste," it is seen that if the results tabulated are compared with those obtained by actual experiment in the best engines, it is evident there must be a great loss in the engine, either by exhaust waste or by a large amount of priming water in the steam. Estimating the work done by thermal units and comparing the result with the total number of units in the heat expended, a loss of four-fifths becomes apparent, and we then examine the causes of the waste to see if a better result cannot be attained by means at our disposal. The first important fact following upon an examination of the question is. that no better machinery than the ordinary cylinder and piston can be devised, and that nothing is to be gained by using many cylinders instead of one, provided, be it noted, that the steam is supplied with heat in the same way. The first statement will attract the attention of inventors of rotary engines; and the second, it will be seen, introduces the question of compounding. To obtain greater efficiency, then, the treatment of the steam must be altered, or some other fluid must be utilised as the medium. The fourth chapter is consequently occupied with a discussion of the action of the heat upon a perfect gas, the result being utilised to study the air-engine in its simplest form. Although the efficiency is more than double that of the steam-engine, fully one-half of the heat expended is wasted by the necessity for a compressing apparatus, which absorbs a very large proportion of the energy originally brought to bear on the working piston. If, however, certain conditions are satisfied, the efficiency of the two engines must not only be the same, but no other engine can have a greater efficiency. This proposition occupies the fifth chapter, which introduces a second principle governing the operation of heat-engines, of not less importance than the equivalence of heat and work—viz., that the practical utility of a given quantity of heat depends upon its temperature. If, says Prof. Cotterill, the vast amount of heat discharged into the condenser could be utilised to produce fresh steam in the boiler, the efficiency of steam-engines would be multiplied many times. There is no reason why this should not be done, except that the temperature of the condenser is so much lower than that of the boiler. The second principle, however, asserts that by no process of the nature of perpetual motion can heat of low temperature be converted into heat of high temperature; and the conclusion that the practical utility for mechanical purposes of a given quantity of heat depends upon the limits within which it can be used, shows, that in designing a heat-engine of any kind the available difference of temperature must be carefully utilised as well as the available expansive energy of the fluid. A table of the performance of perfect heat-engines is given, from which it appears that, with such temperatures as can be employed in practice, two-thirds of the heat expended is necessarily wasted. According to this table, a perfect steam-engine (non-condensing), working with steam of 401°, and reducing it to 212°, would require ·806lb. of carbon per indicated horse-power per hour; a condensing engine with a range of steam temperature from 341° to 100° would require ·592lb. of carbon; a steam and ether engine, with temperature limits of 341° to 60° would need ·505lb. of carbon; and an air engine with temperature limits of 660° to 60° would require only ·33lb. of carbon. Taking the figures for the perfect condensing engine, which is supposed to be working at the rather high pressure of 120lb. absolute, we see that two-thirds of the whole heat expended is wasted, its efficiency being represented by the figures ·299—this waste arising from no fault in the construction of the engine, but solely from the narrow temperature limits. To obtain a better result, says Prof. Cotterill, it will be indispensable to overcome the practical difficulties which exist in the employment of unusual temperatures, although the wider the limits of temperature the more difficult will it be to approach in practice the theoretical efficiency.

The chapters on expansion, on clearance, and wire-drawing, and on the action of the sides of the cylinder will be read with interest by all who take up the book, for Prof. Cotterill clearly explains these branches of the subject—that is to the student: the so-called "practical man" will have some difficulty in understanding him. The vexed question of the compound engine is not treated so clearly as those who are unacquainted with the theory would like, although there can be no misunderstanding the definite statement that "the work done by a given quantity of expanding fluid does not depend in any way upon the particular machinery by means of which the expansive energy is utilised." It depends simply upon the pressure of admission, the rates of expansion, and the amount of heat received by the water from the time it enters the boiler until it returns. "The power and efficiency of a compound engine are (other things being equal) the same as if the steam were used in the large cylinder alone, with the same total expansion." The addition of the high-pressure cylinder has in itself no influence on the power or efficiency of the engine, being merely a device for partially overcoming some difficulties of high grades of expansion. But Prof. Cotterill, in laying down the dictum above quoted, is careful to point out that "other things being equal" must not be forgotten in drawing conclusions, and in the same paragraph he says that "the actual means of efficiency generally produced by compounding" is due to a diminution in the prejudicial influence of the sides of the cylinder, so that the "exhaust waste" is greatly diminished. The action of the sides is treated almost

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* The Steam-engine Considered as a Heat-engine. By J. H. Cotterill M.A. London: E. and F. N. Spon.

ively in the tenth chapter, and the
conclusions on the point include
marks upon steam-jacketing and
ating. Thus, it is pointed out that
unt of advantage to be gained by
of a steam-jacket must vary accord-
e circumstances, and in some cases
e very small. In non-condensing
the evils of liquefaction may be
ntirely removed by jacketing, but
ensing engines the effect of the
not so perceptible. In the high-
cylinder of a compound, says Prof.
, if the terminal pressure be high
ared with the back pressure, so as
idedly above the critical value, the
of temperature will be small
considerable liquefaction will
occur, even though there be
t; and if the terminal pressure
the back pressure, so that the
to liquefaction is strong, the
ay be unable to materially influ-
t tendency, on account of the high
mperature in the cylinder, which
much heat being drawn from the
out if the terminal pressure is at
le below the critical value, the
of heat necessary to prevent the
ation of water will be very small,
ket may prove of material advan-
e use of superheated steam dimi-
e action of the sides, and the
piston also exercises an important
on the depth to which the changes
ature penetrate the mass of the
but the former is unquestionably
potent factor of the two in securing

Prof. Cotterill says that he had
to add chapters devoted to certain
oints in the working of compound
and to the modern theories of
ed steam, and his readers will
t, owing to the size of the volume,
obliged to omit them. To those
e some knowledge of heat as a
physics, a thorough acquaintance
principle of work in mechanics,
familiarity with the working of
-engine and the use of the indi-
book before us may be recom-
s the best of its kind.

GAN : A COMPREHENSIVE ISE ON ITS MANUFACTURE, RAL, AND LODGMENT.*

Y JOHN WATSON WARMAN,

ate of the College of Organists, London.

—GENERAL TREATMENT IN MANUFACTURE.

H reference to one Bellows inside
nother *see* DESIGN (7, i.) and RESER-
j.).

ore exact particulars with respect to
s of some largest Organs will perhaps
: (their makers have been already

(*U.S.*) *Music Hall.* 6 Bellows and
eservoirs; the six feed into one large

Hall. The lower part of the Organ
t. wide by 4ft. 6in. deep; within this
he Bellows, four in number. The
ize of the Organ is 41 Registers.

(*U.S.*) *Cath. of Holy Cross.* (70
tops). 3 Bellows.

ool Town Hall. The supply is from
large Bellows, each having three
hese feed into twelve other Reser-
t various pressures. The Speaking
Organ is 100 Registers.

bert Hall Organ. This has a special
pressure Bellows for the Pneumatic
n addition to this it has two very
, each with but one Fold, but
e Feeders of the ordinary kind. One
placed directly over other, at a suffi-
nce to allow the Crank-shaft to play

between; thus the latter has three short rods leading *up* to Feeder lugs of upper Bellows, and three do. leading *down* to Feeder lugs of lower Bellows: the two Receivers being connected by Trunk and Rods, and one having Inverted rib, of course compensation and smoothness are both attained. The number of Reservoirs I am not able to give; two are in the Swell-box itself. The Speaking size of this instrument is 111 stops.

j. From a very rough and hurried calculation made by the present writer, each of the two Bellows seems about 11ft. × 6ft., or of 132 square feet total. What the heavier one gives there was at that time no opportunity of ascertaining.

k. *The Crystal Palace Organ.* This has nine Bellows of ordinary construction, each with ordinary Handle. The number of the Reservoirs I cannot now furnish; there is certainly one for the Swell Tuba. The Speaking size of this instrument is 65 Stops.

l. *The Leeds Organ.* This has five chief or supply Bellows, each driven by an Hydraulic Engine: the number of Distinct Reservoirs is twenty-seven. The Speaking size of this Organ is 98 Stops.

m. INSIDE SWELL-BOX. In 1851 Mr. Willis took out a Patent (No. 13,538), a portion of which related to placing the Swell Bellows inside the Swell-box; the object, of course, being to prevent the supposed evil effect resulting from compression of air through wind passing into the Swell-box while Shutters closed (*see* SWELL-BOX). It will be sufficient here to observe that the inconveniences of this arrangement would, as a rule, more than balance its advantages.

n. SIZE FOR ONE HANDLE. The actual amount of wind thrown on one Handle will obviously depend to some extent on circumstances; as weight of wind pressure, size of Pallets, nature of Stops, age and strength of blowist, &c.; but I think it may be laid down that a lad, say not over 15, should not be expected to supply more than 18 stops of Sounding size, and that an adult should, similarly, not be given more than 20 Stops (for definition of Sounding size *see* 15, v.). At same time, even latter number is sometimes exceeded; thus, the Organ in Salisbury Cathedral, by Green, which had a Sounding size of 26 Stops (including the Octave-coupler to Pedal), was blown by one man, but the pressure was light—I think only 2in. I believe the two figures just quoted will be found generally reliable.

The foregoing assumes the Handle always a single one—that is, designed for only one person; but occasionally (as at Winchester Cathedral) this will extend beyond fulcrum, so as to be grasped by second blowist, the two persons thus working one Handle; in such case, of course, the one counts as two with reference to number of Stops allotted to it.

o. For actual size of Bellows with given number of Stops, *see* SIZE (15, r.).

*** MOUNTING.

p. There are, speaking broadly, three methods of mounting the Bellows: 1, On a portion of the *Building-frame*; 2, On simple *Legs*; 3, On a *Bridge-frame.*

q. The *Building-frame* should be rendered available wherever practicable, and where no more important reasons exist to contrary, the plan form of Bellows may well be modified with this view. *See* on this point in BUILDING-FRAME (43, c.). It may be observed that it is never recommended to cut Middle-board so that it forms dowels for entry, for by this means a great deal of the leathering at that point may be brought against end grain.

r. When Building-frame not practicable, *Legs*, which are simply short pieces of thickish stuff notched out so as to furnish a shoulder to carry Middle-board, may be used, the thin portion being screwed to Trunk-band. The Leg has the great advantage of *simplicity*; of sufficient *substance* to allow of a hole or other cutting to be formed for Tracker &c. to pass through; of being positable at any point, so as to distribute the bearing points to *best advantage*, avoiding action, &c.; and it does not *diminish* Feeder area: but it requires a Trunk-band, and also affords no support to Bellows, except at outer edge; this latter, however, is easily got over by disposing a special short piece or Stump here and there.

s. When through absence of Trunk-band Legs are not practicable (and Building-frame not available), recourse must be had to *Bridge-frame*; this is simply a long rail passing edgewise under Middle-board, the rail itself being carried by two short pieces into which it is Tenoned — that is, the Style receives the Mortise; where Bellows are sufficiently large, an additional Bridge will generally be required *at* or *near* centre—that is, between Feeder (thus diminishing their area, as previously said). When the Bellows require support at other point than edge, the rail of the Bridge-frame should have short Foot or Style inserted into it to carry bearing to ground; two or even more of these in one rail, if desirable. It will, of course, be understood that if the Bellows be of Well kind (as they generally, in fact, will, if large enough to render their mounting a serious consideration), they may rest on their Wells, thus Bridge-frame required only to carry the intermediate weight.

t. When no Building-frame present, the Bellows will often be mounted on a simple rail, screwed to inside of case.

u. When Bellows mounted up close to ceiling Iron rods will often be found the best method of mounting. They should, preferably, have broad flat parts pierced for screws, and be so arranged as to brace each other—that is, give brace in every required lateral direction.

*** PRESSURE.

v. It will be seen that APPORTIONMENT, or the determination of the particular *portions* which shall receive wind of given pressure, is gone into *before* the actual consideration of what that pressure shall be. The reason is that the latter is in very many cases decided by the former. Thus, for instance, if it be determined to employ a second pressure for Augmentation of Treble, it will be obvious the increase must be slight, or a break may result; and thus will the pressure of the second Bellows be relatively determined. One of the first considerations is whether limited space will render the use of Combination Bellows necessary (*see* 7, f., and on), for in that case modification in apportionment and determination may be required (*see* 16, m.).

w. It has not been thought worth while to spend time in dwelling upon the importance of the question of Pressure; this will be best demonstrated by the care and space here bestowed upon it.

** APPORTIONMENT.

x. By this is meant, as just said, the determination of the particular portion or portions to which the wind of determined pressure shall be allotted or apportioned. It will be seen that it is here treated fully—*Determination*, on the contrary, being gone into fully in *Detailed.* (For reasons *see* DETERMINATION.)

* GENERAL CONSIDERATIONS.

y. *Echo Organ.* It may be laid down that the Echo should never be introduced except upon a lighter wind—that is to say, it demands a second, and that a lighter pressure. As a separate Section (that is, having its own separate Clavier) the Echo is strongly reprobated by author, as Swell and Choir may supply all legitimate Echo effects. If placed on Solo Manual it will interfere with that pressure, which of course should be heavier, and not lighter than usual; besides which it is not desirable to unduly enlarge the Solo, partly on account of the comparative inaccessibility of its Clavier: on the Great an Echo is of course out of question: the Swell Manual is unsuitable because its pressure is liable to be stronger than that of the Great (*see* 10, d., next). The Choir therefore must be the best Man., and when a lighter wind is already provided the Echo may do very well placed on it and sharing its pressure; but it certainly seems to author a great waste ever to place pipes in an Unshuttered box.

See further in AUG. of TREBLE (1, y.)

z. *Solo Organ.* It may be similarly laid down that the Solo should never be introduced without an additional and heavier pressure—that is, every Organ with a Solo must have as many as two pressures; the proper treatment of the Section demands two winds—one for the Tuba work, and one for the remainder; but this, of course, is not essential, except in large Instruments, as a Solo even wholly only moderately heavier than the Great or Swell is very useful and valuable.

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* All rights reserved.

See further in Aug. of Treble (1, y.), also Borrowings (26, e, to end).

[10, a.] *Choir Organ.* The pressure allotted to the Choir will vary with circumstances. If a lighter wind will enable or materially assist in enabling the Choir as well as Swell to be united to Great it is manifest the Sounding size will gain largely, and if the Choir at the lower pressure will be commensurate the plan will often be good—*see*, however, a little further on (11, b.). If it be *known* that the Choir cannot be so united more freedom of choice is allowed. If the Section be small, or put behind the Swell-box, as in Lewis's Organ at St. Mary's, Newcastle-on-Tyne (a most unwise arrangement in author's opinion—at all events, in this and similar cases), or if there will be great demands on the Choir Organ (as in Cathedrals), or other circumstances render strength desirable, then the Choir may well be on the same pressure as the Great. In Concert Instruments that have but 3 Manuals, the lowest Manual, or a portion of it, may well have a stronger wind than the Great; but as the lowest then becomes really the Solo Manual, it must be considered under that Head (*see* z., *ante*).

b. It will be seen that, in the instances given, the Choir is rarely set on a lighter wind than the Great. The reason is simply this, these instructions are to give the best results with the *lowest* number of pressures. It is obviously far better to keep Great and Choir on a moderately light pressure, and give a heavier one to Swell, than to have latter and Great on a *moderate* and Choir on a *light* wind; for the relative *size, nature, position, scale*, and *voicing* of the Great and Choir ought to keep their relative proportional *effect* right; whereas an increase for the Swell is always effective and valuable, all Registers suffering so enormously in the boxing.

c. *See* further in Aug. of Treble (1, y.), also Borrowings (26, e, to end). *See* also Reeds (h, next).

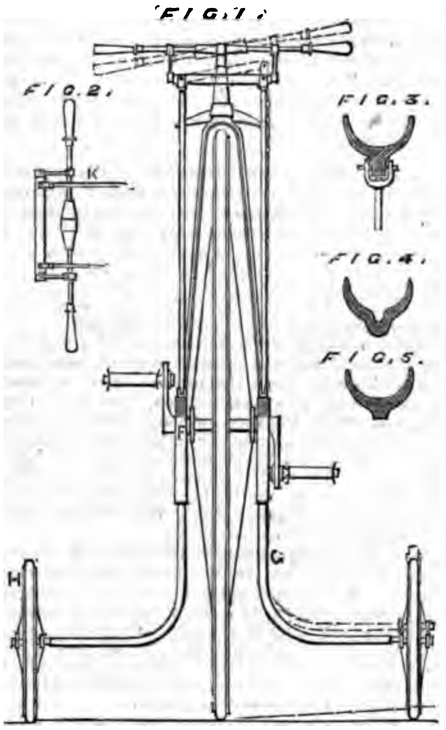
d. *Swell Organ.* The Swell should never be on a lighter pressure than the Great; and it, or, at all events, a portion may with excellent effect have a somewhat heavier. Here, again, circumstances will modify. If the Swell be large, and heaviness is feared for the touch, the pressure may well be same as Great. If Swell incommensurate or touch not feared it may well be, as just said, heavier—at all events, the Reeds. The reason why Augmentation of pressure is so valuable in Swell is, that Pipes lose, as just stated, so enormously by being boxed. The giving a separate wind to the Swell Reeds, perhaps with the Mixtures also, will much add to the value of the Swell to Ped. Coupler—the unsuitable portion for latter purpose being made to come on only when Swell to Great is out. The nature, compass, and entire size of the Swell are, of course, here to be taken into account. *See* further in Aug. of Treble (1, y.), also Borrowings (26, e, to end.)

e. *Pedal Organ.* This may perhaps be considered the Section most liable to variation in its treatment of any. There has lately been a feeling that the Pedale should be on a heavier wind than any Manual, except the Solo; this I cannot help thinking a great mistake, the Pedale has to supply a Bass for the *whole* of the instrument, and while the necessary *power* may be obtained by commensurate size, it is obvious that a heavily-pressed Pipe cannot furnish appropriate bottom for *delicate* Choir or Swell Registers, &c. The proper course with the Pedale clearly is to give it at least two distinct pressures; one—the heavier, for Reeds and Chorus, or a portion of them; and the lighter for the deeper and middle work, or a portion of it. There will, of course, be many cases in which Pedale is incommensurate in size, or bound in height (thus interfering with employment of Open Pipes), or much Grooved or Conveyanced; in such it is clearly sometimes an act of simple common sense to give a little extra pressure throughout. It will be borne in mind that the method of two pressures on Pedale is eminently favourable to the introduction of that which I have termed a *Part* Octave-coupler to that Department (*see* z, next). It will not be forgotten that there is much less risk in stiffening the Pedale than the Manual touches—1st, because the foot muscles are so much the stronger; 2nd, because there is but one Ped. Clavier, the Manuals to Ped. not being in any case a very serious consideration (*see* Specifications); 3rd, because the Pedale, at all events the heaviest portion of it, is much more suitable for the application of the Balanced Pallet (*see* that *Division*).

(*To be continued.*)

IMPROVEMENTS IN BICYCLES.

THE great objection to the bicycle—especially on the part of those who would like to use it as a means of rambling about the country—is the necessity for dismounting when the rider wishes to stay for a few minutes for the better observance of any object of interest, and dismounting and mounting are themselves attended with some risk to all except the most agile. There are, however, objections of equal or greater weight to the tricycle and the four-wheeler, and for some years the attention of certain makers of these machines has been devoted to the construction of a velocipede combining the advantages of the bicycle with those of the tricycle or the common velocipede. Figs. 1 and 2 represent a method by which Mr. J. Turner, of Coventry, proposes to combine the well-known advantages of the bicycle with the facilities offered by three and four wheeled velocipedes to the timid rider in mounting and dismounting. He applies to the bicycle a pair of small wheels, so arranged that they will serve to support the vehicle in an upright position when brought to the ground, and will admit of being raised clear of the ground when the vehicle is running, so that no impediment will be offered either to the running of the bicycle or to the action of the rider. These wheels will run on either side and abreast of the front wheel. When these supplementary wheels are on the ground the rider, however inexperienced, can mount the vehicle without risk of a fall, and can start it with facility; and when fairly under way he can then raise the two small wheels clear of the ground, fix them in their raised position, and proceed on the two centre wheels as on an ordinary bicycle. When wishing to stop, the rider has merely to lower or depress the two small wheels,



lock them in their depressed position,
can then dismount at pleasure. The pr
the fork are formed with a tubular
extension, F F, to receive the wheel st
G, of the lateral supporting wheels,
form supports and guides for the stalks
in. Jointed to the upper end of these
stalks are rods, pendent from a cross
ends of which are jointed to arms, K, k
the stem of the steering handle. This
is mounted in a swivel bearing connec
the upper end of the fork, and it is so fi
to allow of its receiving an axial motio
bearing. The axial motion of the s
handle is for the purpose of lifting the a
and throwing them up in order to l
wheels, H, from the ground; and the mo
of the handle in a swivel bearing allo
either of these wheels, H, rising on mee
obstruction on the road without inte
with the motion of the velocipede. Th
are cranked, to allow of the arms when
up taking the position shown at Fig. 2,
by reason of the joints which couple th
and rods respectively together being
past the centre of the steering hand
wheels, H, will have no tendency to
When these wheels are upon the grou
joints, being in the position shown at
will resist all tendency to yield to the u
pressure of the wheels, H; but on turni
steering handle on its axis, and thereby b
the joints outwards, the wheels will
locked and free to rise from the groun
facilitate this movement coiled springs ar
to the wheel stalks, G, above their gui
which springs, coming into action as th
are bent outwards, will lift the wheels c
the ground. They are then to be locked
action by completing the half-turn
steering handle. The provision for givi
steering handle an axial motion and a t
motion, as above explained, will in n
detract from its efficiency as a steering h
for, its bearing being attached to the for
in a manner that permits of no indep
horizontal motion of the parts, it will ac
the fork in precisely the same manner
were bolted thereto.

Figs. 3, 4, and 5 show sections of im
felloes patented by Messrs. Beck and W
of Birmingham, the object being to gai
strength at the part where the felloe is
for the spoke, and to protect the tire
injury by the spoke, while retaining t
cular groove for the tire. In Fig. 3 the
is rolled with a flange, which is clipped
fork on the spoke; but in Figs. 4 and
metal is thickest where the hole for the
is required, and in the case of Fig. 4 it
seen there is space for a large head
spoke without running any risk of injuri
tire. The patentees also claim the inv
of an improved tire, which consists in co
a core formed of any fibrous material,
rope, made either of cotton or hemp, o
(or a tube of metal of any suitable kind n
employed, and, if necessary, may fir
covered with hemp or other suitable pa
material), with indiarubber, either tubu
coiled in strips. A strong, cheap, and
ciently elastic tire is thus produced, wi
the advantages of solid indiarubber, w
its liability to injury by contact with th
or with any cutting or rough surface.

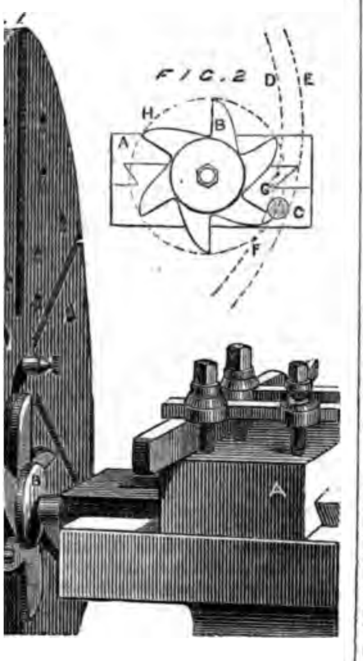
THE STAR-FEED.

THE following answer is given by a writer
Scientific American to the question :—"
can I feed a tool automatically on a lathe whi
a slide rest, but has no feed motion? Wh
star-feed?"

A star-feed is a device for improvising
motion to a slide-rest which has no self-actin
motion, or to a mechanical tool-holding device
cannot be actuated by the self-acting feed
attached to the lathe or machine—as, for ex
a boring bar. It is constructed as follows:—
the outer end of the feed screw of the boring
slide-rest, as the case may be, is fastened a p
iron plate, which, from having the form in
stars are usually represented, is called the sta
the feed is for a slide-rest a pin is fastened
lathe face plate or other revolving part, in s
position that during the portion of the revoluti
which it passes the star it will strike one of th
wings, and move it around sufficiently to brin
next wing into position to be struck by the

ucceeding revolution. When the feed is revolving boring bar the construction , but in this case the pin is stationary r revolves with the feed screw of the bar. 1 and 2 is shown a star-feed applied to a A is the slide-rest, upon the end of the f which the star, B, is fitted. C is a pin the face plate of the lathe, which, as it rikes one of the star wings, causing it to e, and thus move the feed screw. The rotation of the feed screw will depend se of the star, and how far the circle de- the pin, C, intersects the circle described eme points of the star wings. Thus the ted by D E show the path of the pin, C, F H, the path of the star points; and e from F to G the amount which one he other. It follows that at each revolu- arm or wing of the star will be carried int, G, to point F, which, in this case, is revolution. If more feed is required, we the pin, C, so that it may describe a le than D E, and cause it to intersect reater extent, in which case it will move ough a greater portion of its revolution, ry other wing and doubling the amount

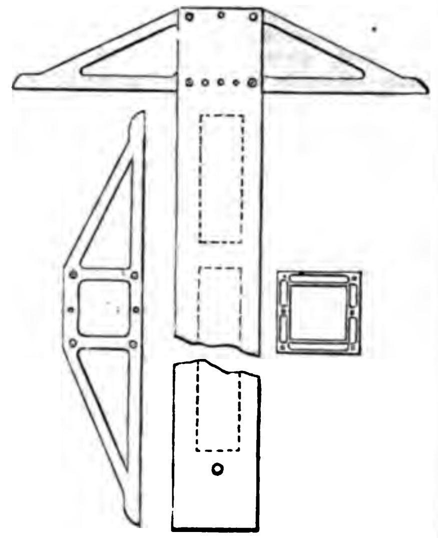
observed that the points, F and G, are the horizontal level of the slide-rest feed therefore that the sliding motion of the the face of the star wings will be from wards the points. This is better, because is easier and involves less friction than e case if the pin contact first approached ceded from the centre—a remark which lly to all forms of gearing, for a star-feed n of gearing in which the star represents el, and the pin a tooth in a wheel or a ing to whether its line of motion is a raight line.



us that in designing a star-feed, the feed screw is of primary importance. example, that the pitch of a slide-rest 4 to an inch, and we require to feed nch to every 24 lathe revolutions, then t have 6 wings, because each revolution will move the rest 1-6 inch, while each the pin, C, will move the star 1-6 of a nd 4 × 6 = 24. To obtain a very the star attachment would require to ltiplying cogs placed between it and the he smaller of the cogs being placed upon w.

CORNELL T-SQUARE.*

or five years the students connected e Sibley College of Mechanic Art, ersity, have to a considerable extent heir own T-square, generally of steel, steel blades and malleable iron heads. these years of practice by different in- T-square that seems to leave little to The main requirements of a good T- curacy and lightness. The long thin use of trouble in the first requirement, f proper material in overcoming that t to infringe on the latter. In seeking en these two steel has been successfully o material maintains its accuracy so well. It will not warp, bend, twist, or kink. For positively *true* work the steel T-square and triangle alone can be depended upon. In form, neatness and strength have been sought after. In the head, usually so profusely ornamented (?), straight lines



bending into curves give the best effect. All useless metal is cut away, and the bars are narrower at the extremes than at the middle or the head—else they would appear to the eye narrower at the middle. There are three pieces to these squares—the head, the pad, and the blade. Of their use, the pad alone needs explanation. The pad is an improvement on the flange, generally used to widen the edge of the heads of metal squares. It is placed between the blade and head. Being narrower than the head and blade by 1-16 inch, it allows the triangle to slip over the head beyond the board, with no other bearing than the edge of the blade, and lowers the bearing edge of the head below the nicks and bruises (that the greatest care cannot prevent) on the corner of the draughting board. Being used only to separate the head and blade it may be made very much lighter than the flange, as shown in the cuts.

The dimensions for blades are a width of 2 inches for blades 30 inches in length. Any narrower blade is apt to spring when the pen or pencil is drawn along the edge at a distance from the head. They are made from 16-gauge steel tempered to purple, and polished for plating. For the head the width is the same as the blade, and the length five times the width. The pad is square, and 1-16 inch less than the width of the blade. Both head and pad are made from 12-gauge steel. There are two ways of putting these squares together:—(1) By rivets or by screws permanently. (2) By screws and steady pins. The head removable. In the first case rivets are best, as they will not get loose, and throw the head out of square, and the work being countersunk, the rivets may be ground off flush. The square may be used as a straight edge, being used on its back with the head on. The second is far the best. The holes in the blade and pad through which the screws pass are reamed larger than the screws. The screw holes in the head are threaded. The steady pins are coning, the holes in which they fit are broached out coning; the pins are driven tightly; the head and pad being so much thicker than the blade retain the steady pins, and the blade being removed may be replaced on the head in the exact position it occupied before. This is an advantage peculiar to the "Cornell Square."

The head may be taken off a five-foot square, the blade being tempered, may be bent double and packed in an ordinary trunk, or, as before said, used as a straight edge unincumbered by the head. If desired, two or more blades may be fitted to the same head—an advantage in respect to cost. After the first blade has been fitted to its steady pins the second blade is fitted to the upper steady pin, the hole over the lower pin is made larger, allowing the head to be adjusted at right angles to the new blade; another pin is now put in at the side of the lower pin, so any number of blades may be fitted to the same head, all having the upper pin in common. The edges of the blades and bearing edges of the heads are trued up by the use of the straight edges made at the University machine shop, which have become so well known among machinists for their accuracy. The edges are made parallel, and tested by the measuring machine in use at the department. The squares may be said to be absolutely straight and parallel, and the bearing edge of the head at right angles with the edges of the blade. A 45-inch square weighs 1¼ lb., and may be balanced within three inches of the centre of the blade. The blade may be slotted as shown in the cut. It makes a very light square when thus slotted, but is expensive. When nickel-plated and polished they make very handsome tools.

A COMBINATION WHIRLING TABLE.

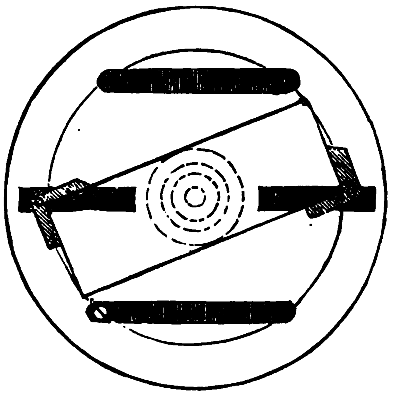
At a recent meeting of the New York Microscopical Society, Prof. R. Hitchcock read a paper on a new combination whirling table, and we are indebted to the *American Journal of Microscopy* for the following report:—

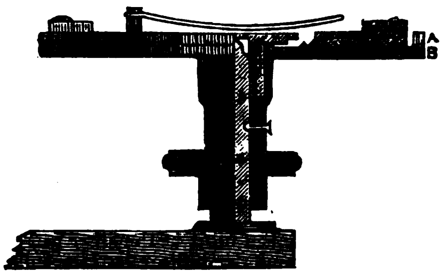
It may seem to many that a turn-table is a very small and unimportant piece of apparatus, and that the common form is good enough for all practical purposes. For myself, I cannot agree with this view. If one desires to have a good series of mounts, there is, in my opinion, no one instrument which will give so much satisfaction in use, and save so much time, as a good self-centring turn-table. It is therefore without the least hesitation that I call your attention to the one before you, made by Mr. Bulloch, of Chicago. The accompanying cuts will serve to give a good idea of its construction.

This is a self-centring table, when the jaws are used, but any slide may be centred by placing it under the springs in the same manner as on the common turn-table.

It will be seen by referring to the lower figure, which is a sectional view, that the top consists of two plates. The upper plate, A, in which the jaws move, can be turned upon the plate, B. The upper face of B has a scroll screw, such as is found in the American scroll chuck. The lower faces of the jaws have parts of a scroll screw, which work in the scroll of the lower plate. It is readily seen that when the upper plate is caused to turn upon the lower, the jaws will be made to approach each other or separate, as the case may be.

Ordinarily the brush is held in the right hand, and the direction of the motion given to the table is from right to left. There is never any danger of the slide getting loose when turned in this direction, but for a left-handed person they can be made to clamp in the opposite way if desired. The centre upon which it turns is close up under the face plate. This table is perfectly balanced, and consequently the motion is perfectly smooth and regular.





Speaking from practical use, I can say that this instrument has pleased me very much, and I can conceive of nothing better for the purpose. One of the greatest advantages I will show you this evening, and it is simply this. In clamping or releasing the slide, the under plate is moved by the finger of the left hand, which is always in the proper position for doing this when at work. I am not usually an enthusiast about apparatus of this kind, but this improvement deserves the highest praise, particularly when price is considered.

The maker claims it will run two minutes. I have timed it 9¼ minutes, and am certain that it can be made to run over ten minutes.

ENAMELLED IRON.

SOME improvements in methods of enamelling wrought and sheet iron have been patented in this country by Messrs. Quinby and Whiting, of St. Louis, Missouri, which include several features of novelty. The invention consists of a new enamel glass or coating which may contain clay, carbonate of magnesia, to render it more opaque, and assist in the spotting

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W. Manning, in *Polytechnic Review.*

or mottling processes, sulphate of magnesia, and arsenious acid, for the purpose of obtaining a more perfect adhesion between the enamel and the metal. The most important consideration in an enamel for wrought or sheet-iron wares is that, of durability, more particularly when this ware is designed for household purposes, to which this invention is chiefly applicable. This quality of durability is referable, first, to the adhesiveness of the material, whereby it clings to the iron and resists separation from it; and, secondly, to the thinness of the enamel, which renders it more pliable, and consequently less liable to break or crack when with the iron it is subjected to strain by accident or otherwise. Beauty of colour or ornament and brilliancy of finish are secondary considerations, not to be disregarded, but still not to be sought after at the expense of durability. The chief object of this invention is to secure in enamelled wrought or sheet-iron. wares both durability and beauty to a degree not heretofore reached, and by operations simpler and more direct than heretofore practised. This art, as ordinarily conducted, involves the employment of two or more coats of enamel—namely, a body coat prepared especially with the view to unite with the iron, and a second coat which is usually coloured with some metallic oxide, and is intended to impart finish and ornament to the article; and there is often a third coat over both of these especially adapted for glazing or imparting polish to the whole. The improved process comprises the composition of an enamel glass or crystal, and also the manner of applying the same with other ingredients as a coating to sheet-iron wares. The composition of the enamel glass or crystal is as follows:—Silica, 100lb.; soda ash, 35lb.; borax, 75lb.; plaster of Paris or gypsum, 10lb. to 20lb.; and arsenious acid in the proportion of 1⅛ per cent. of all the other ingredients. These proportions may be varied to some extent, but those given have been found to work well. When these are compounded the resultant mixture is an enamel glass or crystal, vitreous enough to carry a glaze of itself, with an affinity for wrought or sheet iron which causes it to adhere thereto with extreme tenacity when burned upon it, and which will not exfoliate or absorb moisture in quantity sufficient to destroy its polish. Such of the above-mentioned ingredients of the enamel glass as require it having been comminuted, all are carefully mixed together and brought to a state of complete vitrification in a reverberatory oven, with observance of the rules applicable to glass-making generally. Then the enamel glass or crystal is run off as usual into water to granulate it, when it is ready for grinding.

In making an enamel for wrought or sheet-iron ware 100lb. of the enamel glass is ground in an ordinary porcelain-mill, adding thereto about 5lb. of clay, preferably white, and having a pronounced soapy feeling, which clay helps to give body to the enamel, and to prevent its crazing when it is finally fixed on the iron in the heat of a muffle. This grinding process requires about one working day, but should always be continued until the enamel glass is thoroughly ground, and the clay thoroughly mixed with it. In most or all cases it is advisable to introduce along with the enamel glass and clay in the grinding process calcined carbonate of magnesia in the proportion of 8oz. to 100lb. of the enamel glass. This salt of magnesia serves to make the enamel coat as finally applied less transparent, contributes to the flecking or spotting of it with white, and thus in a measure prevents the iron base from imparting to the enamel coat throughout its own dull and unattractive shade.

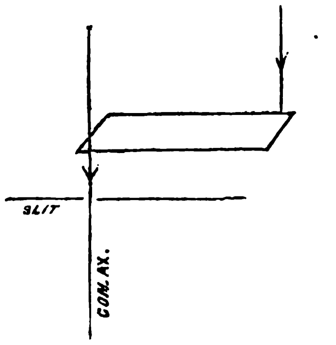
Prepared as above, the mixture is run off through a strainer into tubs, where it is allowed to remain about one day, during which time a sort of ripening is effected, when it is finally prepared as follows:—The mixture being brought to about the consistency of cream by the addition, when necessary, of water, sulphate of magnesia is added until the consistency of the mixture is such that it will no longer run like water upon the surface of the article when applied or upon the surface of the mixing spoon, but is coagulated and pasty, yet still capable of being shaken out into a thin and uniform coat. Two ounces of sulphate of magnesia have usually been found sufficient for 100lb. of the mixture. The mixture having been finally prepared, the wrought or sheet-iron article to be enamelled is dipped into it, having been first prepared by the well-known processes of annealing, pickling, scouring, and washing. For washing the article clear water is used, the wrought or sheet iron remaining therein until it is dipped. Care should be taken that the enamel coating be not laid on too heavily, and that it be evenly distributed. Having received a thin uniform coat by dipping, the article so coated is dried, for if the enamel coat is burned while still wet or damp it will crack or craze. This drying is accomplished for convenience and despatch in an oven constructed for the purpose, the range of heat in which varies from about 100 to 200 degrees Fahr., but the drying may be accomplished at summer heat in an ordinary close room.

One of the objects of this invention being to produce a beautifully mottled or spotted enamel coat, a character is given to the same by varying the temperature at which the drying is accomplished within the range mentioned above. The higher the temperature the smaller and less distinct the spots; the lower the temperature the more pronounced the mottlings. The time required will obviously depend upon the thickness of the enamel coat, and the quantity of moisture present, and upon the degree of heat employed. When thoroughly dried the coat is of a whitish colour, and usually either brown spotted or reddish brown spotted, or mottled; and when burned in a muffle is of greyish colour, dark spotted, or dark and light spotted, or mottled. The colouring matter of these spots or mottles is believed to be a salt or salt of iron produced in a hydrated form on the surface of the metal during the cleansing processes, the same being absorbed by or penetrating into the wet enamel coating when dried. The burning process is effected in an ordinary muffle at a red or cherry-red or slightly greater heat, the ordinary time required being about four minutes. The result is a beautifully mottled enamel coat, and one also which adheres to the iron base with great tenacity; and as to this quality of tenacity, it is found that if the arsenious acid is omitted the enamel coat resulting will not have the adhesive quality necessary for a good enamel; but, in practice, about 2½lb. to 100lb. of silica gives an enamel of the required quality. One coat and one burning are usually found most advantageous.

IMPROVEMENTS IN A SOLAR SPECTROSCOPE.*

BY WENTWORTH ERCK, ESQ.

THE usual practice in observing with the spectroscope, I believe, is to adjust the collimating and observing telescopes so as to render the incident and emergent pencils parallel for rays of mean refrangibility; and, on observing at either end of the spectrum, then to readjust the eyepiece of the observing telescope so as to render the emergent pencil parallel. But this mode of procedure will not give the best definition, which requires that each pencil—that is to say, the pencil first incident on the first prism, as well as the pencil after dispersion—should be strictly parallel; and this adjustment of two variables can scarcely, so far as I am aware, be made while the spectroscope is in position. Now, in the improved spectroscope alluded to, the collimating and observing telescopes are placed close together and parallel to each other, so that the observing telescope shall receive the rays after two internal total reflections. In this position the eyepiece of



the observing telescope and the collin
coupled together by rack-work, so tl
together by turning one pinion; and
first adjustment, the two pencils
strictly parallel for all parts of the s
power varies from 1 to 10 prisms of 6

The second improvement is in the r
ing round the disc of the sun. It is r
turn a heavy, complicated, and delic
instrument upside down, and into eve
position: there is great risk of th
being injured by the flexure. In the ne
the axis of the collimating telescope is
cide accurately with the axis of the g
the edge of the disc is then brought o
by the rotation of a small parallelopi
whose length is equal to the radiu
Thus the parallelopipedon alone rot
spectroscope remains stationary.
exact coincidence of the axes of the
and the collimating telescope is obtai
ing the spectroscope on a strong s
attached to the great telescope, w
adjustment between the bar and the

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* Made by Mr. Grubb for Prof. Young. From the *Monthly Notices* of the R.A.S.

THE ANALOGY BETWEE AND SOUND.—I.

BY PROF. W. F. BARRE

A LECTURE delivered by Pro
South Kensington Museum in
revised and enlarged by the autho
present form contains possibly the b
information concerning the interest
between light and sound. By the kin
Barrett we are enablad to give th
emendations in full.—It will be my
the present lecture to bring before
experiments showing the relationsh
between sound and light. At the ou
to remind you there is no direct
between sound and light; they cann
into each other, as many of the
forces can, but there is a similarity
festation, a parallelism in their phe
is exceedingly helpful in the study
common to both. The analogy of s
has, it is true, long been noticed
language we find an interesting reco
analogy. The same words are freque
sound and light. We often speak of
as well as a loud note, and every one
familiar with Locke's blind man
sound of a trumpet scarlet; and a
see before me, has known of a ca
person suffering from illness and bli
spoke of a sequence of notes as if
sequence of colours. The words D
are, I believe, cognate terms in Ang
speak and to shine, though often
things in the lecture theatre, are
the same words in Greek and in S
might trace this correspondence muc
our business is with the scientific
question. Upon that let us enter.
make this relationship clear, we mu
ground that will no doubt be famil
this audience, and hence I must as
with me occasionally for the sake of c

Almost every one is aware that s
vibration; light also springs from th
Only in the case of sound it is a

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* My friend, Mr. F. Millard, writes to m
points out many curious analogies, wh
people in all ages have instinctively assoc
colour. Thus in Greek we have ξανθός,
yellowish tawny colour, and some delica
sound, which it is hard to define. In
passage (Top. 1, 15, 4, sq.), Aristotle poin
word σομφός (spongy, porous) is applied
diate sound between λευκός (white, i.e. c
(*i.e.* obscure), and hence must be 'h
Moreover, he adds that φαιός (dusky, wh
incorrectly applied by many Greeks to t
sound. Again, in Latin *ravus* is applie
wolf and to a hoarse sound: *fuscus* is s
swarthy hue, or of a husky, indistinct v
candidus, white, *i.e.* clear. *Surdus* is
uses it of a dim, dull hue (cf. French s
dull sounds): while *clarus* is clear in colo
an able article on Grimm's Gramma
Blackwood's Magazine, February, 1840
'I say,' is shown to be connected with *bh*
(Sanscrit)—to give forth sound, and to
to speak and to shine being thus conver
modern languages we find our own sla
loud colour by the side of the stronger
schreiende Farbe,' a 'screeching' colour
'un gilet criard.' But the whole history
testimony to a physical analogy would d
than the space of a note for its discussio
historic periods of the human race the
sign of the appreciation of colour is we
fact adduced in the profound article on th
by the Right Hon. W. E. Gladstone, in
Century, October, 1877; and in the foot-n
Wallace's valuable contribution to Ma
zine, of the same date—together with
philological considerations—may, perhap
there once existed some degree of confusi
of discrimination, between the impressio
eye and ear respectively."

sensible masses of matter, in the case of light of quite insensible molecules. This, indeed, is true throughout the analogy; sound is a gross representation of its sister, light. Here I have a tuning fork, upon drawing a bow over the prongs of which you will hear a sound. The fact that the fork is vibrating can be easily demonstrated by bringing it against a little light suspended ball. The moment it touches the ball, the latter will be tossed to and fro, and as the sound of the fork dies away the ball will gradually come to rest. Vibrations of molecules giving rise to light cannot be made evident to the eye, the smallness of these molecules and the rate of their motion transcend the grasp even of our highest instrumental powers, and can only be deduced by reasoning which is rendered easier by this very analogy we are considering.

Let us now inquire in what way these vibrations reach the eye and ear respectively. Imagine a stick plunged in a lake of still water and moved to and fro; a series of waves will be produced travelling outward and onward from the centre of disturbance. These ripples moving onwards will finally strike the weeds which may grow on the bank, and bend them to and fro in perfect synchronism with the motion of the stick in the centre of the lake. Just in the same way does the sound of my voice excite aerial pulses through the air, and bends the drum of your ears to and fro in perfect accord with the vibrations which are taking place within my larynx. We can obtain an idea of this transmission of motion, without the translation of matter, by means of a simple experiment. Imagine this long elastic tube to be the only medium between myself and my assistant, Mr. Porte, who holds the other end of the tube. I wish to communicate with him, and, to arouse his attention, give a sudden jerk to the tube. You observe the jerk travels along the tube, and before I can speak, it has reached Mr. Porte's hand and jerked it aside. So that something has gone from me to Mr. Porte and conveyed my idea, and yet that something is not matter, for the tube is still in my hand. It is a wave-motion which has been transmitted, and a series of jerks give rise, as you see, to a series of progressive waves.

In like manner, a bell when struck delivers its vibration to the air around, aërial pulses are thus formed which striking our ears give rise to the sensation of sound. When a body is made incandescent, the molecular vibrations do not throw the air into motion. A finer and more elastic medium is necessary. There is abundant reason to believe that such a medium called the luminiferous ether exists, the waves transmitted through which give rise to sensations of heat and light. The rate of propagation of these sound-bearing and light-bearing waves varies very much, just as we might expect from the difference in the genesis of sound and light, the former having a molar, the latter a molecular origin. In the table hung up here you will see the rate of passage of sound and light compared. Light passing through a vacuum travels at the rate of 186,000 miles in a second, whereas sound travelling through iron only moves at the rate of 3 miles in a second, and travelling through air only moves at the rate of 2-10th or 1·5th of a mile in one second. We have therefore an enormously greater velocity in the case of light than in the case of sound. In fact, the velocity of sound through air is even exceeded by the velocity of a cannon ball, so that the ball will reach its target before the sound of the explosion of the cannon is heard. You may take it in round numbers that sound travels ·1,100 feet in a second, whilst light travels 186,000 miles in a second. If a cannon were fired at this moment at Birmingham, which is 113 miles away, the sound of the report, supposing it were audible at this distance, would not be heard here till after the lapse of 8 minutes; whilst the light of the flash would by that time have reached the sun. Approximately we may say that sound travels through 100 miles of air, in the time that light travels through 91 million miles of ether.

This will give you some conception of the enormous difference in the rate of propagation of these two modes of motion. So too we find the relative size, as well as speed, of sound-bearing and light-bearing waves is vastly disproportionate. The average length of a sound-wave, say the middle C of a pianoforte, is about fifty inches, whereas the average length of a wave of light, say a wave of green light, is only the fifty-thousandth part of an inch. Notwithstanding this vast difference many laws are common to both. This is to say, from the behaviour of one agent under certain conditions we may in general predict the behaviour of the other under like conditions. And this is just what we should expect if, as there is every reason to believe, light and sound are both the products of wave-motion—the rate of progress of the waves of each being dependent on the density and elasticity of the medium they traverse. For the element of size does not enter into the region of law. Before, however, I can render evident to you the similarity of these laws, it is necessary to have some means of revealing these sound-bearing waves, and the way in which they are affected.

This can be done by means of a delicate phonoscope—the so-called sensitive flame. I have here a tall burner through which ordinary coal gas can be passed from a holder, placed there for the purpose of increasing the pressure upon the gas. If now I light this tall tapering jet of gas, and place weights upon the holder, so that the gas shall be urged with greater and greater velocity through the burner, I shall presently arrive at a point at which the gas will be extremely sensitive to sound. There it is: and you observe the fact that not only does the flame shrink under the influence of the sound, but that the slightest sound breaks down the flame, even if I go to a great distance from it. The clink of two coins make it fall from a height of 22 inches to less than eight. The motion of the flame is not due to the impact of puffs of air upon the surface of the flame, but is due entirely to sonorous vibrations; in a previous lecture delivered to the science teachers, I have entered into the cause of this curious phenomenon. You will observe that as I speak certain sibilants are picked out by the flame, which responds to them, whereas it is not affected by vowel sounds, but s, x, z, a "whisper" and "hush" are all very powerful in their action. Now this flame is, in fact, an example of what may be called sympathetic vibration. If I strike this particular tuning fork and hold it over this particular jar of air, you will observe there is a loud reinforcement of the sound of the fork; that is due to the fact that the column of air within the jar is exactly tuned to the vibrations of the fork—hence there are sympathetic vibrations set up in the air of the jar which augment the sound of the fork. Now in the flame we have a sympathetic vibration of a column of gas analogous to the sympathetic vibration of the column of air in the jar; only in the case of the flame the sympathetic vibration is accompanied by a manifest change in the aspect of the flame, whereas there is no change evident to the eye in the aspect of the air within the jar. You see illustrations of this constantly. For instance, if a stone be poised on the edge of a precipice, and a series of puffs of air gently rock the stone to and fro, should the period of the motion of the stone coincide with the period of the successive puffs of air, the stone will ultimately be moved so violently that it will fall over the edge of the precipice. Thus a profound change is set up by the very slight sympathetic motion produced in the stone by gentle breaths of air; for the stone in its fall may produce disastrous results, in fact may change the aspect of nature for a considerable distance. Now just in a similiar way this flame, when acted upon by certain vibrations to which it responds, undergoes a profound and entire change in its structure. It is, as it were, a stone poised at the edge of a precipice, or like an inverted cone, a body in unstable equilibrium, easily upset by a feeble force.

I wish now to show you, by means of our flame, that just as light gradually decays as it leaves its origin, so sound also decays. If we go twice as far away from a small source of light, such as a candle, we shall find that the intensity of the light is only one-fourth as great as it was at the original distance. In the same manner sound gradually decays with distance. We find that on doubling our distance the intensity of the sound from a small source is only one-fourth as great, and on trebling the distance only one-ninth as great as it first was. You will be able to perceive the decay of sound by gradually moving a watch away from the flame. You observe now that this flame, though not as sensitive as it can be made, for in a room of this kind, subject to a great many draughts, we cannot obtain it as sensitive as in a laboratory properly prepared for the purpose; nevertheless even here we see the flame beats time to the watch, but on taking the watch further away the flame ceases to respond to it. I will now introduce a tube between the two, and we find by the renewed response of the flame that the tube has prevented this decay of sound. This, in fact, is the behaviour of speaking tubes, and a similar law holds good for light; we may prevent the decay of light by forcing it to pass in a parallel beam through the air or by sending it through a glass rod, which is the analogue of a speaking tube, incessant internal reflection preventing the lateral divergence of the beam of light.

The death is announced, at the age of 66, of Mr. Walter Buchan, sculptor, many specimens of whose chisel adorn the exterior of the Houses of Parliament, the Leeds Town Hall, and important buildings in Glasgow, Halifax, and other large towns.

Imitation Ebony.—Oak is immersed for forty-eight hours in a hot saturated solution of alum, and then brushed over several times with a logwood decoction prepared as follows:—Boil 1 part of best logwood with 10 parts of water, filter through linen, and evaporate at a gentle heat until the volume is reduced one-half. To every quart of this add from 10 to 15 drops of a saturated solution of indigo, completely neutral. After applying this dye to the wood, rub the latter with a saturated and filtered solution of verdigris in hot concentrated acetic acid, and repeat the operation until a black of the desired intensity is obtained. Oak thus stained is said to be a close as well as handsome imitation of ebony.

SCIENTIFIC SOCIETIES.

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ROYAL ASTRONOMICAL SOCIETY.

THE second meeting of the new Session was held at the Society's Rooms, Burlington House, on Friday, the 12th inst.; Lord Lindsay, M.P., President, in the chair.

M. Camille Flammarion, Avenue de l'Observatoire, 36, Paris, and Alfred J. P. Shepherd, Esq., B.A., Queen's College, Oxford, were balloted for and duly elected.

Captain Abney read a paper "On the Photography of the Red End of the Spectrum." He said that about two years ago he had read a preliminary note upon the subject, in which he stated that he had succeeded in obtaining photographs of parts of the spectrum as far below A as A is below D. He had not then shown any of his photographs, and had promised a further paper on the subject, and he thought it right now to redeem his promise by giving some further information on the subject. He had, by the use of gums and a method which he did not explain, succeeded in obtaining emulsions which were sensitive to the red end of the spectrum. His theory was, that by this means he had obtained a larger and more complicated molecule which was sensitive to longer wave-lengths than the ordinary iodide of silver molecule. Some of the photographs which he had obtained were thrown upon the screen by means of the electric light. It appeared that the plates, as prepared by him, though sensitive to the red and ultra red parts of the spectrum, were not sensitive to the yellow rays; there was consequently a gap extending from a little below E to C. In the photographs which were taken with a diffraction spectrum, the lines were beautifully sharp. He had submitted them to Professor Piazzi Smyth, who said that the photographs reminded him of the red region of the spectrum as seen under the best conditions in the clear atmosphere of Spain.

Mr. De La Rue complimented Captain Abney on the important discovery which he had made, and asked whether he had made any progress in the direction of producing coloured photographs similar to those which had been taken by M. Becquerel some years ago.

Captain Abney said that, in a paper which he had read before the Royal Society, he had stated that he believed he had discovered the explanation of these coloured photographs. The colouring depended upon the different oxidising powers of the different wave-lengths of the spectrum.

Lord Lindsay asked Captain Abney how he had managed to focus for the ultra-red parts of the spectrum? He had noticed that the lines on his photographs were very sharply defined; but he concluded that the focusing must have been obtained by a tentative process.

Captain Abney said that he had not come to the society to be pumped. He had, however, obtained the focus by a tentative process. It would be seen that there were lines upon the photographs, which could not be seen with the eye, and there were groups of lines distinctly defined upon the photographs, which could only be seen with the greatest difficulty in observing the spectrum.

Lord Lindsay said that he felt sure that the society would join with him in returning a most cordial vote of thanks to Captain Abney for his interesting communication. He would only add that when a paper of such interest was brought before the society the fellow making such communication must not mind a little cross-examination, and should remember the pleasure and information he was affording to the other fellows of the society.

Mr. De La Rue said that Captain Abney might have the consolation of feeling sure that his well would not be pumped dry.

Mr. Ranyard read a communication which had been received by the Astronomer Royal from M. Fizeau, the President of the French Academy, stating that a committee had been formed for the erection of a statue to M. Leverrier. Subscriptions for this object might be sent to M. Fizeau, or the secretaries of the French Academy.

The Astronomer Royal said: In reference to this matter I think it desirable that the society should remember what has been done in other instances of a similar character. Two or three instances occur to my mind—one was the erection of a monument to Sir Isaac Newton, at Grantham. I am not aware that steps were taken in that instance to solicit contributions from foreign men of science. I speak, of course, under correction, and only of what came to my own knowledge, but I believe that what was done was done entirely by Englishmen. Another instance is that of a memorial to Gauss, although circulars requesting contributions were in that instance addressed to Englishmen, I do not think that much, if anything, was done in England. In my own view of the matter it seems to me that a feeling of local pride should be relied on. I am quite sure that no one who has studied what Leverrier has done during the last 20 or 30 years can have anything but one opinion with regard to that intellectual giant. He was a very great man, but I consider that each country is well able to look after and celebrate the men of science of its own nationality.

Lord Lindsay stated that it had been suggested that the society might, as a body, subscribe, but it seemed to be doubtful whether the council had by the bye-laws power of voting money for such an object.

Mr. Jenkins then read a paper on the "Luminous Spot on Mercury in Transit." After referring to the records of the observations of transits of Mercury made during the last 170 years; he came to the conclusion—(1) that in the May transits, when Mercury is near aphelion, the luminous spot is in advance of the centre of the planet, whereas, in the November transits, when the planet is near perihelion, it appears that the luminous spot follows the centre; (2) the luminous spot has never been seen at the centre, but always a little south of it, and it cannot be due to diffraction; (3) in some of the transits two spots have been seen close together where shortly before only one was observed; (4) in the May transits the rings round the planet are dark and nebulous, while in the November transits they are bright. In the two transits most accurately observed—namely, those of May, 1832, and November, 1868—the contrast was found to be very great and typical. In the 1832 transit there was a diffused spot preceding the centre with dark rings round the planet, while in the 1868 transit there was a sharply-defined spot following the centre, with bright rings surrounding the planet. Mr. Jenkins therefore concluded that on the 6th of May next, when Mercury will be near aphelion, the luminous spot will not be a point of light with no sensible diameter, but a diffused spot rather to the south of the centre, and the planet will be surrounded by dark nebulous rings, and not by light ones.

The Astronomer Royal said that he was somewhat surprised that Mr. Jenkins had not, in the survey of the observations which he had made, taken any notice of the observations made at Greenwich, which were published in the annual volumes of the Royal Observatory.

Mr. Chambers expressed a wish that the paper of Mr. Jenkins might be published, so as to be in the hands of fellows before the 6th of May next.

Lord Lindsay said that he had intended to ask some of the gentlemen who had observed the transit of Venus to aid him in bringing out a circular suggesting the physical observations which should be attended to. He feared it was now too late to ask the aid of the society in anything of this kind. He believed, however, that the observers at Washington had issued a circular with suggestions on the subject.

Mr. Ranyard said that the circular alluded to referred principally to observations of the time of contact, but it was also of great importance that the physical phenomena, such as Mr. Jenkins had alluded to, should be carefully studied. Any suggestions with regard to observations to be made of the spot or spots of light near the centre of the planet would be of considerable interest, as there seemed to be still a great deal of mystery about them, and it was by the study of such mysterious and apparently inexplicable phenomena that new facts were frequently brought to light.

Mr. Knobel said that the Washington circular was mainly intended for the use of very inexperienced observers. It detailed the methods that should be adopted for securing the time of contact, and a diagram was given which it was suggested should be placed at a distance of half a mile, and examined in order to prepare the observer for the apparent size of the planet.

The Astronomer Royal said that owing to the Transit of Venus Expedition he had now at the Royal Observatory several telescopes. He was not at liberty to allow them to be taken away from the Observatory, but if a number of gentlemen—say, eight or ten—were disposed to watch that portion of the transit which would be observable at Greenwich, he would afford them out-of-door accommodation, that is, a telescope, a table, and a chronometer each, but they would have to give him a fortnight's notice.

Mr. Green showed some drawings of the planet Mars, made by Mr. Schiaparelli, of Milan. They showed very remarkable chain-like or mottled structure about the equatorial regions of the planet, and Signor Schiaparelli was of opinion that important changes had been going on upon the surface of the planet since the time when it was in opposition. Mr. Green and other gentlemen who took part in the discussion were, however, of opinion that, considering the small apparent diameter of the planet at the time that the observations were made, and the smallness of the instrument with which the planet was observed, the evidence of the changes must be received with very great caution.

The President then drew attention to a large oil painting which was exhibited in the room. It represented sunset upon a lunar crater, and the picture was criticised from an astronomical point of view by Mr. Marth, Mr. Ranyard, and other gentlemen.

The meeting adjourned at a quarter to ten o'clock.

INSTITUTION OF MECHANICAL ENGINEERS.

AT the meeting of this institution on Friday in the Hall of the Institute of Civil Engineers, Westminster, Mr. John Robinson, of Manchester, in the chair, a paper was read by Mr. William Boyd, of Newcastle-on-Tyne,

On Experiments Relative to Steel Boilers.

In 1877 Messrs. H. Clapham and Co., shipowners, of Newcastle, decided to build a new steamship wholly of steel, and specially suited for the Bilbao iron ore trade. The contract was given to Messrs. C. Mitchell and Co., Walker-on-Tyne, and the machinery was ordered from the Wallsend Slipway Company, who were to construct the boiler entirely of steel made by the Landore Siemens Steel Company. As the vessel was to be classed at Lloyd's, the machinery and boiler came under the supervision of the engineering department of that society, and to satisfy their conditions the experiments described by Mr. Boyd were undertaken. It was determined, after careful consideration of the results of certain experiments, that it would be best to use steel rivets, and to fit the boiler with solid drawn steel tubes, so that the structure might be homogeneous. Tensile tests showed that regularity of quality was now obtainable in a large specification of steel plates without practical difficulty, and that it was not advisable to submit a steel boiler to a greater hydraulic test than twice the working pressure. It would seem that "chain" riveting was superior to the zigzag arrangement, even though the area of solid plate left untouched by rivet holes remained the same, and that the joints if made in steel, would stretch very considerably, and relieve the pressure in the boiler long before it might actually burst. These trials showed briefly, with regard to punched and drilled holes, that the material is not injured by drilling; that it is injured to the extent of about 33 per cent. by punching; but that the nature of the material is restored entirely if the plate be heated and annealed after punching, and allowed gradually to cool—a process of which the benefit may be largely obtained, it was suggested, by using heated steel rivets. In conclusion the author spoke in terms of confident expectation of the future employment of Siemens' steel plates for the construction of boilers.

In the discussion' which followed Dr. Siemens gave the results of experiments, which showed that at least under certain conditions and by the use of some tool like the spiral punch, there would not be anything like such a diminution of strength by punching as Mr. Boyd's figures indicated. Against the use of iron rivets in steel plates Dr. Siemens strongly contended. He had lately witnessed some experiments at Swindon with a view to bursting steel boilers, which he might say entirely failed, for it seemed impossible to burst a steel boiler; the joints and fittings might be opened or twisted so as to permit leakage, but the plates would not break. Mr. Tweddle, referring to a letter from a French engineer—M. Barbar, of Creusot—said that steel was being used largerly in France both for locomotive and marine boilers, and that the typical boiler there seemed to be of steel. Mr. Platts said his experience of French steel for locomotive boilers had been unfortunate; within two months the fire-boxes of a large number of engines had all split, and he should like to know whether, supposing our large ironclads were fitted with steel boilers, and they were obliged to operate in the Black Sea, or in any part of the world where it might be necessary for anthracite or any very hot coal to be used, their fire-boxes, if made of this "mild" steel, could stand for any considerable time. Mr. Tweddle said that in the typical steel boilers used in the French Navy the fire-boxes were not of steel. Dr. Siemens and Mr. Adamson concurred in believing that had "mild" Siemens steel been used in the cases Mr. Platts had mentioned, no splitting would have occurred. Mr. Boyd, in replying, said that to his knowledge only two merchant steamers had been sent to sea with steel boilers, but many vessels were at present being built in the Clyde district fitted with steel boilers, and time must show whether the material would stand the wear and tear to which marine engines were subjected, as well as it had done in land engines. The reading of a paper by Dr. C. W. Siemens "On the Construction of Vessels to Resist High Internal Pressure" (based on his patent described on p. 445, Vol. XXVI.), and the discussion of the subject lasted until the end of the meeting, when the president announced that the next meeting would be held on the 11th of June in Paris.

INSTITUTE OF NAVAL ARCHITECTS.

THE annual session of this institute was opened on Thursday morning at the Society of Arts, Lord Hampton presiding. The first paper was read by Mr. Martell, the chief surveyor of Lloyd's, on

Steel for Shipbuilding.

He said that the time had now come when it could be said by others besides manufacturers that steel could be used with as much confidence as iron in shipbuilding. It was held that while the properties of "mild steel" were in every way superior to iron, the cost, having regard to the reduced weight required, would warrant the shipowner, from a commercial point of view, in adopting the lighter and stronger material. That these views were shared by shipowners was shown by many steel vessels being under construction, and during the last 12 months the committee of Lloyd's had had before them the particulars of over 5,000 tons of sailing ships and 18,000 tons of steamers, with a view to such ships being, if built, placed upon the registry books. He entered into the subject in great detail, and the result of his calculations was in favour of steel ships being more profitable carriers than iron, and pointing to the fact that some vessels had been running for years without leading to the conclusion that there was more rapid deterioration in steel than in iron if the vessels were properly coated and attended to.

The next paper was by Mr. W. H. White, assistant constructor of the navy, on the "Comparative Efficiency of Single and Twin Screw Propellers in Deep-draught Ships." He went at length over the steaming powers of many of our ironclads, and held that the results affirmed that twin screws had proved more efficient than single screws as regarded economy of power.

Dr. Joseph Woolley then read a paper on the "Theory of Deep Sea or Oscillating Waves." He entered into an analytical solution of the problem presented in the proposition—that, while deep-sea waves do conform to the known laws of fluid motion, there may exist other forms of motion. The other papers were chiefly of a strictly technical character.

MICROSCOPICAL SOCIETY OF LIVERPOOL.

THE fourth meeting of the tenth session of this society was held on Friday evening, 5th inst., at the Royal Institution, Liverpool; Mr. George F. Chantrell, President, in the chair. The hon. sec. announced the following donations: Six slides, rare crystals, from Mr. T. H. Day; "Des Microscopes et leur Usages," by Chevallier, from Mr. W. H. Weightman; a volume of micro-photographs of Diatomaceæ, taken by and presented to the society by Dr. John Redmayne, of the Bolton Microscopical Society; proceedings of the Liverpool Library and Philosophical Society, &c.

Dr. Rickard exhibited and explained a new form of polariscope for the oxyhydrogen microscope, exhibiting also its effects with the new magic lantern oil lamp.

Mr. Isaac C. Thompson, hon. sec., exhibited a number of exquisitely fine microscopic tracings of Lissajous' curves on glass and steel, drawn by Mr. R. G. West, of London.

The President (Mr. Chantrell) then exhibited drawings of a common town moss, the "Ulva Crispa" (confervoid alga), showing the development of Protococcus from the plant in its decay on distilled water. Above a score varieties were figured, all arising in a single disc-box, in course of 14 days' careful observation. Besides these were found many examples of Amœba, Actinophrys sol, Monads, &c. The Protococcus is one of the subjects given for careful study in Professors Huxley and Martin's valuable class book on "Histology."

Drawings from life were also given of para[illegible] confervoid alga on the Fontinalis antipyretica, [illegible] the internodes of which the vegetable contents [illegible] become transformed into active zoospores; but [illegible] the internodes of the one plant were not alike, [illegible] one out of the five of which the plant consisted con[illegible]tained active leech-like forms, this, no doubt be[illegible] due to the varying germs contained in the protopl[illegible] of the plant. The active growth of parasites was mostly observable in the autumn and winter condi[illegible]tion of plants—that is, in their decay. Drawin[illegible] the Spirogyra (another confervoid alga), a [illegible] remarkable plant for the beauty of its varied [illegible] forms, and to the microscopist and botanist it [illegible]teresting in its conjugating condition. The co[illegible] of one cell in one plant throwing out a proce[illegible] junction to meet that of another, by which th[illegible]tents of the one cell were discharged into that o[illegible] other, fertilising it, and the future spore prod[illegible] The drawing showed four cells in which this [illegible] been seen to take place, but separating three o[illegible] the four cells were two others in which no junc[illegible] had been thrown out. In these the chloro[illegible] contents had become converted into living zoosp[illegible] and very similar to those before described in [illegible] parasite on the "Fontinalis antipyretica."

Mr. Chantrell said he had followed the fu[illegible] condition of these spores. He had found tha[illegible] colour gradually changed from a bright gre[illegible] olive and brown, and other changes had taken [illegible] in the internal condition (witnessed only the [illegible] before). He had watched the spores in the pro[illegible] of change—the outer skin, as it were, breaking [illegible] and in place rays or spines were thrown out, [illegible]verting the vegetable spore of the "spirogyra" [illegible] an undoubted "Actinophrys sol."

Several living specimens of these were [illegible] bited at the conversazione, as also of spores in cells.

ting discussion followed. in which the Higgins, C. H. Stearn, Dr. Symes, and anister took part.

lent announced that the next meeting ould be devoted to the exhibition of s.

ROPOLITAN SCIENTIFIC ASSOCIATION.

l monthly meeting was held on the 9th ; Shaftesbury Hall, E.C.; Mr. Chas. .S., President, in the chair. The er was by Mr. W. K. Marriott, on

Lac and the Lac Insect.

ott gave interesting particulars of his ches into the natural history of the lac rning which so little has been hitherto specimens could not even be obtained rs of microscopic objects. The lac ecies of coccus, which secretes the gum nmerce as gum lac, and upon opening this substance entombed insects are ll as cavities formerly occupied by bers. He had dissolved stick lac in ie, and the released insects, mounted, l in detail at the meeting. The young alive about July, and at once finds its part of the tree on which it fastens, g the juices of the tree, begins to secrete ng at this period are of elliptical out- owards the anterior, and have two eyes rs of legs, besides two other protuber- in the case of males, develop into the age of a month no difference in ible, but afterwards remarkable diver- place. Supposing it to develop into a n eight or nine weeks it loses its eyes, legs, but its head and posterior organs rmally enlarged. The mouth shows tubes, and the proturberances on each rth extensive trachea. The female, it l, is permanently incarcerated in the nale is developed, the short antennæ the eyes protrude, and two other eyes e ventral side of the head, while the oble limbs. If born in July the male but if born later he possesses them, ent being necessary from the fact that the female under different circum- cell is, of course, provided with an which he can issue. The proportion nales has been estimated at 1 to 5,000, n to question, as some masses examined ott showed the males to actually pre- The young are born in July, and by are secreted, and in September the npregnated. About September 20 the ealed under the lac throw out great a cottony-looking substance through tures. The pouches now contain ova bules containing oily matter, which is food of the young, and globules con- ing matter. The young issue from nd, if crushed at this time, yield a The insects do not appear to frequent riety of tree, but possess the power of kind of juice into gum lac. It seems the lac is secreted through the orifices ecause the insect, when examined, has forations, giving him an appearance Foraminifera.

se of the discussion which ensued, the nted out the remarkable manner in riginal Sanskrit term for gum lac— ha, had been followed by the allied German—Lack, gummilack; French nme lácque; Italian—Lacca, gomma- h—Goma laca; Russian—Laka, gum- n—Laak; Hindostanee—Lak'h. The s of the lac insect exhibited had been remarkable success by the librarian, .

ful new high-level bridge erected by Sir strong, across the Jesmond Dene, in of Newcastle, has been opened to the

hina.—The China *Mail* hears from the coal mines there are a great suc- re hundreds of tons now lying about, s appear to have got the coal so fast ngements for its transport and sale r behindhand. The workers are now ed "winning out the seam." It nonths before the works are in proper tion. Between 200 and 300 tons, how- g turned out per week, and the coal y been worked about six weeks. It that the screens would shortly be in he railway from the mines to the ready in working order down to the

SCIENTIFIC NEWS.

THE fifteen candidates for the fellowship of the Royal Society were selected last week by the Council, and in due course will be elected on June 6. In alphabetical order they are J. Gilbert Baker, F. Maitland Balfour, Rev. T. G. Bonney, Prof. J. Henry Cotterill, Sir Walter Elliott, Rev. Canon Greenwell, T. Hawksley, J. Hopkinson, D.Sc., J. Hughlings-Jackson, M.D., Lord Lindsay, F.R.A.S., S. Roberts, M.A., E. A. Schäfer, H. Sprengel, Ph.D., G. J. Symons, C. S. Tomes, M.A.

M. Coggia announces the discovery at Marseilles of a new planet of the tenth magnitude, in R.A. 12h. 36min.; N.P.D. 90° 58′, moving southerly.

The medals of the Royal Geographical Society will, it is said, be awarded to Captain H. Trotter and Baron F. von Richthofen.

At a recent meeting of the Physical Society Lord Rayleigh exhibited an apparatus he has employed to secure absolute uniformity in the rate of rotation of an axle for certain acoustical experiments. The axle is driven by a power just sufficient to produce the desired speed, and at equal distances around its circumference are arranged four soft iron armatures, which pass successively in front of the poles of a horseshoe electro-magnet. The current is rendered intermittent by passing it into the body of a tuning fork, vibrating about 40 times per second, which it leaves through a small platinum stud touched at each vibration of the fork, the current traversing a small electro-magnet between the prongs, and maintaining the motion of the fork; thence it traverses the horseshoe electro-magnet and returns to the battery. If the driving power is just sufficient to produce the required speed, the axle making one revolution to every four vibrations of the fork, the armatures will be so attracted by the magnet as to be opposite to it at the middle of its period of magnetisation; but if the driving power is insufficient, or from any cause the armatures are displaced from their proper position, they will be attracted by the magnet until the error is compensated. The axle also carries a hollow metallic ring, filled with water, to act as drag. A disc perforated with rings of holes rotates with the axle, and by looking at one prong of the fork through a ring of holes corresponding to the number of vibrations made by the fork, it is easy to see that the uniform rate is maintained by the apparent stationariness of the fork-prong.

In digging the grave for the remains of Sir Gilbert Scott, the virgin sand of Thorney Island was laid bare, showing the wave-mark clearly. It is rare indeed to meet with the virgin sand in digging graves in the nave of the Abbey, because nearly every foot of the soil has been disturbed at some time or another.

A remarkable proof of the present value of substances formerly regarded as waste is seen in the fact that the Bradford Town Council have been offered more than £10,000 per annum for the next seven years for the refuse of the Bradford Gasworks. The average price received during the last ten years was £800, and the contractor who has paid that sum for the past seven years increased his offer to £8,000, which it appears is considerably below the value. The increase is partly due to the advance in price of sulphate of ammonia, but is mainly occasioned by the aniline and other products now obtained from the "refuse" of coal distillation.

Lord Houghton stated in the House of Lords last week that continuous brakes had not been more generally adopted by the railway companies because uncertainty still prevailed as to which was the best brake. We had thought that this uncertainty was confined only to those who allow professional prejudices to sway their judgments; but at any rate the London, Brighton, and South Coast Company is setting an example which, if followed by two or three of the other prosperous companies, will finally settle the matter, in spite of the engineers. A paper on brakes is to be read at the Paris meeting of the Institution of Mechanical Engineers, and the company above-named has consented to fit up an experimental van with self-registering apparatus, to indicate the exact pressure the brake blocks are required to exercise to produce the maximum retardation at various speeds, the rapidity with which all the blocks in a train are brought to bear upon their respective wheels, and to record the speed at different moments between the application of the brakes and the stopping of the train. Practically the results that will be obtained are known, but if other companies will do the same, and place the experiments under control that is beyond even a shadow of suspicion of bias, perhaps the Board of Trade will be able to take a more pronounced opinion in the matter.

It is understood that the Government will introduce a bill requiring railway companies to take precautions for preventing the loss of life amongst their *employés*, especially in the goods yards and other places where trucks are coupled up. Amongst the numerous contrivances for facilitating that operation, one recently patented by Messrs. Douglass Bros. is said to have received the approval of the Board of Trade. It is very simple, and does not necessitate the alteration of the present arrangements, but is merely an addition which can be applied at the cost of a few shillings. We shall be glad to hear more of it.

The trials as to the penetrating power of shells fired at armour plates have, so far, resulted in the complete triumph of Sir Joseph Whitworth's compressed steel. They were the only projectiles that passed through the 12in. iron plate, and they passed through practically uninjured. Five English and four foreign firms competed, but the other shells failed to get through, and were either broken up or so distorted as to be useless as shells, even when fired against thinner plates. A shell which bulges so much as to distort its exploding arrangements and "go off" harmlessly outside a ship is practically as useless as those which break up and drop their explosives into the sea. What is wanted is a projectile that will penetrate the armour and retain its "liveliness" unimpaired.

An interesting volume by M. Bixio, President of the General Omnibus Company of Paris, has lately appeared. It relates to the feeding of horses in great industrial stables, and five years of experiments with a body of 10,000 horses. Among other things M. Bixio gives a classification of eight different kinds of hay, according to their natural weight. Then he classifies them according to their nutritive value for azotised matter. It is thus shown that the heaviest hay (weighing 51·100k. the hect.) ranks last in nutritive value; that the hay of Beauce, Chartres, which comes fourth in weight, is first in nutritive value; and that two other hays having the same weight rank second and sixth respectively in nutritive value. Thus, determination of the value of a hay by its natural weight is vicious. Further, it is a mistake to suppose that a fixed quantity of maize, *e.g.*, can be substituted for (say) 1 kilog. of hay. The proper equivalent in maize must be determined by analysis of the grains. The importance of theoretical treatment of these questions is obvious, and where such a large animal force as that of 10,000 horses is concerned, it opens a way to large and useful economy.

The death of M. Soleil, inventor of the saccharometer, at the advanced age of 80, is announced. He was a master in the science of modern optics.

The Handels und Gewerbekammer of Ulm have offered a prize of 300 marks for the best design for arrangement of a bedroom in a good middle-class house. Particulars are given in the *D. Allg. Pol. Zeitung*, March 23, 1878.

The food supply of large armies in times of war is an important problem in these days. It will be remembered that the sausage-like article called erbswurst, which consists chiefly of peas-flour, was largely used by the Germans in the war of 1870. Experiments with it in the French and Russian armies have shown that it does not universally commend itself to the taste of different nationalities. We learn from the *Deutsche Ind. Zeit.* that a new meat conse called "courrousa," patented by M. Jacq of Nantes, has lately come into use, and promises to be of good service. It has the form of a double gun cartridge, each piece measuring 11cm.; the envelope is of tinfoil, and the mass inside is homogeneous, and compressed hard enough to resist penetration by the nail; it has an earthy fracture, and when stirred with water which is brought to boiling makes excellent meat soup. Analysing the conserve, Dr. Cech found in 100 parts 5·20 of water, 4·32 salts, 1·50 fat, 47·00 starch flour, and 42·21 meat meal. This conserve, then, has the advantages of small volume, handy form, resistance to atmospheric influences, cheapness of envelope (which can be easily removed), and of giving in a few minutes good meat soup, containing ·42 per cent. of nitrogenised substance.

When a struck tuning fork is quickly immersed in a vessel of water one hears—especially if he places his ear on the resonant table—a tone, the pitch of which does not agree with that of the tuning fork in air. From theoretical considerations M. Auerbach lately concluded that the tone must be lowered, and that the tones in air and water must be as 1·18 to 1, or as 7 : 6, the interval being thus greater than a whole tone, and less than a minor third. Experiment showed that the interval approximates this value as maximum, but on an average is somewhat less. The approximation is greater the smaller the period of vibration. These researches are described in Wiedemann's "Annalen."

A French lad of 16, having experienced, in June, 1875, severe headaches, followed by a kind of mumps, felt soon after as if there was a sort of bar in his forehead, and this became intolerably painful after three minutes' reading or six minutes' writing. Treated with leeches, blisters, hydrotherapy, iron, he felt no better in Janauary, 1876. Supposing that the headache might be due to disorders of refraction through short-sightedness, the eye doctors recommended electric currents and smoked and blue glasses, but without success. At last M. Fano, in November, 1876, prescribed the concave glasses suited to myopy, but with a yellow colour. The patient rapidly improved, and by February was able to resume his studies and work all day without any fatigue of the head. By changing the conditions of perception, by the retina, of luminous rays, M. Fano here sought to diminish the functional activity of the brain, in imitation of Ponza's method of treating some cases of madness. Yellow light, taken by chance, having succeeded, M. Fano asks whether it is not simply idiosyncrasy which renders patients apt to be influenced by glasses of different colour, for M. Ponza has mostly succeeded with blue, green, and especially violet light.

M. Toselli, the well-known inventor of apparatus for making ice, has lately found a means of producing ice-blocks of 1 to 5 kilogrammes, in any country, in two minutes. The reason, says *Les Mondes*, why machines which act through refrigerating mixtures can produce nothing in summer—especially in tropical countries—is, that the cold obtained, though intense, can last only a few instants amid the surrounding heat. Now, M. Toselli has devised a very simple instrument, by means of which the cold can be seized instantaneously. The operation is brought to its maximum of rapidity. Thus a child may, in two minutes, produce thicknesses of ice which could only be obtained in other machines in four or five hours' action of several horse-power.

The telephone has received a new and ingenious application by M. D'Arsonval. It is found to make a wonderfully sensitive galvanoscope. From direct experiments he ascertained that an induction coil will affect the telephone at a distance 15 times that at which its action ceases to be perceptible on a prepared frog, which is the most delicate galvanoscope hitherto known. The sensibility of the telephone is estimated to be 200 times that of a frog's nerve. Unfortunately the apparatus does not seem to be capable of furnishing measurements of currents, but only of revealing their existence.

A well-known French chemist—M. Phillippe, of Clermont—has devised a very simple means of separating arsenic from tin and antimony, with which it is precipitated and intimately mixed under the influence of sulphurised reagents. The process consists in boiling in pure water the mixture of the three sulphides. The sulphides of tin and antimony remain absolutely unaltered; but, on the other hand, the sulphide of arsenic is completely decomposed. sulphuretted hydrogen is liberated, and arsenious acid is dissolved. By filtering, all the arsenic contained in the substance is separated from the insoluble matters. This should prove a useful fact for chemical analysis and legal medicine.

In a recent communication to the Industrial Society of the North of France, Abbé Vassart called attention to a process (which is too little known) of treating wool largely charged with lime. Acting partly by dissolution, partly with decomposing effect through a certain rise of temperature, grease seems to be the most appropriate substance for treatment of such wool. The experiments leave no doubt as to the important economy of soap realised by this means. When the wool contains only a little lime it may be submitted to the action of dilute sulphuric acid.

The Telephone.—A modification of the telephone is described in the *Moniteur Industriel Belge*. The receiving instrument is in all respects identical with that known as Professor Bell's. The transmitting instrument is thus constructed: The bobbin of wire in the ordinary instrument is dispensed with, and the magnetised core replaced by a bar or screw of copper. This is brought as closely as possible to the vibrating iron disc. The copper is connected with one pole of a battery, the other pole being to earth. The vibrating disc is connected with the line wire, which is attached at the other end to the receiving instrument, the circuit of course being completed through the earth.

Plaster Casts of Fish.—Fish are taken as fresh and perfect as possible, wiped with a cloth, not only to dry the moisture, but to remove the mucous secretions. The fish is then laid on a flat smooth board, and placed in a natural position by means of little lumps or wedges of potter's clay, raising the parts liable to drop below the axis of the fish. The fins are spread out upon flat cushions made of potter's clay, and are kept in their spread position by means of pins. When the fish has been firmly set in a natural position a rather thin mixture of plaster of Paris and water is poured over the fish, and repeated coatings of this material are applied until a sufficient thickness is attained, when it is allowed to set moderately hard. The mould is now turned over and the fish removed. When the cast is made, a slight coating of shellac varnish is applied throughout the inside of the mould. The plaster of Paris mixture is then poured in, and when sufficiently "set," the mould is chiselled away, the shellac coat guiding the workman as to the depth it is safe to cut. The cast is now trimmed of its rough edges and projections, and a square stiff frame having been made, with the inner edges studded with nails, the cast is placed within it, lying on a flat table, and plaster of Paris is then poured within the frame until it rises to the level of the edges. Embracing the base of the cast, it also adheres firmly to the inside of the frame, and when "set," is lifted from the table. The plaster matrix, which now becomes the back of the fish is smoothed. The plaster cast is now ready for colouring.

The Earth's Magnetic Force.—Captain F. J. Evans, hydrographer to the Admiralty, read a paper before the Geographical Society, on the 11th ult., "On the Distribution of the Earth's Magnetic Force at the Present Time." The paper gave a historical sketch of the invention and improvements of the mariner's compass, and noted the discoveries which that instrument had made of the action of the magnetic forces in different parts of the earth. The lecturer connected the phenomena thus brought to light with the variations of the compass, a due regard to which was absolutely necessary for safe navigation. In one region of the globe—the smaller—this variation was westerly, and in the other—the larger—it was easterly. Westerly a variation prevailed in the Atlantic and Indian Oceans, and easterly in the Pacific Ocean. As a matter of fact, the magnetic condition of the globe was always varying, but in what manner and to what end was absolutely unknown. Auroras and earth currents were then discussed, and notice was taken of the magnetic discoveries made during the voyage of the Challenger. Having marshalled the various facts and hypotheses concerning magnetic phenomena, the lecturer, in conclusion, said, "Such are the facts, and how are we to interpret them? Whichever way we look at the subject of the earth's magnetism and its secular changes, we find marvellous complexity and mystery; lapse of time and increase of knowledge appear to have thrown us farther and farther back in the solution. The terrella of Halley, the revolving poles of Hansteen, and the more recent hypothesis of the ablest men of the day, all fail to solve the mystery."

LETTERS TO THE EDITOR.

[*We do not hold ourselves responsible for the opinions of our correspondents. The Editor respectfully requests that all communications should be drawn up as briefly as possible.*]

All communications should be addressed to the Editor of the ENGLISH MECHANIC, 31, *Tavistock-street, Covent-garden W.C.*

All Cheques and Post-office Orders to be made Payable to J. PASMORE EDWARDS.

⁂ *In order to facilitate reference, Correspondents, when speaking of any Letter previously inserted, will oblige by mentioning the number of the Letter, as well as the page on which it appears.*

"I would have everyone write what he knows, and as much as he knows, but no more; and that not in this only, but in all other subjects: For such a person may have some particular knowledge and experience of the nature of such a person or such a fountain, that as to other things, knows no more than what everybody does, and yet, to keep a clutter with this little pittance of his, will undertake to write the whole body of physicks: a vice from whence great inconveniences derive their original."
—*Montaigne's Essays.*

SELENOGRAPHICAL.

[14219.]—I TENDER my thanks to Mr. H. Sadler for having pointed out (ENGLISH MECHANIC, No. 677, p. 16, letter 14096) that the central crater of Hesiodus is not a discovery of my own, since it is shown in Lohrmann's map. It is very important that, when new or supposed new objects are pointed out, they should be compared with older observations. This has not been done until now for the present craterlet; and I was the more led to believe that it had not been seen before April 25, 1878, that my observation was quoted by Mr. Birt ("Selections," &c., first issue, p. 8) without further remark. I hope observers will keep in mind the second craterlet in Hesiodus, and report accordingly.

CRATERLETS E. OF LEXELL.—Between Lexell and Sasserides B. and M. have three rows of craterlets running in a more or less straight line in a N.E. and S.W. direction. The eastern row is composed of four distinct craterlets. On March 12, 1878, 8h. to 10h. p.m., I observed this region, and I found that the three northern craterlets of the eastern row form a valley, the walls which at first separated them having fallen in. Nasmyth and Carpenter, in Plate XVI., represent this valley as it exists now.

HANSTEEN.—Neison says: "East of Hansteen, on the grey plain, is a delicate rill, φ (S. 217)." This description does not seem to agree with my observation of March 16, 1878, 10h. p.m. I copy verbatim from my observation-book:—"On the floor Hansteen contains the following objects:—[illegible] is a central hill, but very much elongated, like a mountain chain; 2, a hill on the W.; 3, another hill on the S.; 4, another hill on the E. From this hill runs a ridge, 5, which turns W. at hill 7, [illegible] on the N., and reaches the N.W. rampart at 6. [illegible] is a cleft, whose sides are high, as if formed between two ridges. This cleft, which crosses the N. [illegible] extremity of the floor like the chord of an arc, [illegible] stopped by the eastern rampart; but it reappears on the opposite side, curves gently E., and reaches the elongated crater, 10, on the S. of Hansteen. The cleft, as represented by Neison, runs in a straight line N. and S., and is connected neither with Hansteen nor with the elongated craterlet [illegible] the S.

THE FLOOR OF ARISTARCHUS.—On March [illegible], 1878, 11h. p.m., I had an exceedingly good view of the floor of Aristarchus. It is seldom one can have a quiet look at it, as most of the time it looks as [illegible] a fusing state. On this occasion, however, everything was quiet and calm, and the eye could [illegible] here and there to the few objects contained in it. The central mountain was the most brilliant object. This mountain is elongated in a N. and S. direction, and its summit—which is in the middle—very pointed. Browning's mountain, on the [illegible] was of a dull aspect, forming a striking contrast with the central peak. Its sides were sharp, though, as a whole, the mountain is roundish. South [illegible] the floor were seen two distinct hillocks. These are given by Schmidt, but one of them I saw independently on May 30, 1871. At this date I noted on my observation-book that I had a suspicion of another mountain on the west. On March 16, 187[illegible] this mountain was plainly seen as a minute bright hillock, much smaller than any other object known at present on this floor. Schmidt gives a craterlet whose position would be between Browning's mountain and the minute one just mentioned; but I saw no trace of this craterlet. Perhaps Browning's mountain was the object seen by Schmidt. In ENGLISH MECHANIC, Vol. XV., July 5, 1872, [illegible] 406, will be found a sketch of mine of Aristarchus and neighbourhood. Nearly N. of Aristarchus is a plateau, and on this plateau is, among others, crater 41. On the present occasion I saw for the first time, a craterlet outside of 41, and close to [illegible] S.E. border. Another craterlet was seen [illegible] where the No. 46 stands.

FOCYLIDES.—This formation is divided in two [illegible] a broken chain of mountains. 1. The S. portion [illegible] seen with the following objects on March 16, 187[illegible] ht; 2, a crater on the S. wall; 3, a ridge N. of crater 2 to a craterlet; 4, the distance and 2 is about the diameter of 2; 5 is a interior wall running on the E. side of the a crater 2 to a craterlet 7. On this ridge is 6; 8 on the N.E. and 9 and 10 on the W. craterlets. N. is a crater given by B. and the floor of the N. portion of Focylides three craterlets, 14, 15, and 16. 17 is a ter, given by B. and M., and situated on ll, and N.E. of it, also on the wall, there r craterlet, 18. The Plate XVII. of Nas- d Carpenter contains Focylides, but the e, I believe, not exact.

. Sadler mentions a craterlet on the for- II. ξ⁶ W. of Fontenelle. On March 17, a.m., I looked for this craterlet and found is formation was seen as divided in two by a very low and broken ridge running tenelle to the W. extremity. On the N. ere is a craterlet the largest of all, about s of the formation towards the W. Is this let seen by Mr. Sadler? I mark it 9. On and N.W. of 9 there is craterlet 5. About e of the floor, but just S. of the ridge, raterlet 6, and in a kind of bay S. of the are craterlets 7 and 8, very minute. e has three hillocks on its floor.

rs.—This crater was seen on the above two objects only on its floor—a craterlet on nd a wavy-like mountain running E. and ide of it N. there is another craterlet. maeus there is a formation which has much ith the one W. of Fontenelle. Here also running from E. to W., and on the floor craters on the E., three craterlets on the , and one the ridge itself about the centre.

New Crater" N.W. of Hyginus.—Mr. r, in your last issue, No. 680, p. 92, the discovery of a totally new crater Hyginus, made by Dr. Klein, of Cologne, 9, 1877. This crater occupies a position so an object I observed myself in 1871, that some doubt whether it is not the same My sketch will be found in the English ic, No. 339, for September 22, 1871, letter was an observation made during the setting Klein has observed during sunrise. It probable, therefore, that the aspect of this it is the same) was not exactly alike. ately, no description is given of the nature ject, my observation having reference only ft A joining the Hyginus cleft with the riadaeus. I have not observed the cleft Klein, but if I judge by an observation I September 29, 1877, the number of clefts Hyginus, and Triesnecker have singularly . As an instance, the crater b, S.E. of which is represented quite isolated in the ntioned sketch, was seen by me as the focus fts.

r. Webb and others.—Will Mr. Webb y if he has observed during this season the f the Poulkova Cat., near Castor, and if he as severe a test as when he wrote his l Objects," &c.? On two occasions lately, it with power about 500. Is this a binary what is its actual distance? ζ Cancri is, much easier.

C. Gaudibert.

COUNTIES; OR A NEW PLAN A CATALOGUE OF LUNAR CTS.

—The following plan for dividing the f the moon into districts, for the purpose of a catalogue of Lunar Objects, has been com- d to me, and it appears to be so suitable purpose, that I send it to you for publica- the author's permission; also the plan of n of Fracastorius. W. R. Birt.

lan is this:—Certain arbitrary points are which may be found by alignment; these re connected by straight lines, which thus boundary of a county, inclosing a named n.

jects included in the county bear the name principal formation, with the addition of a r Roman letter as a suffix; the names and of Beer and Mädler, being in all cases re- o far as they go. Other objects will then letters so far as the alphabets will allow, tters being in all cases assigned to *elevations* t streaks, and Roman to craters and *depres*- To avoid any possible confusion between k and Roman letters when they are of the m, an accent should be added to the Greek thus the Greek capital Rho should be d to distinguish it from the Roman P. When habets are exhausted new objects will be by the letter of a neighbouring object, with tion of a number—odd numbers indicating s, and even ones depressions.

talogue of the objects in each county can constructed in which the objects are re- t, and by the same marks can be readily in- d on a map.

The adoption of the standard nomenclature of Beer and Mädler keeps the system in unison with books and maps already published.

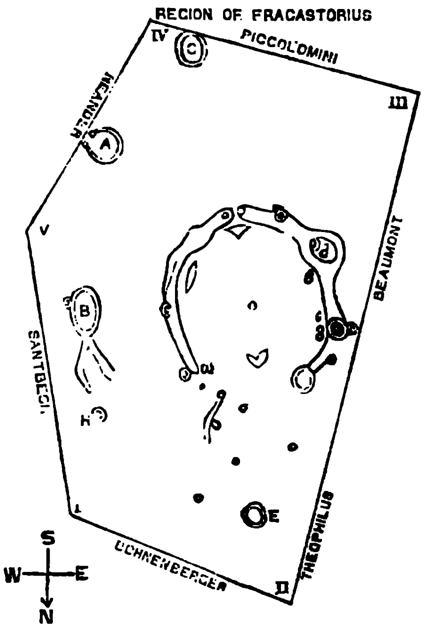
The boundaries being for the most part straight lines, too short to be materially affected by libration, an observer, with a single wire in the eyepiece of his telescope, can at once determine in what county any object is situated. Moreover, this scheme affords a great convenience to the student since it enables him to recognise at once by mere inspection of the map, to which of the named formations those distinguished by a letter only belong. Without it no one, unless exceptionally familiar with the locality, can say, without reference to the descriptive text, to which name many of the letters marked on the map should be appended.

A copy of the small map of Beer and Mädler may be had for two shillings, and if any one will outline on it the boundaries subjoined as specimens of the method, he will be able to judge of its utility so far as concerns rendering the map intelligible.

Formations Near the Mare Nectaris.

1. *Fracastorius.*—From a point (I) midway between Fracastorius H and Bohnenberger A to a point (II) equidistant from Beaumont, Bohnenberger, and Theophilus A; thence to a point (III) midway between Polybius A and Piccolomini *b*, thence to a point (IV) midway between Fracastorius *c* and Neander *g*, thence to a point (V) midway between Santbech *b* and Fracastorius X; thence to (I).

2. *Santbech.*—From a point (I) midway between Neander and Borda to Fracastorius (V); thence to Fracastorius (I); thence to a point (II) equidistant from Santbech, Cook *a* and Bohnenberger D; thence to a point (III) equidistant from Borda, Birt A and Santbech, thence to (I).



3. *Bohnenberger.*—From Fracastorius (I) to Santbech (II), thence to a point (I) midway between Santbech (II) and Colombo; thence to a point (II) midway between Bohnenberger and Colombo A′; thence to a point (III) midway between Fracastorius (II) and Guttenburg *c*; thence to Fracastorius (II); thence to Fracastorius (I).

The illustration is not intended as a complete map of the district of Fracastorius, but only as showing the principle on which the author proposes to divide the moon's surface. Observers will be furnished with copies of plans, on which they will record their observations as set forth above. It is intended that these observations should be forwarded to a selenographer, who will undertake to examine them and report thereon.

P.S.—I have given the above communication in the same state as I received it. I however venture to think that the term "Province" would be preferable to "County." W. R. B.

THE LUNAR CRATER PLATO.

(*Continued from p.* 117.)

[14221.]—1878, moon's age, April 20, a.m., 17·1 days midnight.

1861, moon's age, February 26, 11·15 17·17 days.

The night favourable. Terminator passing very near the western edge of the Mare Crisium. The illumination of but few of the peaks westward of the Mare indicates the smooth surface to be nearly of the same level as the bases of the mountains.

The floor presents nearly, if not quite the same, inky grey tint as it did the previous evening. The eastern portion exhibits the light cloudy streak with the minute central points. The summits of the rim irregularly illuminated. On the 25th February, 1861, a spot was observed westward of the western extremity of Plato in a line with the longer axis of the apparent ellipse and described as "bright." On the 22nd of March, 1861, at 9.30, moon's age 11·3 days; it is r of my key plan, Report British Association for the Advancement of Science, 1861, p. 187, and is thus described: "A mountain on the exterior western slope of Plato XXX. On March 22, 1861, it was seen with the shadow eastward; it had a rounded summit, and the western slope was shining with considerable brilliancy." There are no indications of shadow within the crater (Plato).

1878, moon's age, April 21, a.m., 18·1 days midnight.

1860, moon's age, February 9, 11·0, 17·95 days.

Terminator through Picard on the Mare Crisium; the eastern edge of Picard very brilliant. Terminator just grazing the western edges of A and B, and passing over some ridges in the Mare Fœcunditatis some distance west of Messier.

Northern summit. A bright spot on the rim about 0·33 from the western rim. This bright spot is the mountain ε on Neison's Map; from it to the north-east the brightness of the rim is interrupted.

Eastern summit, bright.

Southern summit, bright.

Western summit, bright.

Floor, no streaks visible, but of a uniform dark diluted inky character, a bright irregular marking towards the eastern part of the ring.

1878, moon's age, April 22, a.m., 19·1 days midnight.

1861, moon's age, July 26, 11·50, 18·89 days.

Terminator grazing the western age of Posidonius.

Northern summit, the spot ε on the margin very bright; from this point to the east rim the summit is very dusky; in the locality of a bay-like indentation in the north-east rim the outline assumes a somewhat squareness of form.

Floor, the whitish cloud-like marking diagonally on the east side of the floor very distinct with a much brighter spur (short) in the immediate neighbourhood of the bay-like indentation mentioned above. The luminosity of the whitish marking not equally intense; it is strongest towards the south-east rim.

Eastern interior in shadow, the shadow narrow, the short light spur when the atmosphere is clear, appears somewhat of the character of a ledge. The eastern part of the spur is bounded by the shadow of the mountainous ridge.

The south-west and north-west rims are becoming more decidedly illuminated as the opposite portions become covered with shadow.

From the bright spot ε to the eastern rim the north and north-east interiors, which are seen so well and so distinctly with their two oval markings under the morning illumination, are not distinguishable as separate features. The only part now visible is the spur raised as it were above the general level of the floor, and apparently consisting of a material reflecting a stronger light; neither the rock ζ nor the triangular marking south of it are distinguishable.

The short mountain range on the north-west, its western side in shadow when the air is sufficiently steady—the range with its sinuosities and indentations is well brought out.

The mountains west of Plato beginning to show their shadows with great distinctness, λ on the south-west of Plato in shadow, also the mountain ι north-west of Plato.

On the south-west rim a dark spot apparently a shadow of a bright point, which occupies the position of the peak γ of B. and M.

Western flank of Plato. On the west flank not far removed from the summit a small bright crater, G, of B. and M., with a bright streak to the mountain r, see ante 1861, February 26, its western side in shadow; it is, however, not so distinct as the mountain ι north-west of Plato; westward of this mountain the streak is crossed by another light streak running between the two mountains; the small crater (G) is in the line of the longest diameter of the apparent ellipse now presented by Plato.

A line drawn diagonally from the south-west rim, the lucid point with shadows to the north-east corner lies in the direction of and passes through the largest and most western of the chain of craters, A, of B. and M., extending eastward from Plato.

The above ages of the moon are given for civil midnight.

Should the morning of April 22 be clear, it is recommended that the above recorded features should be observed, an interval of nearly 17 years having elapsed since the observations were made. The recent discovery by Dr. Klein of a crater not on our maps, not very far from Hyginus (see English Mechanic, April 5, 1878, p. 92, letter 14168, and the announcement by the Rev. T. W. Webb in the *Selenographical Journal*, April 2, p. 3) of a small white spot on the inner slope of the low rim of Wargentin will, I doubt not, induce a much closer scrutiny of minute lunar features than heretofore, and it may be that in the interval above mentioned some alteration in the rim of Plato may have occurred.

Buckhurst-hill, April 4. W. R. B.

SATURN—SMALL STAR NEAR CASTOR.

[14222.]—I have not noticed any observations of Saturn near the last disappearance of the Rings; the circumstances were certainly very unfavourable. I saw the planet on some evenings in Jan.—on the 15th. It being at the time somewhat cloudy, I only managed to glimpse the *p*. or W. half of the Ring, the other not being seen. Again, on the 23rd, I find an entry in my note-book to the same effect: and also on the 28th, while not being certain of seeing anything of the Ring, I sometimes fancied I saw a faint streak *p*. the ball. On the 30th I could see nothing of the Ring.

Has any observer noticed that the W. half was the more conspicuous or longer visible before the disappearance? My observations would seem to suggest so; but, without corroboration, they are of course almost worthless, both from the insufficiency of my telescopic means, and from the bad position, &c., of the planet.

Would Mr. Espin, or some other possessor of an object-glass larger than mine, kindly look up a little star *f* Castor, which I picked up for the first time the other night, and give an estimate of its magnitude? It lies between 1′ and 2′ a little *s* of *f* Castor; "F. R. A. S." mentions (on p. 279, Vol. XXV.) the closer companion *n*. as of (Smyth's) 11 mag. The star in question is much fainter than that; it is, indeed, not far from the limit of my eye and telescope, and this is why I should like to have an idea of its magnitude. I once or twice imagined I caught another extremely faint point a little *n* of *f* Castor, rather further off than is the 11 mag. star; but I should think this is probably a myth.

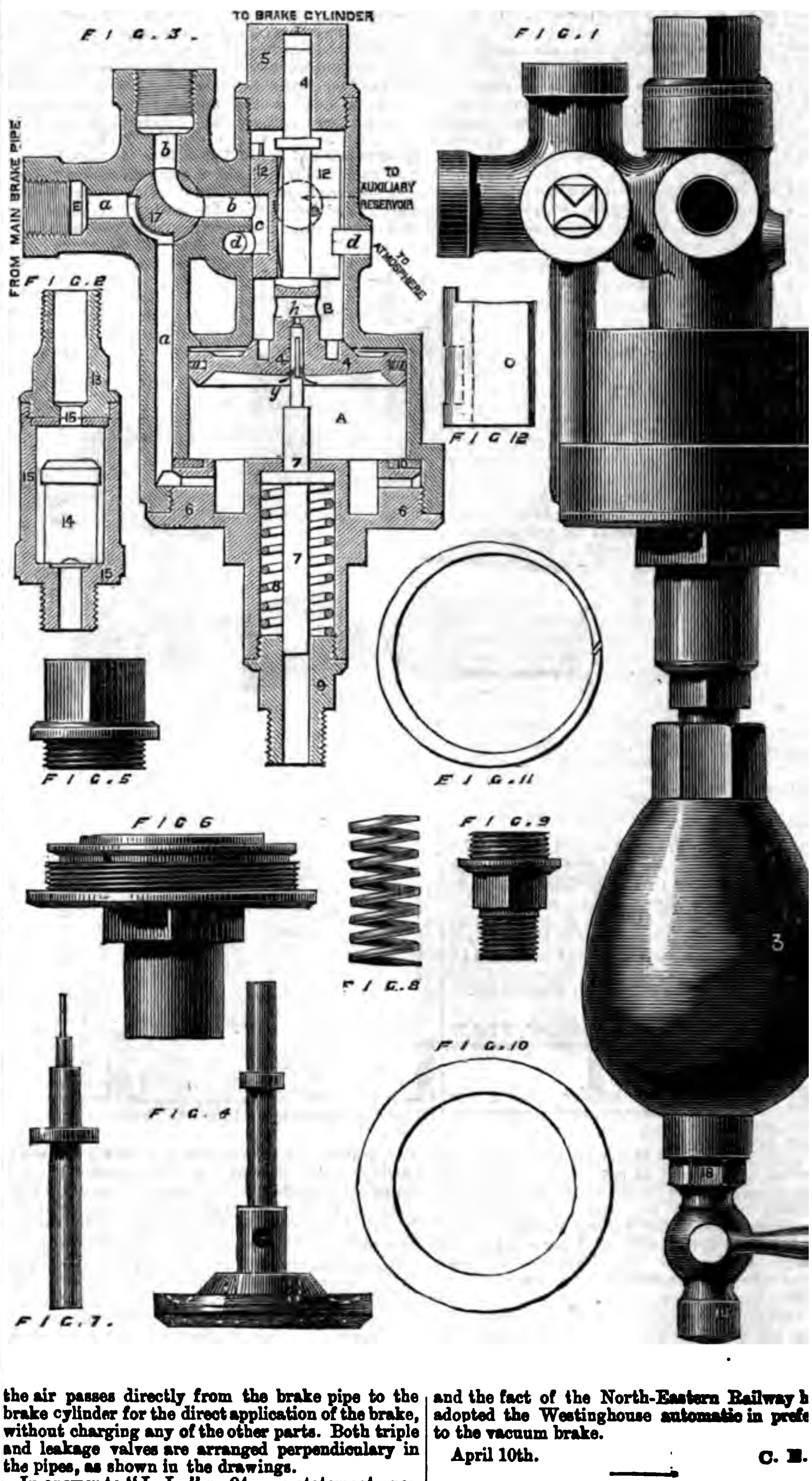
Mac.

THE WESTINGHOUSE AUTOMATIC BRAKE—THE TRIPLE VALVE.

[14223.]—In my description of the automatic brake in last Vol., p. 578, I explained the action of the triple valve, but to make it perfectly clear a diagram is required.

Mr. Westinghouse lately stated before the Institution of Mechanical Engineers that "the triple valve was a very simple affair, its complication lay in one direction only—it was complicated to describe." This description of the triple valve is perfectly correct, but I trust that, with the assistance of the diagrams I shall be able to make the apparatus clear to your readers.

The triple valve shown fully in Fig. 1 has a case or body, with three connections for ½in. gas pipe, the connection from the main pipe being through the port, E; a second pipe connection from the port, F, leads to the brake cylinder, while the remaining port, shown in dotted lines back of the valve, 12, is connected to the auxiliary reservoir. From the main brake pipe the air enters by the port, E, and then by the passage, *a*, through a suitable opening in the plug of the four-way cock, passes on through holes drilled in the cap, 6, into the bottom of the chamber, A, where, acting on the piston, 4, it forces it with the slide valve, 12, into the position shown, opening the port, *g*, whereby the chamber, B, and auxiliary reservoir connected therewith, are charged to the same pressure, this pressure being maintained throughout the train in all of the reservoirs and main brake pipe. To fully apply the brakes air is discharged from the brake pipe, and consequently from the chamber, A, when, by excess of pressure in the chamber, B, the piston, 4, is forced down, closing the port, *g*, and forcing the stem, 7, with its spring, so as to permit the piston to seat itself on the rubber packing ring, 10, at the same time the valve, 12, is moved, so as to uncover the port, *b*, establishing communication from the auxiliary reservoir to the brake cylinder. To release the brake, air is again admitted to the main pipe and chamber, A, causing by excess of pressure the piston with valve, 12, to assume the position shown in the drawing, whereby the ports, *b* and *d*, are brought in communication through the cavity, *c*. The port, *d*, communicates directly with the atmosphere, and with a cavity, *c*, formed in the valve, 12, and the port, *b*, constitutes a discharge passage for the release of the compressed air from the brake cylinder after the application of the brakes; at the same time the port, *g*, is opened for recharging the reservoir. To apply the brake lightly a slight reduction of pressure is made in the brake pipe and chamber, A, which causes the piston to move so as to uncover the port, *b*, applying the brakes and reducing the pressure in the chamber, B. As soon as the pressure is reduced so it about equals that in the chamber, A, the spring, 8, acting against the collar of the stem, 7, and piston, 4, moves the valve far enough to close the port, *b*, without releasing the brakes. The force admitted to the brake cylinder will depend altogether upon the reduction of pressure in the brake pipe and chamber, A, such reduction being entirely under control. To prevent the application of the brakes after the engine is disconnected from the train by such reduction of pressure in the brake pipes as may result from leakage, a small valve, No. 2, the construction of which is clearly shown, is inserted in the pipe between the port, F, and the brake cylinder. This valve consists of a case, 15, with a cap, 18, having a rubber face, 16, and within the chamber of this case a valve, 14, which is acted upon by air pressure entering the lowering port. When the air enters this port slowly, as resulting from a leakage in the brake pipe, or other slight reduction of pressure, the valve, 14, remains in its position, such air passing around and to the atmosphere, without setting the brakes. When the brakes are being operated the valve is seated upwards against the rubber face, 16, preventing any escape of air. A drip cup, 3, is screwed on the cap, 9, of the triple valve. The plug, 17, of the four-way cock, by a quarter turn, brings the ports, E and F, in connection, whereby the air passes directly from the brake pipe to the brake cylinder for the direct application of the brake, without charging any of the other parts. Both triple and leakage valves are arranged perpendiculary in the pipes, as shown in the drawings.



In answer to "L. L.," p. 94, my statement upon p. 39, that the Midland have fitted their trains, which run to Liverpool and Manchester only, with the vacuum brake because it is the brake adopted by the Cheshire lines and the Manchester, Sheffield, and Lincolnshire Company, is perfectly correct. It is quite true that the Midland work their own trains to Liverpool, but they are not independent of every other company, as "L. L." supposes.

In the first place, the Cheshire lines committee have adopted the vacuum brake upon their t and the Midland often take carriages fro Cheshire lines and Manchester, Sheffield, an colnshire railways to various parts of their lin through Midland carriages often have to b upon Cheshire lines joint trains, and this change of traffic is also intended to be incr This is, as "L. L." very truly remarks striking example of the pernicious effects of dif companies adopting different brakes."

The length of my present letter compels leave until next week any remarks on the re lately made to Parliament by the railway comp

and the fact of the North-Eastern Railway h adopted the Westinghouse automatic in prefe to the vacuum brake.

April 10th. **C. E.**

MR. PROCTOR AT LIVERPOOL.

[14224.]—Reading "F. R. A. S.'s" letter 116), I learn that I made some remarkable s ments at Liverpool a few weeks ago, and two letters tell me more on the subject. I can onl with the old lady of domestic tradition, "Sur isn't I" (I fear she said "me"). Some one been poking fun at your readers.

Richd. A. Procto

THE PHOTOGRAPHON.

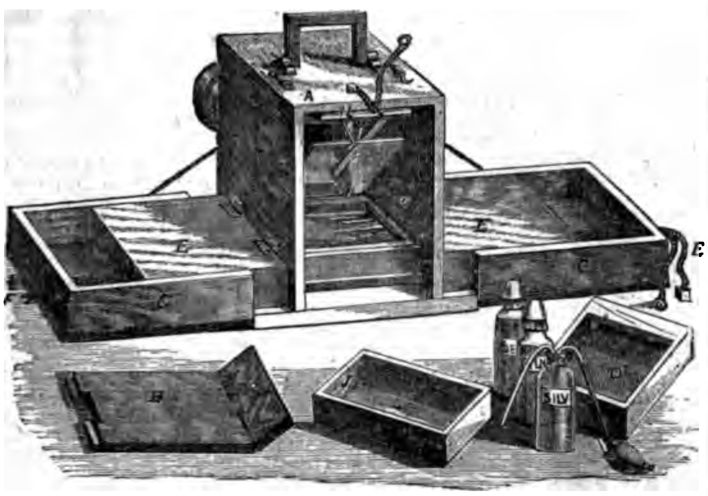
25.]—HAVING been an amateur in photo-
ever since I was eighteen, and worked many
various processes, I always felt dissatisfied, on
hand with the bulky apparatus required for
wet process," let alone the mess the hands and
occasionally got into, and, on the other hand,
e constant uncertainty attending the working
ry plates." Though these are more get-at-
ow, yet somehow many amateurs still prefer
t process with all its attendant paraphernalia
ally practised, and no wonder; for unques-
y say they, it is better to know what you have
ime, after the labour, trouble, and expense,
go on taking random shots here and there,
id after all that your expected picture is not
Therefore, to satisfy both the disciples of
le compact apparatus and the advocates of the
of "look-before-you-leap," I hammered my
ve faculties (phrenologists say constant use
s the organs) till the "photographon" leaped
quipped into existence. In its early days it
ristened the ladies' camera out of compliment
ortability, convenience, and cleanliness; but
title seemed to drag it into the category of
playthings, which most emphatically it does
long to, being thoroughly adapted to and
of every work, both for professionals and for
rs, that can be
lished with the
y stereotyped
f apparatus, it
-christened the
raphon, for want
tter name—one
I suppose it will
r the term of its
l life, especially
result of the
xhibition, where
shortly be exhi-
should tend in
y to increase its
and consequent
ty. Owing to a
detail of con-
on it particu-
adapts itself to
rpose of scienti-
tography, either
nicroscope, tele-
or spectroscope,
"scope" which
put before it or
it, its own scope
nlimited, as part
n even be used
aring and deve-
dry plates, much
ting these ope-
, and insuring
ness of hands and

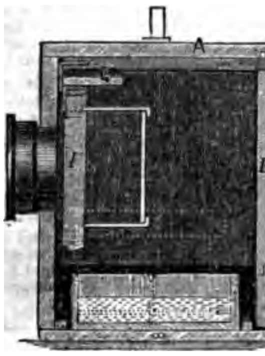
usual manipula-
the stumbling-
of most neo-
are performed
mechanically
the closed appa-
the motion of
the, plate-sensi-
developing, and
g frame (with
ver hooks) being
led by the pul-
same cords from
tside. Thus the
or is perfectly
d unconfined in
y, and compact-
perfect regularity of action, simplicity, and
ness are insured at one stroke; and dull
ay indeed must be he who could not master
king in a very few hours. A lady has in
sence taken a satisfactory negative after a
r of an hour's teaching, I having coated the
with collodion for her. Here we have proof
no previous knowledge of photography is
d, though pity would it be should it fall into
so indifferent or lazy as not to be desirous of
g the chemistry of so fascinating an art.

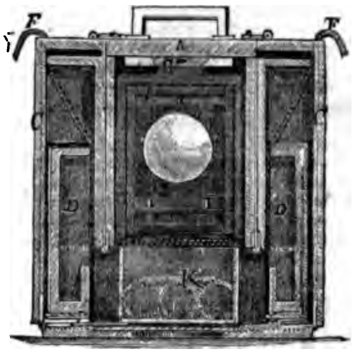
re mentioned cords or strings—these sound
flimsy, toy-like, yet they are just the
ical means best adapted to their purpose, as
n be led anywhere to assist in performing
licate operations entrusted to their charge.
pliable, strong, yet soft, they do not scratch
re the polished mahogany, and last, but not
can be changed and replaced in an instant
ere, should long use at last cause them to part
y. So also with every other part, the
care, from practical experience, has been
to insure that anything accidentally getting
order could be set right in five minutes, so
prings and everything liable to break or diffi-
replace have been systematically avoided.

t people do not like staining their fingers—
ack hands are not ornamental at a dinner-table, to say nothing of cuffs destroyed. And as it was found that stains mostly arose, in every kind of apparatus, from the pouring to and fro from bottles to baths, and vice versâ, it was determined to avoid this altogether by having the silver and the iron solutions in bottles with glass siphons. By means of a small indiarubber ball, with valves acting as a force pump, air is forced through an indiarubber tube, ending with glass, into the bottle, and the pressure of air forces the liquids into the *flat horizontal baths*. To empty these and return solutions to bottles the action is simply reversed, the air exhausted, and the desired result obtained. Be it, however, clearly understood, that at no time do any of the solutions come into contact with the indiarubber, as the sulphur would be fatal to the well-being of that delicate and capricious patient, the silver bath, which is most strongly affected for good or evil by homœopathic doses (whatever "Allopaths" may say) of anything injurious to its health.

You will notice that flat baths are provided, as generally used all over the Continent, of a material now much in favour there—"the Carton Durci—" as strong as wood, unaffected even by hot acids and not liable to injure the constitution of the most delicate silver bath. These baths I get made in Paris. Another point with flat baths is that, however, much stock in reserve we may have at home, a comparatively small quantity is required for work, thereby much diminishing the lamentable consequences attending a spill, smash, or indiscriminate mixture of chemicals with which clumsy, careless, or unfortunate photographers occasionally become acquainted, and having experienced, rarely forget.







Having now disposed of these preliminary remarks which were necessary partly to describe the apparatus, and also to show with what care all sources of failure and annoyance have been examined and guarded against, let us look at the woodcuts and refer to them as we proceed (the letters of reference are not essential), but I must now beg leave to refer to Tissandier's work, p. 117, and quote almost verbatim, as his description of the apparatus and mode of working is so clear and good that I should fail to improve on it, and have already taken up more space than perhaps you will think the subject justifies, yet one sees so many queries about photography in your columns from would-be amateurs that this evidence of the interest it excites must be my apology.

The Photographon.

This new camera is a very ingenious combination of camera and dark room for using the wet plate process either in the studio or in the field. It has been called (as explained) the ladies' camera, owing to its cleanliness, convenience, and portability—qualities which should certainly not lessen its value in the estimation of operators of the sterner sex, whether amateur or professional. Having seen a number of these cameras in various sizes, we have no hesitation in saying, from their simplicity, the ease with which they are worked and the thoroughly good manner in which they are put together (Mr. G. Hare is the maker), that they only require to be known to be appreciated by the photographic public. A glance at the illustrations at the end of the volume will give a better idea of it than any verbal description. The apparatus, when packed for carriage, occupies but little more space than the ordinary camera, and yet it includes a plate box for clean plates, one for exposed plates, silver bath, developing solution, collodion, pneumatic holder, bath—*i.e.*, tray, for the silver solution, bath for developer, &c., in fact, every requisite for taking a picture by the wet process up to the point when the development is complete, and the picture prepared for intensifying and varnishing.

One very great advantage in using this camera is that the operator is protected from the unhealthy atmosphere of the ordinary dark room or tent. After replacing the camera on the stand, the sides—each containing a flat bath—are let down as in the illustration, and the view is focussed. The plate is held in position by four silver hooks fastened to a movable frame. To obtain the focus it is only necessary to place a piece of ground glass in the grip of these silver hooks and to draw out the frame till the picture is in focus. After the plate is coated with collodion the ground glass is removed and replaced by the plate which receives the image on exactly the same plane as the ground glass, so that the focus must be correct. The silver solution having been poured into one bath and the developer into the other, and the baths pulled into position by means of strings on right and left of the camera, the hinged back which excludes all light is adjusted, and the next operation is to sensitise the plate. By pulling a string the silver bath (or tray) is brought into the centre of the camera, and directly under the glass plate; by pulling another string (all the strings are worked from the exterior of the camera) the frame holding the plate is gently lowered flat into the silver solution. After remaining in it about two minutes, and being gently raised and lowered a few times to get rid of "greasiness" (the repellent action of ether and alcohol), it is pulled back into position, and held by a catch; the frame is then pulled out to the focussing point, and the picture taken. After exposure the silver bath (or tray) is drawn under its cover on the left side of the camera, and the developer pulled under the plate, which is lowered as before. The developer used is Mr. Carey Lea's, with gelatine restrainer, and the strength of the solution is such that whilst forty-five seconds' immersion will bring out all detail, a much longer immersion (even twenty minutes) will not injure the picture. After development the plate is again pulled into the upright position, the developing bath is pulled back under its cover on the right side of the camera, and a bath with water for washing is introduced, by lifting the hinged door at the bottom of the movable back of the camera; the plate is lowered into the water as before, and washed, removed, fixed in daylight, washed finally, and stowed away.

If another view at some little distance from the first is wanted, the camera is carefully lifted from the stand and carried in situ to the desired spot. The baths contain such a small (comparatively) quantity of liquid (as the plate is immersed flat, simply enough to cover it being all that is required), and yet are so deep that, with ordinary care, no spilling need occur. If the distance is great, or the travelling rough, it is only necessary to return the solutions out of the baths into the bottles (the few drops remaining in the baths are immaterial, owing to the pocket-like form of these latter); stow everything inside, fasten up the sides, and the camera is ready for even the tender mercies of railway porters (the bottles being protected by their own respective indiarubber tubes, as explained). Though we are unable to speak from experience with this camera in the field, we feel sure it will be found as good in practice as it is in theory. Here ends the quotation.

W. A. Brice.

[Mr. Brice's "Photographon" is all that he asserts it to be; but for opinions of the professional press our readers may refer to the *British Journal of Photography* of August 11, 1876, the *Photographic News* of July 14 and December 8, 1876, the Photographic Almanacs of that year, and the *Scientific American* of June 24, 1876.—ED.]

ON THE ANGULAR APERTURE OF MICROSCOPE OBJECTIVES.

[14226.]—IN reply to the query of Drs. Nickols and Bull, at page 120 of the last ENGLISH MECHANIC, I have to state that the apertures specified in lists of object-glasses are all taken with the adjusting collar set for "covered," as this position shows a larger angle than at "un
The 1-5th lens, from which I gave the list

and true apertures, performed best as an immersion. I therefore took the apertures at this position, at which it might be assumed the rays were all brought more nearly to a focal point with the least aberration; water was placed between the front and a plate of glass, through which the sector was measured, the focus or crossing point being thus in the glass, and free from aberrations, though practically the measurement is the same whether the glass is there or not. I used the plate in front, because in the Transatlantic controversy of some years back, wherein the ridiculous aperture of 180° was claimed, in one of my measurements to disprove this angle I did not use this plate—I was accused with considerable acrimony of falsifying the conditions in not trying the glass in its working conditions with the focal point immersed. However, I need not now enter into this question, which may give rise to much quibbling, but take a case where adjustment need not enter into the consideration. I selected a ⅔rds object-glass, with an angular aperture of 28°, measured as usual by the sector. The focal distance from the point of the lens was ·51; on this I set the adjustable slit, opened out to ·045 of an inch. The aperture again measured by the sector was very close to 15°. This was the false aperture. The true aperture deduced from the distance of the focal point up to the diameter of the slit was only 5°, a threefold error being shown by the usual measurement.

I here point out an error of dimension in my diagram on page 68 of the English Mechanic of March 29th. The vertical height or focal distance should have been marked ·041 instead of ·001.

F. H. Wenham.

TELESCOPIC APERTURES.

[14227.]—I thank you for having inserted in the English Mechanic what I have written upon this subject, and I had no intention of troubling you again about it, but I beg you will allow me to inform "W. G. P." (let. 14182) that when he says "he seems to suppose it is superficial measure," he is much more under misapprehension than I am, as I do not suppose anything of the kind. Superficial measure is what I say it should be, and "A Fellow of the Royal Astronomical Society" (let. 14134), to some extent takes the same view of the matter as I do.

8½-in. O.G.

THE BRITISH WORKMAN—TESTS FOR TELESCOPES.

[14228.]—The letter of "F. R. A. S." (March 29) tells not merely against the British workman, but quite as much against the British builder. Some time ago I had occasion for just such a repair to be done as "F. R. A. S." describes. I applied to a builder, who sent, not four, but two men. The time which they took about the job, including journeys, was something under four hours, and for this, though no materials were required, I was charged 27s.; and this is not all—the work was done so ineffectually that it had to be done over again. This time, however, I applied to a respectable skilled workman, who brought a labourer with him, and did it well; and for this and several other little jobs, which took up rather more time than in the former case, he charged me 4s. 3d.

In "F. R. A. S.'s" case it was quite as great a grievance to have twice as many men sent as were wanted, as it was that they should take twice the time about it that they ought to have done. Such instances as these suggest to persons who have work to be done to apply directly to a skilled workman without the intervention of a third person, where it can be done; for, of course, such a person must have his profits, and they are sometimes very considerable.

"H. G. H." (query 32588) will think that, if I can persuade him to invest half-a-crown in the purchase of "Proctor's Half-hours with the Telescope," I shall have done him a much better service than by sending him tests. No beginner should be without it.

W. G. P.

THE BRITISH WORKMAN.

[14229.]—Some one writing once on a time about the coddling regulations and goody-goody literature and amusements provided by fussy philanthrophists for workmen's clubs and similar institutions, remarked that they formed too lofty a conception of the working classes. He further suggested that it might be possible that some of the workmen might be quite as unintellectual as if they were gentlemen, and that, therefore, it might be well to lower the arrangements of the said workmen's clubs more to the level of clubs arranged by gentlemen to meet their own requirements.

It is really a similarly mistaken ideal which appears to be the source of these complaints about the working man's conduct. It is assumed that he is to be a perfectly moral, honourable, and industrious being, always delighting in his work, and rejoicing in the reflection that if he gets bread and cheese by it, yet it enables some one else to enjoy his haunch of mutton or venison and his bottle of wine. Now, I am sure that "F. R. A. S." is far too liberal-minded to consciously adopt such a view, and yet some such distorted expectation alone could induce any one to endorse the complaints about the working classes typified in Sir Edmund Beckett's charges, which "F. R. A. S.," 14190, p. 116, corroborates. Now, my intention in writing letter 14179 was not to attempt to "rebut Sir Edmund's charges;" I am quite willing to agree that they are, as to fact, "unanswerable." What I do say is, they are not applicable to the "British *Workman*" alone, but to the idle and dishonourable among all classes, and that they are unreasonably laid on the working classes in particular, *because there exists a perfectly unreasonable ideal as to the duties of the working classes.* I have had occasion and opportunity to associate familarly with a great variety of classes, and I have no hesitation in saying that there is no difference whatever in classes; the differences are in the individuals, and are very equally distributed among all the classes. A few years ago I got a good deal of blame in these pages because I pointed out mistakes which the working men were making, and indicated consequences which are now being realised; I am, therefore, quite impartial in pointing out other views of these class relations.

I have frequently heard people complaining of the exactions of the workmen as preventing their doing well, and so on. I have on such occasions sometimes inquired what the moral law was that required that workmen should willingly content themselves with the barest existence in order that other people might keep horses and purchase estates and so on. The fact is, no such right exists—it is all a question of might; the workman has as good a title to drink champagne and ride horses as his employer, or as an estated gentleman. The point is, that he *cannot* do it, and as long as he cannot he will do wisely to make the best of what he can attain. The plain English of this is that no man and no class have any claim to require of any other man or any other class, any amount of service except upon such terms as the will or necessity of the latter render acceptable or inevitable.

Now, if it be the case that these complaints are true and generally applicable, *that fact only proves that the complaints are unjust.* If the position of things enables the workmen to be lazy—that is, to do less work than formerly, to demand higher wages, and apply them to more luxurious living, the workmen are only exercising the inherent right of free men. The complaints merely express the idea that there exists some right in those who claim to be the *upper* classes to require, on their own terms, services from those they consider the lower classes. Now this is just the spirit and essence of slavery; the meaning of freedom is that the conditions of the service, if rendered at all, must be a matter of *mutual* agreement.

But, then, I do not believe in the truth of the complaints as directed against classes, except in so far as that the working classes are, no doubt, endeavouring to exercise their just right to claim a larger share of the fruits of their labour. Whether they are doing so wisely or not is another and wider question on which I shall not pretend to enter now. But wisdom should not be limited to the workmen—the whole community must exercise it. Would it not be well to endeavour to set up conditions which should make it more clearly worth while to be industrious and economical? Suppose that, instead of complaints, there were a serious consideration of the causes at work, and a real earnest attempt made to deal with the causes?

Sigma.

[14230.]—Disclaiming any intention of interference between "F. R. A. S." and "Sigma," I should, having had considerable opportunities of becoming rather intimately acquainted with the manner, habits, and general disposition of the individual in question, as well as of the treatment to which, as a general rule, he is subjected, like to say a word.

No reader of the English Mechanic can more highly value the contributions of "F. R. A. S." than your humble servant. He writes so well and with such an evident desire to do good that it really gives one pain to hint that possibly he may mistake as to his being impartial or unprejudiced. Let us examine the matter from another point of view—most cases have two sides to them. "F. R. A. S." sent to his builder for a man to see a leaky gutter, and four came. Does he suppose these men came without orders? I guess it was something like this. Builder to plumber: "You must proceed to Aristocratia to repair a gutter." "All right. How am I to get at it? Shall I want any one besides Jack (the apprentice)?" "I don't know, but you had better take a couple of labourers to get up the ladders, as it may be a difficult place." Plumber collects tools, pot of metal, &c., and they all leave the yard.

Next they come round to the front in a "sort of procession." It is not stated whether they walked four abreast, two and two, or in single file. Anyhow they were wrong, and we ought to be told the proper way for four men to come round to the front, as I doubt if one man in a thousand knows. Next they all looked at the mansion. Wrong again. Three of them should have stood facing the other way while the plumber, as leading man, estimated the length of ladder required, and then instead of leaving two of them in the drive he should have taken them all to find a ladder, but not in a "sort of procession."

Well, it seems they ascended and ascertained what was amiss, and shortly after disappeared, and after a time they were discovered smoking in a shed, not drinking ale in the servants' hall. Perhaps, if these men came from a distance it was now breakfast time. At any rate the metal pot would probably have to be heated before the job could be done.

Does "F. R. A. S." know how the British workman in such a case takes his breakfast? When he goes to work on the roof of a gentleman's house he does not have chair, table, plate, knife and fork, cup and saucer, or any comfort of that kind. He probably takes a lump of bread and a lump of beef, boiled yesterday, and with this in one hand and a knife in the other he stands or perhaps sits on a wet plank or empty cement cask and swallows a few mouthfuls, which he washes down with some cold tea out of a tin bottle, and out comes the pipe, which he persistently smokes until his half hour is up, and as much longer as you will allow him, and is it any wonder that in about an hour after he is glad to exchange twopence for a pint of beer?

The British workman is what he has been made, and if "F. R. A. S." is not aware by what means, "Sigma," for one, can inform him. Did the British workmen have anything to do with making out the bill? I will not say a word for the scamp that got the coffin by telling a lie. It has not been proved that it was the British workman's fault that the cellar was flooded.

Old Ploughman.

THE DIGNITY OF LABOUR.

[14231.]—I am glad "F.R.A.S." in his exultations over Sir E. Beckett's pamphlet (letter 14134, p. 62) acknowledges at the outset that he can speak from experience with regard to working men only in so far as he has been brought in contact with them from needing their services. But if "F.R.A.S." acknowledges that he only cared for noticing working men at all so long as he required their labour, is not politeness the very least which in return the working classes should expect from his fraternity? For it seems that such expressions as "the rascal of a workman," "the balderdash of the organs of labour," freely made use of by "F.R.A.S." (letters 14134, 14190, pp. 62, 116), are altogether out of place when used by gentlemen who have to thank the accident of their birth for having exempted them from manual labour. Long let "F.R.A.S." live under the happy illusion that none but their self-appointed leaders and flatterers sympathise with the working classes. Shelley has asked them long ago these most pertinent questions:—

Men of England, wherefore plough
For the lords who lay you low?
Wherefore weave, with toil and care,
The rich robes your tyrants wear?

The discussion of this gigantic problem, "the social question," is altogether beyond the powers of any but the most eminent thinkers. That "Sigma" belongs to those selected few he has again shown in his letter 14179, p. 94. Such a master's condemnation of Sir E. Beckett's pamphlet, even with "F.R.A.S." still believing in it, may make Sir Edmund remember the words of Gellert:—

Wenn deine Kunst dem Meister nicht gefält
So ist dies schon ein schlimmes Zeichen;
Doch wenn sie gar des Narren Lob erhält,
Dann ist es Zeit sie auszustreichen.

Leidhold.

PURIFICATION OF SEWAGE.

(*Continued from p. 66.*)

[14232.]—In 1868 when it was found that the Local Government Board had failed to find a process that could be recommended for the utilising of town sewage at a profit, and that sewage still remained a nuisance, the British Association for the Advancement of Science appointed a committee "to report on the treatment and utilisation of sewage," which I think the committee did in as efficient a manner as their means would allow. Still I think the British Association split on the same rock that the Local Government foundered on.

The committee were instructed to "report on the utilisation of sewage," whereas I consider the proper method of dealing with this question is, first to demonstrate that the sewage can be purified without causing a nuisance, or that it cannot be so purified. If it could be proved that it was impossible to purify sewage without creating a nuisance then there would be an end of the subject, and we should have to submit to having it all delivered into the sea as quickly as possible; but it has not yet been proved to be impossible to purify sewage, neither has it yet been *publicly* proved to be possible to purify sewage by any process without causing a nuisance somewhere. It is no answer to the question to say that irrigation and filtration purifies sewage, because the very process of irrigation and filtration, as at present conducted, causes an intolerable nuisance at the place where it is carried on.

rst question to be answered is (leaving the of expense out altogether)—can sewage be by any process whatever without causing a ? Then having proved if possible that it can ified, the second question would be—what is possible expense for which it can be purified? s it possible to profitably utilise the purified

By the above method of dealing with the I make the utilisation the last question of the first, as has hitherto been done. I doubt that if the question had been treated ove order by engineers and chemists from we would have had the question set at rest

eive the General Board of Health committed eat mistake in striving to prove the value e by the chemical value of the excrements of lation. It was a common thing to hear that of the sewage of a town was sufficient to the expense of sewering, draining, road- and all other expenses of a town. The f a town has been valued at from 10s. to head of the inhabitants per annum. At the e a town of 10,000 inhabitants would pro- age worth £5,000 a year, but we know that of the sort has ever been realised, and yet health and engineers are still to be found after this shadow of a valuation, and still to utilise without first proving it to be to abate the great national nuisance. If ad attempted to demonstrate the famous position of the 1st book, without first proving proposition, he would have failed. For like ngineers and chemists have failed to de- e the advanced proposition of how to utilise at a profit, because they have failed nstrate the necessary preliminary propo- of the possibility of deodorising, dis- , clarifying, and purifying the sewage. Let r propositions be first demonstrated, and proposition of utilisation will necessarily nd I have no doubt would soon be satis- proved. Another cause of failure in dealing sewage question has been by considering all as possessing the same characteristics or s. I have found the sewage of every town ave examined has some constituents or ty in it different from that of other places, e special constituents require to be specially h in every case. I have found the sewage more difficult to deodorise and clarify in ces than in others. By deodorisation and ion I do not mean the same thing as that by Rawlinson and Read in their report, , where it is stated, "All chemical t of sewage by patent processes or otherwise deodorisation—that is, at clarification and on." That is a most astounding piece of ion to me. In all my experience I never at deodorisation was the same thing as ion and purification. I have always found age could be deodorised without clarifica- urification, and that it could be clarified deodorising or purifying, and that it could deodorised and clarified without purifica- t it cannot be purified without being pre- eodorised and clarified.

there is a great fallacy in the mode adopted in calculating the quantity, and strength of sewage by engineers and —viz., that of calculating by the number of ontributing to the sewage, or the number of osets in a town. Such a mode of calculating ether misleading, because the sewage of residential water-closet towns — such as nd, Brighton, and Tunbridge Wells— is very t in so far as the ease or difficulty of puri- is concerned. From my own experiments I t Brighton sewage is easier to purify than ond, and that Richmond sewage is much to purify than Tunbridge Wells sewage. The of the water supply, with regard to softness mperature, influences the quality of the sew- a great extent. The state of ventilation has great effect upon the sewage. I find also that pidity with which it travels, and the distance ich it travels, also qualifies the sewage to a erable extent, with regard to its susceptibility ng acted on by certain chemical reagents.

Brighton, where I had peculiar opportunities of g the sewage in every part of the town for rds of four years, I found that the sewage from lat, ill-ventilated sewers was in every case more ult to purify than the sewage from the steep ents and well-ventilated sewers, even where the e number of inhabitants contributed to them. is a qualification that the Local Government rd does not appear to have taken into consider- n at all. Again, we have towns which send the ater part of their linen to country villages to be hed, and others that wash all their dirty linen at e. The sewage of two such towns must be very erent to deal with, even supposing the same num- of inhabitants contribute to the water-closets.

gain, some towns have their dairies and cow- es all within the town, which make a large ntity of sewage, and there are other towns ich have no cow-houses within the sewer district, but are all outside, and contribute nothing to the sewers. There are also manufacturing towns which contribute a variety of refuse to the sewers of a different nature altogether from water-closet refuse, which requires to be specially treated. These facts show the absurdity of estimating the quality of the sewage by the heads of the population contributing to it.

There is another error that all writers on sewage that I have consulted have fallen into—viz., they all, without exception, speak of and treat the odours from sewage as gases. They all seem to know that sulphuretted hydrogen stinks badly, therefore everything that stinks, according to their logic, must contain sulphuretted hydrogen; and as coal-gas is purified from sulphuretted hydrogen by lime at the gas-works, therefore lime must purify sewage; but it has been found that lime alone does not purify all sorts of sewage. In well-constructed and ventilated sewers sulphuretted hydrogen seldom or never can be found. The most of the smells that are called sewer gases are not gases at all. The smells which emanate from the sewage are produced from the volatile vapours of essential oils formed from the decomposition and recombination of vegetable and animal matters. These subtle volatile vapours travel at a very rapid rate through the air, by conduction or diffusion, whenever they are liberated. They travel even against the wind. An idea of the rapidity with which they travel may be formed by the quickness with which the carrion crow, the vulture, and the albatross discovers carrion at a great distance.

If a dead animal be thrown into the middle of the South Atlantic Ocean, where not a bird is visible, the smell will attract numerous albatross to it in a very short time. Even man's obtuse sense of smell can discover the rapidity with which smelling vapours travel. If we go into a large hall or church where the air is perfectly still, and let a smoker kindle his pipe at the farthest distant corner from us, we will smell the vapour almost as soon as he kindles his pipe. These facts, illustrative of the rapidity with which smelling vapours travel, show how ridiculous and absurd it is first to liberate the volatile vapours of sewage, and then to try and arrest them with solid and liquid disinfectants—even disinfecting gases such as chlorine and hydrochloric acid cannot destroy all these volatile vapours, because the gases travel at a much slower rate than the vapours, and cannot overtake them when they are liberated in the air. The process of first liberating the volatile vapours of sewage and then trying to arrest them in the air by other substances is often tried, but with very unsatisfactory results—in fact, it cannot be done.

To deal properly with these volatile vapours they ought to be arrested and condensed in the liquid state in the sewers, and the essential oils decomposed at the outfall before the sewage is finally discharged into the open air, whether it has to be utilised on the land or discharged into the sea. When this is properly done there will be no nuisance anywhere, and it will then be possible to utilise the sewage of any town, and to purify it so as to allow it to be run into any stream without the slightest danger of its ever becoming a nuisance to any one.

Wm. Burns.

EXPLOSIONS IN THE MANUFACTURE OF OXYGEN.

[14233.]—HAVING a few weeks ago seen accounts in your valuable paper of explosions in the manufacture of oxygen from a mixture of manganic oxide and potassic chlorate, owing to the MnO_2 containing impurities, I beg to state that I have tried the experiment of substituting well-dried sand instead of the manganic oxide, and I find that I get off an equal amount of oxygen at a similar temperature, and that the process is unattended by the danger of explosions.

$$MnO_2 + 2KClO_3 = MnO_2 + 2KCl + \underset{16 \times 6 = 96 \text{ grammes.}}{\underbrace{3O_2}}$$

$$\left\{\begin{array}{llll} 2K & = 39 & \times\ 2 = & 78 \\ 2Cl & = 35{\cdot}5 & \times\ 2 = & 70 \\ 6O & = 16 & \times\ 6 = & 96 \end{array}\right\}$$

$$\overline{244} \text{ grammes.}$$

$$SiO_2 + \underset{244 \text{ grammes}}{\underbrace{2KClO_3}} = SiO_2 + 2KCl + \underset{16 \times 6 = 96 \text{ grammes.}}{\underbrace{3O_2}}$$

When all the oxygen has been expelled from the $KClO_3$ I just empty the retort, treat the residue with water, which dissolves out the KCl, allow it to stand for awhile, decant off the clear liquid (which contains the KCl), dry the SiO_2 ready for use; another time evaporate the solution of KCl, allow it (the KCl) to crystallise out, collect the crystals, and use them for some other purpose. Besides being harmless, this is a much cleaner process than when the MnO_2 is used. Perhaps this may be of some use to some of "ours"; if so, they are quite welcome to it. **H. Hollewell.**

A GOOD SUGGESTION.

[14234.]—IT may interest many of your readers to know that they can see all volumes, except the first ten, of your esteemed paper, free of charge, on Mondays, Wednesdays, and Saturdays, from 10 a.m. to 10 p.m., at the Educational Library, South Kensington Museum. On other days the hours are shorter, and a charge for admission is made; but no letter from a householder is required as at the British Museum, and it takes but a minute or two to get the volumes, which are well bound and in good condition. The City Library at the Guildhall does not contain a single number even of "ours," and I cannot but believe that, if those connected with the Library saw two or three numbers, they would at once show their appreciation of its excellence by subscribing, and I accordingly send a small sum to pay for a few numbers being sent there. May I venture also to suggest that, if any of your readers who have more back volumes than they know what to do with would send those where needed, to either library, they would have the satisfaction of feeling that they had borne a part in advancing and encouraging the scientific knowledge of the people. The City authorities can well afford to pay for those volumes, which are to be had first hand, and are also so few in number. **B. K. H.**

[We are much obliged to our correspondent, and have sent the numbers paid for.—ED.]

SOME RECENT IMPROVEMENTS IN THE METALLURGY OF NICKEL.

[14235.]—I HAVE read with much pleasure the report that has appeared in your columns of Mr. Alfred H. Allen's address on "Recent Improvements in the Metallurgy of Nickel," delivered before the Society of Arts. I was, however, much surprised to see that a patent, briefly but minutely described by Mr. Allen, had lately been obtained in France by MM. Christofle and Bouilhet for a new method of treating the New Caledonia ore in the wet way. When we hear of a patent I think we generally anticipate learning something new, though it does not always follow, as in the present instance, that our expectations will be realised. What is there *new* in this process patented by MM. Christofle and Bouilhet? The only *new* feature I can see in it is the obtaining magnesia and lime at the end of the process in admixture with the hydrated oxide of nickel, and even this is simply on account of the ore treated containing much of that compound. Excepting this single circumstance, incidental to the ore not to the process, this method of separating nickel has been used for many years.

Liverpool. **G. Paterson.**

PROFESSOR MILLS ON DESTRUCTIVE DISTILLATION.

[14236.]—I HAVE recently read Prof. Mills' "Manualette on Destructive Distillation," and cannot quite agree with your review of it, as I fail to discover in it any new or useful process in the "distillation of tar;" but, on the contrary, some statements which might lead the novice astray. Prof. Mills says "coal yields from 1 to 2 per cent. of 'liquor,' and from 3 to 6 per cent. of tar." My experience is that from one ton of coal there is produced from 24 to 34 gallons liquor (14 to 16 per cent.), and from 12 to 17 gallons tar (7 to 8 per cent.). All "coal tar" is heavier than water, not because it contains naphthaline, but from the bulk of of its component parts being heavier than water. I should very much like to be let into the secret of obtaining 10 per cent. of naphtha sp. gr. ·78 to ·83. In my experience, now extending over some 20 years, I never arrived at such satisfactory results. As to making commercial benzol, according to Prof. Mills' formula, all you would get would be "rectified naphtha containing benzol," but certainly not commercial benzol. In the manufacture of sulphate of ammonia Prof. Mills uses sulphuric acid, sp. gr. 1·4. I am afraid that he would obtain little salt, and a great deal of what I call "mother liquor." The acid used here is of sp. gr. 1·72; oil of vitriol I take to be of a sp. gr. 1·83. Prof. Mills' process of purifying ammonia by lime I most unhesitatingly say would fail. Using lime to disengage the gas is a very old process, but it requires something else to deprive the gas of its impurities.

Destructive Distillation.

COTTON-SPINNING.

[14237.]—BEING a constant reader of the ENGLISH MECHANIC, I have observed for some few weeks past a series of interesting articles on the "Technology of Paper-making." Now could not some of our readers, who are well versed in the subject, give us a somewhat similar treatise on the "Technology of Cotton-spinning?" This would, I feel sure, be the means of conferring an in boon on many in this manufacturing di ours, who, like myself, are beginning branch of industry. One thing which to make the request is that several tion to this and kindred subjects have, from time to time, appeared in your periodical; therefore, I think the matter is not wholly without interest to a large proportion of our readers. Xylon.

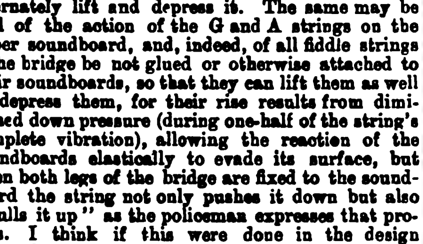
THE LAST LETTERS OF "THE HARMONIOUS BLACKSMITH."

[14238.]—We give below the second of the two letters communicated by Mr. Savage to "Fiddler."

Soundboards for Violin.

I should be much obliged by your favouring me with your opinion of the probable effect of the inclosed arrangement of two soundboards in one violin, one bridge being common to both, and especially if you think it preferable to clamping two soundboards together in the manner I proposed in my "funny first fiddle," figured in No. 374 of our journal. You will, of course, perceive the leg of the bridge, which is beneath the 3rd and 4th strings passes through the upper, and rests on the lower breast, thereby enabling you to employ, if thought desirable, a larger and somewhat thicker belly for those strings—say, as large or rather larger than that of the tenor, which would, I think, improve the tone.

As a matter of course, the E and A strings would have but little influence on the lower belly unless the bridge were glued to it, in which case they would alternately lift and depress it. The same may be said of the action of the G and A strings on the upper soundboard, and, indeed, of all fiddle strings if the bridge be not glued or otherwise attached to their soundboards, so that they can lift them as well as depress them, for their rise results from diminished down pressure (during one-half of the string's complete vibration), allowing the reaction of the soundboards elastically to evade its surface, but when both legs of the bridge are fixed to the soundboard the string not only pushes it down but also "pulls it up" as the policeman expresses that process. I think if this were done in the design inclosed (*a*, bridge; *b*, leg of bridge passing through upper and resting on lower soundboard; *c c*, upper soundboard; *d*, lower soundboard) both pairs of strings being caused to act on both bellies, must produce more powerful sounds than when only one belly is employed. Is there any practical objection to fixing the legs of the bridge to the belly?—Yours faithfully, Alfd. Savage.



Aug. 26, 1872.

P.S.—I presume you have seen the loan exhibition of funny fiddles, some of them unique, at South Kensington Museum, which only remains open until the end of this month. If you have not, go and look at them, for so extensive a collection of fiddles and other ancient musical instruments never before was, and almost certainly never again can be "gathered together" in the name of the L—, no, I mean in the name of the Duke of Edinburgh. Their total cost must be something fabulous, or, to speak more correctly, no money could buy some—yea, many of them. "Strad's," "Josephs," "Amatis," "Gaspar de Salis," Ruggeris, and Staainer's abound, not to mention Sordinos, Kitts, Pochettes, Viols, one Welsh Crwth, a violo, A.D. 1452, by J. Carlino, a violin by do., a very peculiar viola, No. 138 in cat., Irish harps, Welsh harps, &c., harpsichords and spinnets galore, 2 organ harpsichords, one A.D., 1745, not in cat., the other A.D. 1759, a regal, No. 422, with reeds, free reeds instead of pipes, of the 15th century, a clavichord, No. 32, in cat., a piano, A.D. 1767, flutina, the most ancient English instrument known to exist.

Will you support a movement for enlarging the English Mechanic? Lots of excellent "stuff" is "crowded out" every week. The Editor promised if we could augment its circulation fifty per cent. he would give eight additional pages instead of charging 3d. for the journal as I proposed.

CHEAP BICYCLES.

[14239.]—Get the best quality rubbers. The grey is in reality the purer of the two, but the red is rather more durable on account of a mixture of a hardening nature, sulphur being the principal ingredient. Therefore, have the red, or, as it is called, "indestructible."

The weight will be about 4lb. The better the rubber the lighter—consequently there is not much gained by buying the lower quality. If you have a good smith available, as you seem to have, you will get on well, as that is "half the battle." Hold him responsible for the quality of the iron he puts in. That mentioned in your letter will do very well. As you inquire about the wheels first, I will begin with them. Cut the No. 9 wire into 40 lengths, each 26in. long, and head them at one end. The way to do this is as follows:—Get two pieces of iron, and drill or file it as in sketch No. 1. These pieces or clamps, as we will call them, when put in the vice will hold the wire firm. The hole must be of such a size as to leave a little space between the clamps when they are closed on the wire. Leave the latter ¼in. above the clamps, and close the vice tight; then, with a medium heavy hammer, make a good head. Do not smash it down flat with the blows of the hammer all delivered in one place, but hammer all round the edge as well as at top. This will make a sound reliable head. Having headed your 40 wires for the front wheel, proceed to cut the lengths for the back wheel. These will be 9¼in. long and 16 in number; head them at one end. If the cavity in the clamps is too large to hold this size firmly, make another one in the same clamps for this purpose, and proceed as before. As you are a joiner, I suppose you can do a little in the pattern-makers' line. Make two patterns as follows:—See Figs. 2 and 3. Fig. 2 is for the front wheel; two of these will be required. As will be seen, they are discs or flanges 4in. in diameter—a hole in the centre ⅞in. The edge or outer diameter is 9-16in. thick and radial depths ⅞in. from this edge to within a short distance of the centre of the disc, or hub we will in future call it, may be thinned out as in the side view, making it lighter. Leave plenty substance in the root of the hub, so as not to split when being keyed up. Next make a pattern for the back nave, as in No. 3. Let the flanges of the nave be 2½in. apart, measured from the outside, the flanges themselves being ¼in. thick and 2½in. in diameter, the body of the nave to be narrowed as in sketch. Allow a slight projection on the outside of the flanges, as in sketch (side view), the back and front to be of malleable cast—not ordinary cast-iron, as it comes from the moulders; but after they are cast let them be allowed to cool very gradually, a few days if possible. This annealing will make it easy to work, and very much tougher than ordinary cast iron—in fact, ordinary cast iron will not do for the front hub at any rate. These cast and annealed, they must be turned and bored. Before this we will make our front axle and back cones and bolt. For the front axle get a piece of bar iron of best quality (round) 1in. in diameter, and 9½in. long. Centre it, and get it to run true in the lathe. Turn each end down to ⅞in. diameter (full) by 2in. This will leave 5½in. untouched; in the centre of this length turn two tapers 1¼in. long, the outer diameter being ⅞in., the inner (or nearest the middle) 15-16in. This will be a taper of 1-16in. in 1¼in. See Fig. 4. The remaining 3¼in. in the middle may be turned down to ⅞in. The hole in the hubs must be bored to fit these tapers, and drive on tight, then secure to a key pin driven in longitudinally so as to take a bearing—half in the axle and half in the hub. The tension of the wires will prevent any possibility of them opening or coming off the axle. Having bored your hubs and made the keyways, we must fit the cranks on the axle. These must fit on firmly. Put them on in line at opposites, and drill the boss of the crank whilst on the axle, so as to go through the axle, and also drill a keyway similar to the one in the hub. Take off both cranks and hubs, and smooth the bearings (these are 1¼in. measured from the taper) in the lathe. The next process is case-hardening these two places. This must be case-hardened with leather and bonedust, with caustic soda added in small quantities (this latter substance drives the hardening in deeper). Inclose the axle in a tube, and put this mixture where it is required to harden. Close the ends with loam or clay, or otherwise, so that air cannot get in, and expose to a re

about eight hours, then plunge in cold w

this means a coating of steel will be fo

where it is required, and as hard as gl

1-16in. deep. If these parts are polish

case-hardening, as they should be, they

out quite smooth, providing that no ai

them during the carbonising process.

done, the hubs must have 20 holes drilled

and tapped at equal distances. The size

holes must be determined by the nipples,

the outside. After the holes are drilled a

key on the hubs to the axle, and skim the

and the surfaces if you wish them to

Having now made the axle and hubs, dr

with 40 holes for the spokes. Then put

on the spoke, bray the end of the latter t

rim, and head it so as to leave it of suc

that when screwed up the head at the

⅛in. below the edge of the hub. Before p

nipple in finally, put on the lock nut for e

all the nipples are screwed down, tighte

nuts on the hub. It will be as well to ma

as flat as possible on a smooth flat pl

spoking; also make it as circular as pos

that no angularities exist, as these will

of trouble in truing up. When you ha

spokes screwed up to an even tension, a

irregularities in the circular contour of t

a mallet and knock them out. This will

heads of the spokes, and do no harm

Cementing the rubber tire is the next th

is generally done with a mixture know

cement, being a mixture of gutta-percha

or you may make a solution of shellac or

of wine (not methylated as sold in druggi

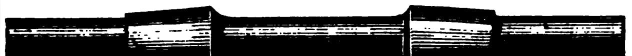
Directions will be found in back numbers o

Construction," for the former process

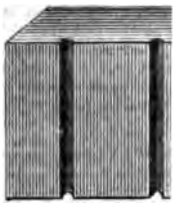
carried out as directed, will be satisf

Nos. 607 to 613 inclusive): On second

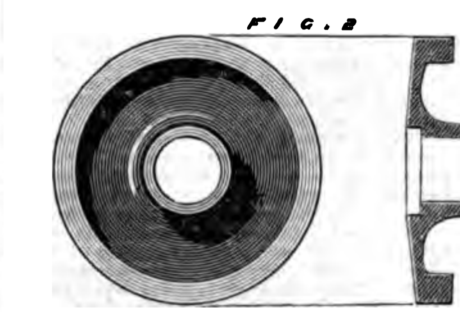
F I G . 4



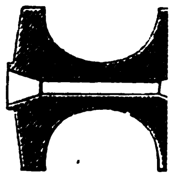
F I G . 1



F I G . 2



F I G . 3



will be advisable to buy the cone bolt f

wheel, as it only costs two or three shil

steering will be of the down-shaped

kind. Of this, more next week.

Middleton, Manchester. Fredk. L.

JAMIN MAGNET.

[14240.]—Having seen a description

back number of the English Mecha

it a trial. I obtained a gas pipe conne

1¼in. in diameter and 1½in. long. Ha

through from end to end, I made it red

it cool in the ashes. I then covered it

of paper previously soaked in paraffin

done, I covered it lengthways with thr

cotton-covered copper wire (as shown

English Mechanic) about 16 guage,

I soaked the whole in paraffin wax, and

with gutta-percha, inserting a piece of i

and extending ½in. beyond. This

convenience of lifting or suspending.

result. I applied the ends of wire

battery of two pairs of plates, about

Putting the magnet to a block of iron

it lifted it, and led me to try heavier

by arranging a box to hold sufficient we

it would lift 36lb. At that I left it, sa

is superior in construction to anythin

before. C.

HORSESHOE MAGNET TELE

[14241.]—In reply to "Mongibe

14173) it is indifferent which way the w

so long as the coil on one pole is w

opposite direction to the other, and

connect the wires, so that the current

the opposite direction on each pole;

wires together is sufficient, but always

when possible.

The extremities of the bent iron piec

spart. I have not tried the telephones They were put on with the idea of poles of the magnet nearer the centre agm, though I have no doubt the ild work without them.

er the soft iron poles to the magnet, ight spoil the magnetism.

g screw would be an improvement, but ould be rather difficult to affix to a shoe magnet, I recommend the follow- fter the soft iron poles, coils, and bent , on the magnet, place it in the groove he tail piece, then glue the tail piece hone case, and allow it to stand until rmly set. Now take a straight edge, he top of the case, and regulate the eans of the brass plates and screws, former sketch, until you have a space nagnet and the straight edge about the piece of good writing paper. You may e diaphragm and mouthpiece, and test s. If you think you should get better regulate them better.

ts are 4in. long, and cost 9d. If the filled with paraffin (or white wax will o fear of them getting out of regula- know that there is any other benefit them. Got four telephone terminals, l see advertised. It is better than twist- which are liable to break. You may of wire for the line. I shall be glad to further assistance, and to know how

W. P.

TELEPHONES.

BEG to send a description of wire tele- I have fitted up, and which works with ss between my house and workshop. are much louder than the electric tele- en all is quiet a prolonged "Hulloo" 20ft. away from the instrument, and carried on without putting your ear to it, the party conversing standing about of the instrument, and does not require position. Not being able to carry the ct line, I tried indiarubber, glass, rope, ad thick string the best material for se wire from the poles.

ered copper wire used is about the same the tinned wire on soda-water bottles, ough a hole in the glass of the window without touching the glass, to a pole 70 orth from window, thence to another , and again due north, then through orks the same manner as before. The nded from the poles by loops of twine se twine called marling), but must not ther substance. The instruments at simply two American apple tins 4in. in d 4in. long. Wire is put through a bottom of tin and attached to a button. the wire is stretched the better the

ma" please say if I am incurring any lightning by having the copper wire e, and, if so, what precaution I should

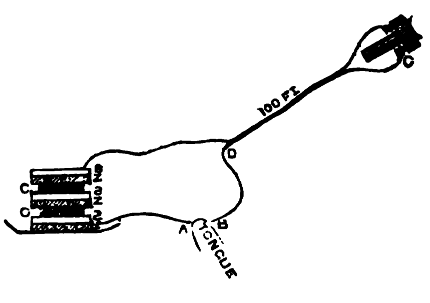
S. W.

VARIOUS reasons have been given to action of this instrument each of which ed to be discarded as soon as thought of, y will not bear scientific criticism. r all the explanation of the action is as he instrument itself, and so after the d molecular theories are found wanting, may, perhaps, be allowed to step in and s means. We know from the simple of influencing a soft bar with a magnet, suspended at, say, one-eighth of an inch the bar will be acted on apparently by ce of the magnetic condition of the air elf and the end of the bar, thus showing r not only conducts the electricity from the disc, but also acts upon it, which is e same as if the bar touched the disc, but great consideration—viz., that the air ts as an intensely elastic cushion, and in the telephone allows the vibrations in the to take place, which could not if the touched the bar.

of of this would lie in experimenting with ons in vacuum which could easily be done termediate one.

J. D. H.

I SEND you a simple mode I have r testing the line wire, &c., of telephones. the process is not new, but its application Make a voltaic pile of discs of zinc and with pieces of cloth interposed, as in ing sketch. Use a "lucky" shilling for n, and a piece of zinc with a hole in it for the s, the cloth discs to be rather smaller than ces. Remove the wires from one telephone and twist one of the wires coming from the other into the hole in the top shilling; twist another short piece of line wire into the hole in the bottom zinc. Now pile up the discs in the order shown in a saucer, previously well wetting the cloth with salt and water. (I used three pieces of well-cleaned zinc and three shillings.) Then place the end, A, of the wire on one side of the tongue, and touch the other side with the end of the wire, B. If the insulation be all right the usual acid taste will be at once developed. As, however, the same effect would be produced if there were a leak in the line wire, unfasten the line wire from the telephone at C, and try again; if there is no touching of the bared wires at D, and no leak, there will be no acid taste, showing that to produce the first effect the electricity has travelled the whole distance truly. My wire is only about 100ft. I fancy some of your correspondents must be deceived as I was in making my telephone, as they are so easily put together with a little care. I fancied (not knowing such extreme quietude was necessary at the receiving end) that mine were imperfect, though, when they were tried under proper circumstances, they were found to be all right. Mine are bar magnet telephones, no cores, and the materials were purchased from one of your advertisers.



April 8, 1878. B. H., Solr.

SELECTED CORRESPONDENCE.

THE SUN'S DISTANCE.*

A FEW months ago I said in these columns that the determination of the sun's distance, then recently communicated to Parliament—namely, 93,375,000 miles—was probably some 800,000 miles too great; and I spoke of the method on which the determination was based as to some degree discredited by the wide range of difference both between that result and the mean of the best former measurements, and between the several results of which that one was itself the mean. Captain Tupman, as straightforward as he is skilful and zealous, announces as the result of a re-examination of the British observations a distance about 600,000 miles less than the above, or, more exactly, about 92,790,000 miles, as the sun's mean distance. But, while he obtains from the ingress observations a mean distance of only 92,300,000 miles, he obtains from the egress observations a mean distance of about 93,040,000 miles; and the value, 92,790,000 miles, is only obtained as the mean of these two values duly weighted, the egress observations being more satisfactory than the ingress observations. I formerly expressed my doubts whether Mr. Stone, Astronomer Royal at the Cape (to whom the Astronomical Society in 1865 awarded its gold medal for researches resulting in an estimate of about 91,500,000 miles for the sun's mean distance), would accept the results published by his former chief, the Astronomer Royal for England. Strangely enough, the same publication which announces the corrected Greenwich estimate above stated contains a paper by Mr. Stone, in which he deduces from the same British observations during the transit of 1874 a solar distance of nearly 92 million miles. Captain Tupman points out that Mr. Stone has not yet seen all the British observations, still this value, deduced from the best of them by a skilful mathematician, well informed as to the sources of probable error, is very significant. He considers that the observations show the distance to lie between 91,400,000 miles and 92,500,000 miles; whereas at Greenwich no distance much smaller than 92,790,000 miles is regarded as admissible.

It appears to me that the doubts which I formerly expressed as to the trustworthiness of the method employed are to some degree justified.

To the general public it will be more interesting to inquire what probably is the true mean distance of the sun. To this it may be replied that in all probability the sun's distance does not lie so much as 200,000 miles on either side of the value, 92,300,000 miles.

Richard A. Proctor.

REPLIES TO QUERIES.

**** In their answers, Correspondents are respectfully requested to mention, in each instance, the title and number of the query asked.*

[31875.]—**Japanese Carpenters (U.Q.).**—The following paragraph may possibly serve as a reply to this query in the absence of more detailed information:—The Japanese habit of reversing everything, if we may regard our own way of doing as the proper way, is very curious, and in some of its details very interesting. Mr. Griffiths, in his work on Japan, discusses it thus: "Another man is planing. He pulls the plane towards him. I notice a blacksmith at work. He pulls the bellows with his feet, while he is holding and hammering with both hands. He has several irons in the fire, and keeps his dinner pot boiling with the waste flame. His whole family, like the generations before them, seem to get their living in the hardware line. The cooper holds his tubs with his toes. All of them sit down while they work. Perhaps that is an important difference between a European and an Asiatic. One sits down to his work, the other stands up to it. Why is it that we do things contrariwise to the Japanese? Are we upside down, or they? The Japanese say that we are reversed. They call our penmanship 'crab writing,' because, say they, 'it goes backward.' The lines in our books cross the page like a crawfish, instead of going downwards properly. In a Japanese stable we find the horse's flank where we look for his head. Japanese screws screw the other way. Their locks thrust to the left, ours to the right."—E. S. A.

[31877.]—**Cement for Driving Belts (U.Q.).**—Will not Prout's glue suit you? Belts get soft and pliable of themselves without anything—at least, I find they do.—TELESCOPE TELE.

[31877.]—**Cement for Driving Belt.**—I have seen castor-oil used with advantage for softening driving belts, and preventing slip.—J. B. R.

[31878.]—**Bogie Tanks on S. and D. Joint Railway.**—I cannot understand what "S. D. J. Ry. Loco." means by his reply on p. 97. I deny in toto that any engines have been built at Nine Elms for the Joint Line—in fact, the L. and S. W. Ry. Co., owing to insufficient accommodation, have not been able to build engines at their works for some years prior to the taking over of the joint line; so any assertion made to the contrary would only emanate from a person quite ignorant of what takes place at Nine Elms. If your correspondent, "S. D. J. Ry. Loco.," is the official he represents himself to be, he would know that, since the S. and D. Ry. has been leased to the S. W. and Midland Cos., the loco. department of the Joint Line has been, and is, under the control of Mr. Johnson, of the Midland Co., and if new engines were required for that line (S. and D. J.), they would either be built at Derby or contracted for.—NINE ELMS WORKS.

[31936.]—**Brass Kettle to Clean (U.Q.).**—Boil it again in some more soda and water. I am afraid you never made it strong enough. Try again. Boil for a long time, and then let it soak.—TELESCOPE TELE.

[31976.]—**Compound v. Ordinary Condensing Engines.**—From the remarks of John S. Sunderland he evidently does not believe in compound engines, but perhaps he could explain the following:—Steamers plying between the port where I live and Glasgow make the voyage in three hours less time and less than half the quantity of coals when fitted with compound engines than those steamers fitted with ordinary engines (that is to say, two cylinders, both equal diameters, and both receiving steam from boilers). Another instance I would wish to bring before his notice: one of the Liverpool steamers plying here has had her old engines compounded. She now makes the voyage in considerably less time and with less coals. How is this? I also understand that French locomotives are being fitted up on the compound system. Now, are all these engines fitted up to suit the freak of fashion, as John S. Sunderland would have us believe in one of his former communications? I would fancy that eminent firms, before fitting up these engines, must have found out that, both in theory and practice, they are the most economical power of the two.—D. L. B. A., Londonderry.

[32159.]—**Tricycle for Invalid (U.Q.).**—There is a drawing of just what you want published in this paper on October 6th, 1876—one that you will be able to make yourself.—TELESCOPE TELE.

[32162.]—**Noiseless Gear for Lathes.**—The levers *f* and *g* are jointed to the tee-piece at f^2 and g^2 respectively. The stem, *i*, of this tee-piece rises or falls in the bed, K, of the lathe head. The hand lever, p, is jointed to the lever, *g*, and similarly the lever, F, is jointed to the short link, *q*. The other end of this link is again jointed near the handle-end of the lever, P. By depressing the hand-lever, P, the levers, *f* and *g*, are pressed outwards by the spring that is fastened to the top of the tee-piece and disengaged from the pinion, E, thus pr rotation. Now, when the slow motio the eccentric causes the pinion to be and the top of the levers, *f* and *g*, therewith, partake of the same mo rising and falling of the stem, *i*, equa of the eccentric. (See ENGLISH MECHANIC, Aug. 24th, p. 586.) With regard to the cost of this motion, it depends on the sort of lathe to which it may be applied, but, in any case, it would be considerably less than the ordinary back gear, and much better in every way.—J. JEWSBURY.

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* From the *Times*.

[32298.]—**Great Eastern Engines.**—Is your correspondent, "G. E. R.," sure of his facts? I notice several inaccuracies, and would ask seriously whether he believes an engine could run 50 miles in 55 minutes, with 16 coaches, considering she has to climb two banks and slacken through several junctions and stations? Is he aware that the quickest train from Waterloo to Basingstoke takes 1h. 7m. to run 47½ miles of tip-top road, nearly straight, and with a ruling gradient of 1·250 only. The L. and N. W. R. allow 1h. 6m. for running the Trent Valley 50½ miles, ruling gradient 1·330. The G.W.R. allow their fastest narrow-gauge express 1h. 25m. to run 63¼ miles of almost level and straight road, which is about 17 minutes too much, according to "G. E. R." I have ridden the distance he refers to in 1h. 3m., and thought it a very good performance, though only 8 carriages were attached. —HELIOS.

[32301.]—**London Firewood.**—I believe there is a machine for splitting, but the wood is as frequently chopped by hand, and bundled in the ordinary bundling box. Immense quantities are now chopped and bundled at the industrial homes and workhouses. —J. T. M.

[32303.]—**Jamin Magnet.**—I wrote my reply to this query from memory. Since then I have hunted up my original source of information (p. 473, Vol. XII.), where, in a letter from Mr. Tonkes, that gentleman gives the following dimensions:—A tube of soft iron, 3in. long by 1½in. inner diameter by ¼in. thick. Have it planed longitudinally, so as to leave an opening of about ⅜in., then wind longitudinally with about three coils of No. 16 W.G. cotton-covered copper wire. He adds that with a magnet made on this plan, the core of which weighed about 14oz. only, he has sustained a weight of 190lb., using four Bunsen's cells. I see that this is Joule's magnet, not Jamin's.—GLATTON.

[32305.]—**Artificial Incubation.**—I have a recollection that Mr. Fletcher once described a good gas regulator for incubators and greenhouse boilers, but I have failed to find it. Perhaps he can help the querist.—OBERHOF.

[32315.]—**Lemon Juice.**—Mr. Allen being, probably, too busy to reply, I venture to send the following analyses of two good samples of lemon juice.

Citric acid	7·770	7·640
Total solids	8·990	8·970
Mineral mattter	·26	·310
Sulphuric acid	·002	·002
Spec. gravity	1035·16	1034·72

The complete analysis of one sample is: Potash, 54·56; soda, 1·42; lime, 15·19; magnesia, 4·85; sulphuric acid, 4·94; phosphoric acid, 15·63; silica, 1·77. Loss, &c., 1·64.—J. M.

[32318.]—**Claret Stains.**—"Mac" should refer to page 217, Vol. XX.—D.

[32320.]—**German Silver.**—There are different kinds of German silver in the market, and as "Scipio" does not say for what purpose it is required I can only send him some recipes, and leave him to choose.

Copper	50	50	8	6
Nickel	18·7	25	4	2·5
Zinc	31·3	25	3	2

The last with a very little lead (about ½ of a part) is suitable for rolling.—TAGES.

[32339.]—**Loss of Voice.**—"Baritone" can surely think very little of his "voice" if he is willing to try "remedies" which may be suggested by chance readers of his query.—M. D.

[32341.]—**A Working Man's Garden.**—So much depends upon circumstances. A quarter of an acre would be a good size for an allotment, and would not always be convenient to attach to a house. Of course the garden with the house is preferred, but allotments are jumped at, and need not be fenced off, though it is preferable if fencing is cheap A pig-stye is far before a hencoop, because, unless there is a green "run," there is no profit in keeping fowls.—BLISWORTH.

[32344.]—**Isthmus of Panama.**—I think the canal to cost 22 millions dispenses with locks, the enermous cost being due to the tunnels that would have to be cut. I think there will be very many wars before such a canal is cut, though it should be a tolerably large British interest.—JINGO.

[32345.]—**Grain of Violin Wood.**—On p. 98, Mr. Davies is good enough to notice the above, and I forget how long ago I desired the aid of our microscopists in examining violin wood; but the query was about the direction of the grain of back wood in opposition to the belly wood. I knew it was daring of me, so I am grateful to "W. H. D." for treating me tenderly. Sound is one thing, resonance is another, yet both go together in their motion. Then, if the motion or direction of the vibrations operating on the belly are in one direction, then the direction of the reactionary back should be in the contrary way. For instance, I take a long piece of wood capable of bearing the strain of a tensional string, and attach to its middle a soundboard or box over which comes the said wire or string, supported by a bridge, so that the bridge divides the string by halves; when I vibrate one-half of the string wire, the vibrations go in a certain direction—viz., to the bridge, and so by leverage to the soundboard. Now, I tune the string so that each half before and behind the bridge is in unison; thus, when vibrated, the bridge conveys the vibrations of sound not only to the soundboard, but to the other half of string; then these secondary vibrations are in opposition to the primary, and by their return to the bridge re-act, and resonance is consequently produced, and a louder tone. The more the string is vibrated by the bow on its side near the wrest pin, the greater the tone without a soundpost. But if we use a soundpost, then the back officiates as the second half of string, and we do away with that to economise space. Now, this is the reason why I asked about the direction of grain; if the vibrations are reinforced by opposition, why not have the different grains of wood in opposite directions?—FIDDLER.

[32355.]—**Organ Query.**—I have omitted to reply to this query, thinking that perhaps "Istriel" might be able to tell your correspondent how to alter his F organ to a C. I regret that I cannot, but at the same time would express my opinion that there can be little, if any advantage in doing so. Are nearly all church organ manuals of C scale? I was under the impression that they often began on G or A. But supposing the F tube-board would do for the C set of reeds, "Amateur" would require to alter his key-board, and that would be a work of time scarcely worth attempting. It would be better to exchange for a C key-board. While writing, permit me to express my acknowledgments to "Eleve" for his kindly criticism of my letters. As professionals have not the leisure—possibly not the wish—to give full instructions for making instruments, amateurs must undertake the task; but when they do, we see that not being acquainted with all the refinements of the atélier, they are apt to bungle in their directions. I hope, however, that none of your readers has made any serious mistake through my laches. The "clear case of heterophemy" arose through my misunderstanding a conversation with the agent of Messrs. Gordon, the actions being, as I find, got up both ways.—ORGANON.

[32356.]—**Telegraph Engineering.**—"Frank's" best course would be to obtain employment as an assistant to a telegraph engineer.—M. S. T. E.

[32430.]—**Defective Harmonium.**—Possibly it may be that you, to play loud, force the wind. There is a maximum pressure at which the reeds speak loudest with the least harshness, but if wind is forced it will almost of necessity cause a hissing. They might perhaps be improved by a tuner, but it may be most likely that you work the bellows too strong.—HENRI ÉTIENNE.

[32447.]—**Electrical Indicator.**—I think, with J. Jones, that electrical means are too complicated for "An Old Reader's" purpose. He says he wants it done by electricity, because laying the mile of pipe is out of the question. But if he will follow me I will try and show that the sounding apparatus which he mentions, and calls the "patent sounder," will act perfectly over a mile, or over two miles if necessary. The "patent sounder" is for the purpose of showing exactly how much a body of water is rising or falling—thus, water rising or falling in a cistern, or in a ship's hold, or in a tidal river—such as our friend wants to measure—and its action is simply this. If it is wanted to know how much water there is in a ship's hold, a metal box, about 6in. square, is secured to the bottom of the hold, and a hole having been made in the bottom of the box, so that the water can get into it, this part of the apparatus is ready; the box is, of course, full of air. And should the ship spring a leak, or, through any other cause, should water get into the hold, the water as it increased in depth, would enter through the hole into the box and compress the air in it, and the higher the water rose in the hold the more the air would be compressed. What the "patent sounder" does is to show on an indicator the amount of this compression, and this is done by having a small pipe from the box to the indicator, which is so marked that you see clearly what depth the water is in the hold. Now, if I understand "An Old Reader's" query, he wants nothing more than a "patent sounder," (which he appears to understand), rigged up with a mile of pipe from the box at the river to the indicator at the office. The pipe will have to be the smallest he can procure, and the box at the river as large as possible. Thus, if he uses the pipe that is sold for pneumatic bells, which is ⅛in. inside diameter, or ⅛in. iron pipe, the box would have to be at least 12in. square. The best size, I believe, would be about 24 × 24 × 6in. deep, the object being always to have much more air space in the box than in the whole of the pipe. If he goes in for this plan, and wants economy, buy the pipe from the maker, and not from dealer, and a mile of this size won't amount to much money. There are two or three makers of the pneumatic tube in London. The indicator will have to be bought from the patentees. I have read "Draughtsman's" letter, and think his plan very ingenious, and will look out to see what our electrical friends say about it.—PNEUMATIC.

[32447.]—**Electrical Indicator.**—"An Old Reader" will not, I fear, get much help from the replies to his query which were inserted in last week's number of the ENGLISH MECHANIC. If he wishes to use electricity to work his indicator, he must necessarily have a rather more complicated apparatus than if he only uses a wate
tube. I will endeavour to describe
cator:—On the water place a float, wor
guides: from it have a small chain,
two pulleys (see Fig. 1), and kept tight
on the other end. Between the pu
board, C D, which is longer than the
float; and on this board fix two stri
E F and G H—a few inches apart, on
connected with the line wire, and the
earth; and at every 6 inches up ce
plank (or closer, if a finer reading is re
two mercury cups (see Fig. 3), one
being in metallic connection with eith
cups must not touch each other, b
about 1-16th of an inch apart. Instea
chain the whole distance from the

FIG. 1

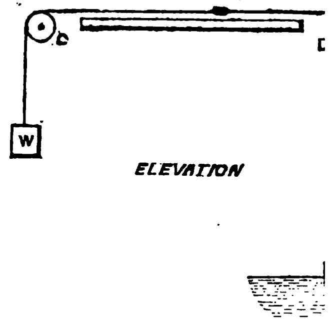


FIG. 2

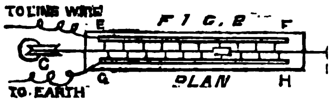


FIG. 3 PLAN OF PLANK

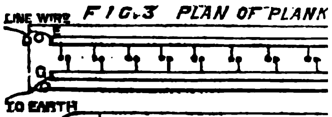


FIG. 4

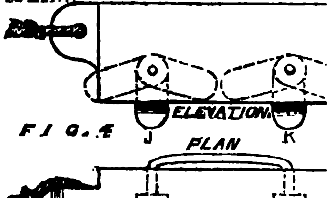


FIG. 5

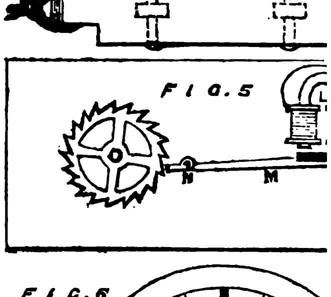
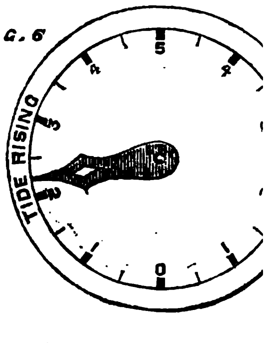


FIG. 6



weight, a cord should be used in the pa
over the plank. To this cord attac
connector" (represented in Fig. 4), wh
wood. It has two feet of brass—J a
work upon two connected joints, and
play to allow of their being in the posi
in dotted lines. As this "current conne
along the board its feet dip first int
cups, and then into another, of cours
the current at each time. At the ot
line, for reading off the height of
necessary to have an instrument
Fig. 5). L is an electro-magnet,
time when the current is connec
catch, M, and this, by its move
ratchet-wheel to turn round one n
joint, N, allows the catch to f
moving the ratchet-wheel. O is a
the catch away from the magnet

ɔrk. On the end of th's ratchet-wheel fixed a hand, which works over a face :hat shown in Fig. 6. The ratchet-wheel 'e twice as many notches as there are ɔs on the board, and so the board makes tion while the tide rises and falls. If Reader" wishes to ask any questions bject, I shall be happy to answer them ar as I am able.—A. A. Watkins.

Carbonate of Ammonia.—My thanks Os,'' who says it is used as a stimulant lepression, but he does not think it would e pain. I know some persons who take ɔni until it becomes a kind of dram to can't do without it—it's another form of s. The lump or carbonate not being so likely to be used so. Depression, I take s of the nerves, and pain may result from the nerves; indeed, it is generally said low, apply this remedy—viz., a pinch of i the tongue, every three or four hours, of tooth-ache or spasms relief should have succeeded in four out of six in both ld, and I find that more than a 5 grain ime defeats the end in view. Perhaps urs" will report effects after a trial.—

Harmonium.—I never heard of any ings that were better than the spiral lo not comprehend the question, as the id to be hinged in front. The springs eath what we call the reservoir, which lly all round and falls not more than Henri Etienne.

- Railway Companies and Goods uestion is very vague. Each railway s a special Act of Parliament which he changes they can make. Biggs' cts 1830 to 1874," published by Waterlow es all the Acts which apply to every Browne's "Practice before the Railway ers" is also an excellent book, and conet of 1873, under which they sit.—Jim

Boiler Flues.—Will this rule suit "A The diameter at the base should not be th of height; batter of chimneys, 3in. to ickness of brickwork, 1 brick from top from ditto; 1½ brick from 25 to 50 feet p, increasing by ½ brick for each 25 feet op. If the inside diameter at the top 6in. the top length should be 1½ brick Quantity of coal consumed per hour in ight of chimney in feet; H.-P. = in-power; A = area of chimney at top in s—

$$A = \frac{15\,F}{\sqrt{h}} \text{ or } \frac{150\,H.\text{-}P.}{\sqrt{h}}.$$

Alfred.

Driving Belt.—I should recommend leather belting.—Telescope Tele.

Eyesight.—This is the result of overɔ the eyes are strained. Some two years ere just the same, but by attending to a ules I can now compete with any one for ion. I first substituted a lamp for gas by, and, if possible, keep the light from t upon the eyes. We used to have a ach, and connect by a pipe to a gaspipe I found this most ruinous to one's sight, the case of several destructive to sight. th cold water is good, but always rest break when eyes are at all fatigued. fully attend to the stomach, as this is ant, for if not in order it will be sure to es.—Scipio.

Sulphuric Acid.—The way to procure o have a bottle or jar containing oxygen er, then place a piece of sulphur about pea into a copper spoon, and set fire ndle and blowpipe. (I may just remark on is made on purpose for such experixt, plunge it into the jar. The sulphur ith a beautiful violet-coloured scintil-, and the jar will shortly be filled with a ur, which is sulphuric acid gas, which y combine with the water, and form id. Specific gravity should be 1·850 or hur Alfred.

Normal Sulphuric Acid.—Normal id is dilute sulphuric acid which contains of H_2SO_4 per litre. It cannot be made m H_2SO_4 by dilution, but you will first ke two other solutions—viz., a standard solution and a standard alkali solution. is this: It is impossible to obtain the of H_2SO_4 by simply weighing out the weight of ordinary sulphuric acid. The acid which would be required for this uld be of 1·842 sp. gr., and, further, it ire to be perfectly pure. Again, the vity of the acid cannot be accurately by the hydrometer, and H_2SO_4 has a affinity for water, absorbing a large rom the atmosphere in a short time. normal acid solution must be "titrated , made up to the same strength as a ormal alkaline solution. Now the equivaalkalis used for this purpose (viz., caustic caustic soda or ammonia) cannot be t, as in the case of H_2SO_4; the first two of their rapid deliquescence, the last because of its great volatility. Therefore the alkali must first be made up to equal strength with some acid, the equivalent of which can be weighed, and by far the best acid for this purpose is oxalic acid. The oxalic acid used must be perfectly pure, and without a sign either of moisture or efflorescence. Molecular weight of oxalic acid, $C_2H_2O_4H_{20}$ = 2 + 24 + 64 + 36 = 126; molecular weight of potassic hydrate KHO = 39 + 1 + 16 = 56. Now,

$H_2C_2O_4OH_2 + 2(KHO) = K_2C_2O_4 + 3H_2O$;

∴ 1 equivalent of $H_2C_2O_4OH_2$ = 2 equivalents KHO;

∴ $\frac{126}{2}$ „ = – 53 „

∴ 63 grammes „ = 53 grammes „

Therefore the equivalent of the oxalic acid to be used = 63 grammes per litre of solution. Accurately weigh out 63 grammes of the pure dry crystal acid, free from moisture and efflorescence, and introduce it into a "litre" flask (flask containing 1,000 c.c.); add about 500 or 700 c.c. of hot water, and shake till all the crystals are dissolved. Care must be taken not to spill any of the solution during the shaking, as the accuracy of all volumetric analyses depends upon the preservation of measured quantities of solution. When the flask is cool fill it up with water to the litre mark, and transfer to a dry, clean, and well-stoppered bottle. All water used for the oxalic acid solution must be distilled; for the other two solutions ordinary water may be used. The standard normal alkali is best prepared by adding about 3½oz. of caustic potash to about 100 cc., and when dissolved letting the liquid cool and making it up to the litre with water. This alkali must be titrated up to strength with the oxalic acid solution, so that 1 cc. oxalic acid = 1 cc. caustic potash. The caustic potash will then be a standard normal solution, and will contain 56 grammes KHO per litre. The titration is thus effected: 25 cc. of standard normal $C_2HO_4OH_2$ are measured out accurately into a beaker, coloured with litmus solution, and the potash solution then run in until the "neutral" tint is reached. Suppose 21 cc. of potash solution were required for this purpose; ∴ 21 cc. standard normal oxalic = 21 cc. of KHO solution; ∴ for every 21 cc. of the potash solution 4 cc. of water will have to be added to make it equal to the oxalic acid solution. ∴ 1,000 cc. require $\frac{1{,}000 \times 4}{25}$ = 190·5 cc.; ∴ the litre of potash solution will require 190·5 cc. of water added to it to make it up to the required normal strength. If these directions have been carefully carried out 1 cc. of $C_2H_2O_4OH_2$ will be equal to 1 cc. KHO. In the same way the normal sulphuric acid is prepared by adding about 2½ measured ounces to about 100 cc. of water in a litre flask, allowing it to cool, and making it up to 1 litre with water. The acid is then titrated up to strength with the normal KHO, so that 1 cc. standard normal KHO = 1 cc. standard normal H_2SO_4; ∴ 1 litre of H_2SO_4 normal contains 49 grammes of H_2SO_4 per litre because H_2SO_4 = 2 (KHO) (producing $K_2SO_4 + 2H_2O$);

∴ $\frac{98}{2}$ = 56, or 56 grammes KHO = 49 of H_2SO_4;

∴ 1 litre of normal KHO, containing 56 grammes KHO per litre, = 1 litre of normal H_2SO_4 containing 49 grammes KHO per litre. Standard normal sulphuric acid thus prepared contains 69 grammes H_2SO_4 per litre = 0·049 grammes H_2SO_4 per 1 cc.;

∴ 1 cc. N. H_2SO_4 = 0·017 grammes of NH_3
„ „ = 0·040 „ NaHO
„ „ = 0·040 „ KHO

&c. The standard normal oxalic acid and caustic potash solutions should be kept and used only to "standardise" the H_2SO_4 solution, which, however, should be standardised continually, as it gradually deteriorates in strength. Note.—The letters "cc." are used for the words "cubic centimetres." I shall be happy to give any other information which lies within my power, but should recommend "Derby" to refer to any of three text-books:—1. "Fresenius' Quantitative Analysis," price 14s. (I think); 2. Sutton's "Volumetric Analysis," 12s. 6d.; 3. Thorpe's "Quantitative Analysis," 4s. 6d. 2nd. part of query:—"Twaddel" hydrometer strength is easily found from the actual specific gravity by deducting from the latter 1,000 and dividing the remainder by 5, thus:—

1,842 real specific gravity
1,000

5) 842

168·4° = Twaddel hyd.

Baumé's hydrometer has no direct relation to Twaddel's hydrometer, and I should advise "Derby" to get tables (they are to be found in Thorpe's "Quantitative Analysis"). For liquids heavier than water, each degree Baumé from 1° to 10° roughly represents 0·007 increase of real sp. gr., from 10° to 19° 0·008 increase, 20° to 25° 0·009 each, 25° to 30° 0·010, 30° to 38° 0·011 each, 39° to 44° 0·012, and so on. For liquids lighter than water a different arrangement is adopted by Baumé, 1·000 sp. gr. being represented by 10°, 0·933 by 11°, &c.—H. L. S.

[32540.] — **Blistered Hands.** — A little clean tallow rubbed upon the inside of the hand is a good thing, and do not hold your hammer tight. Let it go nice and loose.—Harry Beta.

[32541.]—**Lacquering Tin Articles.**—The match boxes are simply brown japanned, and the grocers' canisters japanned; the figures then are placed on or "transferred," and varnished on the fancy parts.—Scipio.

[32544.]—**Cooking Stove.**—The action of the stove is to consume oxygen, and also to form carbonic acid gas. It is therefore injurious in two ways—1st, by depriving the air of the oxygen, which is essential for life; 2nd, by the formation of a gas which is a decided poison, for we cannot live in an atmosphere which contains the small amount of 10 per cent. of carbonic acid gas.—R. N. P.

[32545.] — **Incrustation of Boilers.** — W. L. Thompson and Co., of London, are agents for supplying Field's patent "galvanic boiler-scale preventer," of whom a circular, with description, may be had, and I think is perhaps the same as inquired for.—H. Prior.

[32547.]—**Railway Rates.**—"Pera" should get Browne's "Practice Before the Railway Commissioners," published 1876; G. Stevens and Haynes' "Report of the Commissions for 1877;" Railway and Canal Traffic Act, 1854, from all of which he will learn that railway companies must not give undue preference to any one. The case of Holland v. Festiniog Railway Company, cited at page 19 of the Commissioners' report above referred to, seems to be very similar to that of "Pera."—Corcyra.

[32548.]—**Westinghouse Brake.**—Your correspondent is ignorant of the first principle of the Westinghouse automatic brake, for if the pipes closed when the train breaks away the brake would not be applied, and would not deserve its name of "automatic." The hose simply pull apart without injury, and let the air escape, and consequently the brake goes on. In uncoupling in the usual way, first turn the taps vertical, so that the air cannot escape beyond a slight "pop," due to the liberation of the air in the hose, and the brake remains off. The vacuum has a self-acting flap, which falls and closes the pipe when the hose are pulled apart; they also use an internal perforated tube closed at the ends, which pulls out and makes a joint should the train break in two.—Helios.

[32549.]—**Photographic Lenses.**—The old idea of correcting spherical aberration by placing the diaphragm in front of the combination has been exploded by the introduction of the central diaphragm known as the Waterhouse diaphragm. The front diaphragm was, of course, better than nothing, but is of much less value than the central diaphragms. By all means remove them, and have Waterhouse diaphragms fitted. As to the Ross, I cannot think that it is at all similar to the other lenses. Probably it is a view lens, but as you add "they are portrait combinations," I cannot understand it. I would like to have more particulars regarding it before suggesting alterations.—W. J. Lancaster.

[32550.]—**Boiler Pressure.**—If the boiler is properly riveted and stayed it should work safely at 300lb. to the square inch when new. Slight corrosion, however, would greatly weaken such thin plates. Your correspondent, "L. L." (let. 14175, p. 94), is rather hard on the L and Y, who were the first railway to adopt continuous brakes, when most of the present generation of brake inventors were "creeping, like snail, unwillingly to school." I cannot agree with your correspondent that the vacuum is a notoriously bad brake; it has one great good quality—simplicity. Any one can work it, and understand it. It is slow, the bags and hose are made of a perishable substance, and if they fail when the brake is on, the effect may be disastrous. No one in his senses supposes it can stop a train as quickly as the Westinghouse or Barker's, but both the latter are complex affairs not easily understood by porters and ordinary mortals, while the former at least requires careful attention and watchfulness, and sometimes displays its automatic qualities when least expected. Probably, however, if manufactured in substantial John Bull fashion (plenty of weight and strength everywhere) these spots on the sun would disappear.—Helios.

[32550.]—**Boiler Pressure.**—If the boiler is riveted, you could work safely up to a pressure of 150lb. The boiler would drive the model easily enough.—Arthur Alfred.

[32552.]—**Boring Tool for Wood.**—Get a 3 or 4-sided file, and grind down the end to a V shape; grind it so as to leave plenty of clearance. The point and 2 edges keep very sharp, especially the point. I have used it for a very long time; it cuts it out splendidly.—Telescope Tele.

[32554.]—**Weigh Shaft.**—I advise your correspondent to read the article on "Valve Gear in Locomotive Engineering," by Zerah Colburn; it is the best treatise on locomotive valve gear with which I am acquainted.—Helios.

[32556.]—**Electrical.**—Saw them out of the lumps of carbon to be obtained at the gas works as taken from the retorts. You will find full directions as to cutting them in back numbers, but I would recommend you, unless you have hours to waste, to order them the size you want. 2. You may use a couple of pint Smee's or a Bunsen's cell. The Smee's would cost about 3s. each, the Bunsen's 5s.—W. J. Lancaster.

[32557.]—**Shaking Grate Bars.**—W. A. Martin and Co. were the patentees and manufacturers. I had a set put in my boiler in 1862 from seeing them in the International Exhibition of that year. They are remarkable for their durability and clearing the fire all over, and separating the clinkers.—H. Prior.

[32558.]—**G. W. R. Broad Gauge Engines.**—There are several slight variations in the 28 engines of the Great Britain class, but roughly their dimensions are as follows:—

Cylinders	18in. × 24in.
Driving Wheels	8ft. diameter
L. and T.	4ft. 6in. ,,
Boiler ...	10ft. 6in. long × 4ft. 9in. dia.

Number of tubes 270 to 305.
Total heating surface, 1,600 to 1,950 sq. ft.
Grate surface, 20 to 26 square feet.

Total weight engine road worthy, 36 to 40 tons. Weight on drivers adjusted according to weather and state of running shed foreman's conscience, say from 14 to 19 tons. The tenders differ considerably in size; only a few of them can run from London to Swindon without the aid of the water-crane. I have heard so much about the wonderful 70 mile an hour engine of the distant future supposed to be building at Swindon, and have seen so little of its performance that I can't undertake to say what they are building there. I do, however, know that on four recent journeys by G. W. R. narrow-gauge express we only arrived punctually once, while for the last two months at one of our largest and most crowded metropolitan termini over 90 per cent. of the trains have arrived within 5 minutes of their time. How is it that the fastest narrow-gauge express to Swindon takes 1h. 55m., while the G.N.R. run the same distance with twice as heavy a train and over steep gradients in 1h. 30m.? The stoppages cannot make all this difference. Your correspondent, "Ambidexter," is certainly not binocular; before rushing into print with such nonsense, I would say to him, circumspice. —Helios.

[32561.]—**Machinery Brass.**—The following are good mixtures for machinery brass—the last is the hardest:—

Copper ...	16 ...	6 ...	16
Tin ...	2½ ...	1 ...	3
Zinc ...	¼ ...	½ ...	¼

—Helios.

[32561.]—**Machine Brasses.**—If you require best gun-metal mix in proportion 16oz. copper, 2½oz. tin. But a good hard brass is this: Take, say, 7lb. copper, 3lb. old brasses, 1lb. spelter, and 12oz. tin. The first is the cheapest in the end, but in the prevalent rage for cheap things you will find the last very serviceable. What is called "dipping metal" is nothing more than ordinary ingot brass, and costs about 56s. per cwt. I often use instead, say, copper 16oz., spelter 10oz., which dips well. A vast deal lies with the dipper.—Scipio.

[32567.]—**Accident to Bicycle.**—This was caused by the wheel not having enough width at the hub. Two or three years ago I had a machine that whenever I went over rough heavy stones used to behave in the same manner. It is a defect in construction. Paraffin is very good as a rust-preventer.—An Amateur.

[32567.]—**Accident to Bicycle.**—It is by no means an uncommon occurrence for the wheel of a bicycle to return to its right position in the way you describe. Last year the same occurred to my bicycle; the rim got so bent that I could hardly wheel it along, and the spokes looked in a hopeless condition. I took it to a blacksmith's, and laying the wheel on an anvil, pressed the rim in two opposite parts, when the wheel returned to its former position. It speaks well for the bicycle, showing that the spokes can bear a great strain, consequent on the bending of the rim, without being permanently bent. I don't think it would happen with thin spokes, and if they were got back to their normal position I don't think they would remain there long. I have only tried one varnish, and have discarded that in favour of sperm oil, which I find answers best.—C. C. G.

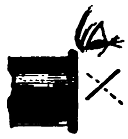
[32567.]—**Accident to Bicycle.**—The cause of the wheel acting so is because of the flanges not being sufficiently wide enough apart. Have them made wider apart, and then your trouble will cease. The distance apart ought to be about 6in. for a 50in. machine. Clean and oil your machine when you come in; wipe it all over with a piece of rag with oil on it. That is all that is required if done properly.—Telescope Tele.

[32569.]—**Bisulphite of Lime.**—I do not think there is such a combination of lime. Perhaps "F. R. M. S." means the combination of sulphuric acid and lime called sulphate of lime.—Gamma.

[32574.]—**Leclanche Battery.**—In my own cells I made a cardboard box, tying it round with binding wire, the length and breadth of which were each ¼in. more than the width and breadth of the top of carbon, and depth ⅜in. Holding the end of carbon in this, not quite touching the bottom (I stuck a tin tack through bottom to prevent its doing so), I poured lead in the box, thus forming a leaden cap on the carbon, ⅜in. deep by ¼in. thick all round. I then immersed the top of the carbon for about 1½in., including the cap, in melted paraffin, then took it out, and when cold scraped paraffin off cap, and soldered copper wire to it. Brunswick black over wire and cap gives a good finish, but in this case it is best to apply the varnish immediately after casting, while lead is still hot, and then smear paraffin over the carbon with a hot iron, as the varnish does not seem to dry well on a surface which has been coated with paraffin. I have never had any trouble with cells made with such carbons.—Glatton.

[32575.]—**Beale's Camera Lucida.**—You require a good light on the object, and then a fair amount of illumination on the paper. Thus, the two should be as nearly equalised as possible, and the surroundings of the eye should be as dark as possible. You should only see the object and the paper, not every other object around you. The paper could be well lighted with a small bull's-eye lantern. Of course you are aware that when the microscope tube is horizontal the reflector should be at an angle of 45°. —W. J. Lancaster.

[32575.]—**Beale's Camera Lucida.**—Is "W. R. C." sure that he has not got his neutral-tint glass reversed? I mean has he placed it in the position shown by dotted line? It should be in the position of full line. I have one which I made with an ordinary covering glass, not neutral tint, and it answers perfectly. Let "W. R. C." first see that the centre of his neutral-tint glass comes exactly opposite that of eyepiece of microscope. Place the microscope in a horizontal position, about 10in. from table, and on the latter, immediately beneath camera, place a sheet of white paper. Place an object, preferably a transparent one, such as a flea, on the stage, and focus, looking straight through microscope and having plenty of light. Now, shading the paper with a book or the hand, look downwards through neutral-tint glass (see sketch) and you will see the object if all is right. Take away the book or hand from paper, and gradually increase the amount of light on the latter, and decrease the illumination of the object until a very faint image appears on the paper. Now, keeping both eyes open, and still looking with one of them through the camera, you will be able, with a little practice, to trace the image with a fine-pointed pencil. The great fault with beginners is a tendency to illuminate the object too strongly, which prevents their seeing the pencil at all. A very faint image is quite sufficient.—Glatton.



[32576.]—**Dilapidations.**—The reply to this query depends greatly upon the exact terms of the lease, and notice to paint, &c. If a lessee chooses to let premises become dilapidated he cannot, by merely painting them in compliance with a notice, free himself from liability to repair. I fear "A Poor Leaseholder" is liable.—B. H., Solr.

[32578.]—**Brakes.**—The G. N. R. engines (Nos. 265. 266) fitted with Westinghouse brake carry 80lb. to 85lb. on the square inch air pressure; 60lb. is the usual pressure for working local or stopping trains and 80lb. for express trains. 100lb. pressure can be easily carried; the brake then acts like a flash of lightning, and will stop an express in the length of a long platform. Very respectable stops can, however, be made with 50lb. pressure. The boiler pressure should be from 20lb. to 40lb. in excess of the air pressure. The N. E. R. have adopted the Westinghouse automatic. Barker's hydraulic brake can be made automatic, and a train thus fitted will shortly be running. It is a powerful brake, gives little trouble, and its power can be regulated to a nicety with great ease and precision.—Helios.

[32578.]—**Brakes.**—In reply to "S. D. J. R." I believe the Midland Company have at the present moment 1,346 locomotives. During the next twelve months they mean to build about 90 new locomotives at Derby. The brake question has not been quite settled on the North Eastern. They have fitted a number of their coupled 7ft. express engines with the vacuum, so as to run the Great Northern expresses from York to Edinburgh, but, I think, the Westinghouse brake will be adopted eventually. Would "C. E. S." be kind enough to say if it is intended to fit the 1330 class of bogie engines with the vacuum brake? I saw an engine, 1341, fitted with a brake I thought was the vacuum, but had not time to look at it. Would it be too much trouble to "Itzaex" (query 32379) to favour us with some of the performances of Cornwall? I think a great many would be interested.—L. L.

[32578.]—**Brakes.**—If "S. D. J. R. Loco." will make further inquiry I think he will find that Barker's brake will shortly be self-acting, and in use in that form on the Great Eastern Railway. I am glad to see some one support this brake in "ours," as I have always heard a good account of its performance.—B. H., Solr.

[32578.]—**Brakes upon Midland Engines.**—"S. D. J. R. Loco.," page 101, No. 32578, asks: "What brakes are used in Midland engines, Nos. 66, 135, 239, 1,304, 1,332?" No. 66 was fitted with the Westinghouse air brake in December, 1873. This brake was converted to the Westinghouse automatic brake in May, 1876. This engine has a tractive force of only 86·71lb., and is, therefore, not used for working the Scotch expresses. In July, 1877, the Westinghouse automatic brake was removed from No. 66 and placed upon No. 811, one of the large rebuilt 18in. cylinder express engines which I mentioned in Vol. XXV., page 71, and Vol. XXVI., page 511. No. 811 is stationed at Leeds to work the Scotch express traffic. No. 66 is at Bedford, and is not now fitted with any continuous brake. No. is fitted with Barker's hydraulic brake upon coupled and tender wheels. No. 132 is also fi with the same brake. These two engines stationed at Bedford, with the 24 carriages wh have Barker's brake, and work local trains d between Bedford and St. Pancras, and Bedford Northampton. Nos. 235, 236, 237, 238, and 239 w originally fitted with the Westinghouse air bra which was converted to the Westinghouse au matic brake in May, 1876. These engines have "engine brake" working upon the driving trailing wheels, as shown in the diagram upon p 39, and they are used to work many of the lo trains between Bedford, Luton, St. Albans, London. No. 1304 is fitted with the Westinghou automatic brake, but has not the "engine brak upon the coupled wheels. This engine is stationed Skipton to work the Scotch traffic to Carlisle, also to Normanton. No. 1,332 was fitted January of the present year with Smith's vacu brake, to work the express trains which run betw London, Liverpool, and Manchester only, as explain in my letter, page 39. This engine is at the pres time stationed at Kentish Town (London), and ru to Leicester. I have seen trials with Barke hydraulic brake. It stops a train quicker than "vacuum," but is far inferior to the Westinghou and is also not self-acting in case of accident C. E. S.

[32578.]—**Brakes.**—The Great Northern Railw Company have, since December last, had two expr engines—Nos. 265 and 266—and a train of 15 coach fitted with the Westinghouse automatic brake, mentioned upon p. 482 of last volume. This trial tr has given the most satisfactory results, and h again proved beyond doubt that the "automatic is the best brake. When upon the engine No. 266 few weeks ago, the pressure of air used was 80lb. p square inch. It is also quite true that the Nor Eastern Railway Company have adopted the aut matic brake, which is to be fitted to the whole the passenger rolling stock as soon as possible. C. E. S.

[32580.]—**Midland Engines.**—The letter placed after the number indicates that the engine an old one which has been placed upon the dup cate list, and that a new engine has been built in i place. No. 1 was built at Derby in 1859, and is "single" express engine. About two years ago new four-wheel coupled express engine was built its place, and numbered 1. At the same time t letter A was placed upon the old engine, as it is duplicate one. There are at the present time 50 these duplicate engines. They have either the lett A upon them, or are numbered above 2,000. T duplicate engines have "lived out" their time, b are working till they are worn-out, when they w be broken up. The Midland have not 2,024 engin No. 1,366 is the highest on the ordinary list. T engine which is now numbered 2,024 is a four-wh coupled tank engine, and is one of those which t Midland Company took to when they leased t Swansea Vale Railway in perpetuity. This engi is at the present time stationed at Wigston. C. E. S.

[32582.]—**Rays of Light.**—The upward a downward rays of light seen through partially-clo eyelids is a diffraction phenomenon, due to t edges of the eyelashes, and presents nothing un countable.—W. J. Lancaster.

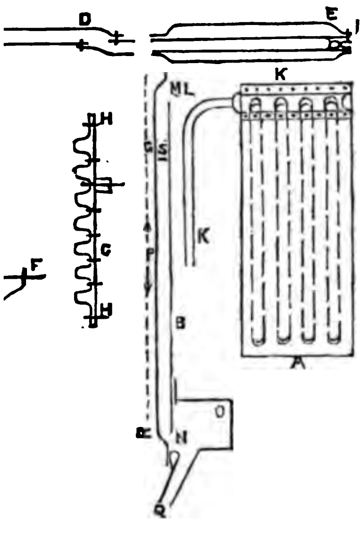
[32583.]—**Horses' Sore Heels.**—Your ma heels should be lathered with soft soap twice a da and well dried afterwards. No water should allowed to dry on her heels, and you must av wetting them more than needful. She should exercised every day. If the soft soap remedy do not answer, you had better apply to a veterin surgeon.—T. L.

[32583.]—**Horse's Sore Heels.**—Your ho probably has what is known as "Grease." T cause is dirt and bad stable management. Howe in some horses it is hereditary, and conseque very hard to get rid of. The first symptoms intolerable itchings and rubbing one leg against other; the legs swell. The next stage is a disch like drops of oil, which will be found clingin the hairs. The heels are hot and greasy. If horse has got to this last stage, put on warm lin meal poultices, change frequently, until you g heels clean, and then apply some carbolic oil, one part of the acid to four of oil, at first, w may be increased to half-and-half; or tannin, glycerine, 2oz.; or nitrate of silver, 8 gr glycerine, 2oz. Let the diet be of a laxative na such as bran mashes. If the animal is not w give a dose of purgative medicine or an alter powder.—Jos. Atkinson.

[32587.]—**Discs for Wheel of Life.**—motion—or apparent motion—of the objects in zoetrope is due to the difference of one in the n ber of slits and pictures. In printing these all t is necessary is to take this into account, and t careful that the object rotates or gambols—w ever else it may do—precisely in one revolut This is done by dividing the revolution into preci the same number of parts as the number of diagr —W. J. Lancaster.

[32590.]—**Telephone.**—You may send the curr through 340 yards of No. 40 copper wire. This give you a resistance of 700 ohms; or, of course, can increase indefinitely the length of wire; or ater, unacidulated. I have spoken through f water.—W. J. LANCASTER.

—**Surface Condensation.**—Being somerested in the application of steam to tram- I forward the following sketch of what the best way of disposing of the exhaust The condenser consists of corrugated galva-, about 20 B.W. gauge, the corrugations not rough to end of plate. A is the dished B, section of the same; C, cross secone method of putting them together E, in pairs; F, brackets for bolting them t the side of wall or blank end of a house nary engines; G, ferrules for bolting them H H, top plates riveted with a tape or dressed with red lead, white lead, and ; I is one shape of stop end or socket, as nay be, for double; J is for another for is one riveted, with the channel and con- K, fitted to socket end, L, while M and the outlets and general arrangements condensed steam in the shape of water rns, O; Q, the outlet, should be entered into nd in case of a pair, as at P, arranged back, exhaust entering the one at R,



g in S, giving a slight fall, the water g itself into O. The draught for furnace e taken from between the two condensers, a constant current of cool air warming it in ge, conveying the surplus vapour through rnace. But the best arrangement is to into a jacket around the cylinders first, nveying it to the condenser, and spread the ke a fan upon its entry, to prevent noise. pplicable to stationary engines. I took the m what I saw when I visited a saw-mills. und the water from the river a nuisance, ing able to keep boilers clean. A well was at with worse consequences. The engine is 0 horse-power beam, Cornish. They diswith condenser and air-pump, and rigged a and down a blank wall of 2in. gas barrel for er. The water goes into a tank under , and is pumped into the boiler, and, I am d, with very good result for some years, with eption, that the barrel is rapidly consumed, joints are difficult to break and make, which not be with my idea. Perhaps "A. W. E." e us some idea what he can put an engine on ys to do duty as regards weight. I calculate ing it upon the present cars with the addi- another ton and a half, if they will give me vilege of adding another 4ft. in length in the d a bogie, and giving them 140 gallons of —BEAVER.

]—**Boiler Incrustation.**—2oz. of muriate nia put into the boiler twice a week prevents ation, and decomposes scale; or carbonate is a very good thing. Pieces of wood susd in the boiler, and renewed monthly, prevent ; also frequent blowing off.—ARTHUR

]—**Boiler Incrustation.**—In your query do not say whether the incrustation is carbonate lphate of lime, but I suppose it is both. If your r is working at a low pressure the lime can be lly extracted by blowing off. The best thing an do is to get a good book on the subject. e is a very good one written by Robert Wilson, spector for the Manchester Steam Users' Asso- n.—HARRY BETA.

]—**Flanged Ends of Boilers.**—I beg to J. H. Cooper that boiler ends are flanged by ery at the Bowling Iron Works, near Brad- Yorkshire, and the Midland Loco. Works, —C. MITCHELL, Jun., Colne.

]—**Partial Greyness.**—The solution of h to which you refer is probably a solution of tic potash," more properly called, "potassium ." When potassium is placed in water, cal combination takes place, and potassium is formed ($K_2 + 2H_2O = 2KHO + H_2$). The properties of it are—the power of converting certain vegetable reds into blues or greens, vegetable yellows into browns, and the power of neutralising acids. It does not act as a dye, and, since the colour is gone from the hair, it could not have any power of even changing it. Nitrate of silver would be a very dangerous salt to use, since it acts as a caustic, and destroys animal matter. It also turns black under the action of the light. Greyness depends on the decay of the glands at the roots of the hair, and since, in the case you mention, this is only partial, and only just commenced, there is hope of restoring them to their former health by stimulating the scalp. I should advise you to try this before resorting to a dye. Use the following night and morning:—Tincture of cantharides, 1dr.; oil of rosemary, 10 drops; eau-de-Cologne, 1oz. To be applied to the scalp on a sponge. The head should be carefully washed with glycerine soap twice a week, the diet should be nutritious, and the shower-bath may be used with advantage. I should advise you to use this before having resort to a dye, and if it does not answer you can then obtain any dye you like—for there are plenty of safe ones prepared by chemists, &c., which would be much better than preparing one for yourself. I consider the one you mentioned decidedly unsafe to use.—R. N. P.

[32599.]—**Electric Light.**—You cannot do what you wish better. If you mean to have the light, get it fitted up by some one who thoroughly understands the work, and purchase a good machine. At present there is nothing sufficiently simple, and yet cheap, to do the work for so small a place.—W. J. LANCASTER.

[32600.]—**Swelling in Groin.**—The swelling you speak of would probably be relieved, if not cured, by the following treatment:—Apply to the swelling, night and morning (with a brush), tincture of iodine. Keep the bowels open by taking, when required, a Seidlitz powder, and try two or three bottles of the following mixture, which you can, if you wish, make for yourself:—Ammonio-sulphate of iron, ½dr.; sal-volatile, 2dr.; peppermint water, 6oz. Mix. A sixth part to be taken twice a day—say, at eleven and four o'clock. Take a cold bath every morning; live on a plain and nutritious diet, with a moderate quantity of light beer. Avoid any extremes of temperature. Take plenty of walking exercise, but do not run or even walk fast. If the swellings give you much pain, use a little chloroform liniment, rubbed in with the hand. Avoid any local irritation. This is the best advice I can give you, from what you say of the swellings, and I think, if you try it, you will find it answer. I shall be glad to hear again from you—what benefit you derive from it—as perhaps I could advise something different should this not answer. The object of this treatment is to purify the blood and reduce the swellings.—R. N. P.

[32600.]—**Swelling in the Groin.**—Paint them with iodine night and morning. There are very few cases of glandular enlargement that will withstand the use of iodine when continued steadily for a period of six weeks or two months.—ARTHUR ALFRED.

[32612.]—**Double Star.**—The "4in." cannot refer to the distance of the comites of Castor; such measures are given in seconds of arc. The distance of γ Leonis was given by Mr. Knott as 3″ in 1871, and in the same year Baron Dembowski gave 5·6″ for Castor; so "Argus" will see that the former is much the closer double. I do not know Slugg's "Observational Astronomy," but I am pretty sure Mr. Webb's "Celestial Objects" would be a much more useful book to "Argus."—MAC.

[32613.]—**Telescope.**—You can put in a lower power eyepiece without losing definition. The erector need not be altered. Have lenses for eyepiece 1½ times focus of those now in.—W. J. LANCASTER.

[32619.]—**Draughty Floors.**—The only way to do it well is to plug the cracks up with thin strips of wood driven firmly in.—A. B.

[32620.]—**Thermometer.**—You cannot determine the accuracy of your thermometer unless you have another one with which to verify it. Then you should put them both into water, and let them remain for two minutes. Note differences again in water at about 100° F.; again note differences. Lastly, if they go up to 212°, hang them to a kettle handle, so that the bulbs will be ½in. above the boiling water, and you will have all the corrections you require.—W. J. LANCASTER.

[32623.]—**Light for the Magic Lantern, &c.**—The wheel of life is a failure with the limelight, so I am not surprised that you have not succeeded with the paraffin light. The half-plate lens will do well for the front. Don't touch the lenses. Use all of them just as for taking photos. The picture will be smaller on the screen than with present arrangement, but much clearer and better defined.—W. J. LANCASTER.

[32630.]—**Phonograph.**—1. There is no special contrivance for regulating the speed. The barrel being rather heavy acts to a certain extent as a flywheel. With a little practice sufficient regularity for all purposes, except the reproduction of rings, is easily attained. 2. The barrel revolves about once in a second. 3. The length of my barrel is 4½in; that of Edison's last is, I believe, 16in. 4. The style is attached by means of tin or soft solder.—SPERAVI.

[32631.]—**Amateur Printing Press.**—In answer to your inquiry I can tell you from experience that a wooden press is no good whatever after a little use. An iron one, as you say, about £5 is the thing, and will do all you want. As to copper-plate printing, you want quite a different sort of press for that; it consists of two wooden or iron rollers, with a mahogany plank running between, on which you place the plate, then the paper, and over these four blankets, 2 fine and 2 coarse. The top roller can either be worked by a large flywheel or 4 long arms.—COPPER-PLATE PRINTER.

[32631.]—**Printing Press.**—If you wish to throw your £1 to "the dogs" buy a wooden press. You will print circulars, cards, invoices, &c., very nicely on one of the presses advertised. I have seen one of Francis's presses print memorandums admirably. A self-inking press will print two or three times as fast as the common one, and ink the type much more evenly than any amateur could do.—JAMES A. MORETON.

[32632.]—**Artificial Finger.**—You can have an artificial finger, but the success will depend upon the means of attachment. If there is a part of the finger left it will be easier to adapt the artificial finger. You should apply to some anatomical mechanician, or if you do not know one, write to Salt and Son, Bull-street, Birmingham.—W. J. LANCASTER.

[32642.]—**The Telephone.**—It is not at all likely that any result would be observed by the arrangement of a lever in connection with the receiving disc of a telephone for several reasons, as, *e.g.*, its vibrations are so infinitesimal that I believe I am right in stating that they have not yet been made evident by any of the means usually employed for observing small motions. Very fine copper wire will do for a line wire through a house quite well.—J. BROWN, Belfast.

[32649.]—**Dynamo - Electric Machine.**—The Weston machine at present is arranged only for producing currents adapted to electro-depositing, and is not adapted for lighting purposes. No doubt some modifications would easily render it suitable for this purpose. A few numbers back, just before my article on the Weston appeared, there were given descriptions of some half a dozen different machines for the purpose, from which "Prometheus" could select one to try his hand at.—SIGMA.

[32650.]—**Compound Microscope.**—To MR. LANCASTER.—Refer to the diagram, Vol. XX., page 466, then work as follows:—C should be 8in. long from the top to *c*, and it should have another tube 4½in. long sliding inside, so as to increase the length of body when required. The inside diameter of the inner tube should be ¾in., and the eyepieces made of 1¼in. tube. The thread for objectives must be cut to the Society's thread. No other lenses besides eyepiece and object-lenses are necessary. I will be pleased to give you any further information you may require.—W. J. LANCASTER.

[32653.]—**Microscopic Photo of Bank Notes.**—I have seen hundreds of such photos, but never have heard that a micro-photo of any note is not in accordance with Act of Parliament. I have no doubt the fact of printing them on albumenised paper might be indictable, but I cannot see why it should be so.—W. J. LANCASTER.

[32656.]—**Conductor.**—You can make it of dried wood covered with tinfoil, but don't varnish it at all. You will find a lot of information with regard to Winter's rings in back numbers. For any given plate the ring should be same size.—W. J. LANCASTER.

[32656.]—**Conductor.**—Wood covered with tinfoil makes an excellent conductor; varnishing is not requisite. The Winter's ring acts as a conductor or condenser. I should think one might be made by winding paraffined paper in strips over the ring, instead of inclosing it in the usual wooden case.—SIGMA.

[32656.]—**Conductor.**—I have made conductors of wood and tinfoil, but it is nearly impossible to make them smooth enough. A metallic ball which can be polished is preferable. You will find directions for making the Winter's ring in Vol. XXII., pp. 284 and 564. Its diameter is recommended to be 1 to 1½ times diameter of plate.—J. BROWN, Belfast.

[32660.]—**Phonograph.**—1. I do not think that the writing of either the phonautograph or the phonograph would be made larger by increasing the size of the diaphragm beyond certain limits, because, though the power might be increased, the work to be done would also be increased, and often in a greater proportion. 2. The principle of the phonautograph and of the phonograph are the same, in so far as they both register sound vibrations. The characters of the latter are, however, embossed upon the receiving surface, while those of the former are traced on a plane. A phonautograph could hardly be adapted so as to be used as a phonograph. 3. A phonograph might be made to speak by drawing a straight slide covered with tinfoil under the point, but a cylinder is infinitely more compact and convenient.—SPERAVI.

[32661.]—**Telephone.**—1. No. 36 wire will do quite well. 2. The soft iron poles used are solid, but the magnet will work without them quite well. 3. Fault is probably in the steel, but you ought to get very fair results from magnets strong enough to lift one another.—J. BROWN, Belfast.

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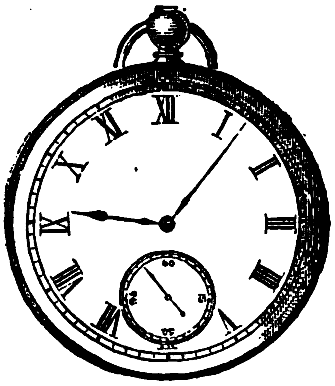

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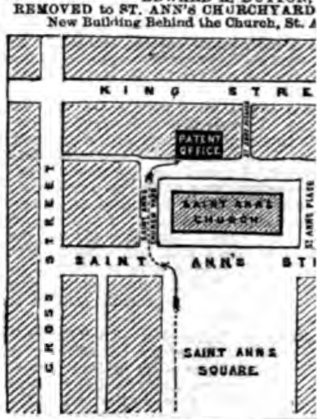

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ARTICLES.

ME DIFFICULTIES IN THE STUDY OF CRYSTALS.

y J. H. Collins, F.G.S.

ecretary to the Mineralogical Society of Great Britain and Ireland.

2. PSEUDOMORPHS.

rmer paper (ENGLISH MECHANIC, 1 5, 1878) a comparison was made n crystal forms belonging to dif- stems which might easily be mis- each other, and these were called *forms*. The crystals now to be are such as have the form of one and the composition of another. the results of processes of change e constantly going on in nature— organic not less than the organic

ostatic Pseudomorphs[1]. These are y the deposition of mineral matter surface of pre-existing minerals. instance, common to find crystals oated on certain planes, or coated as the case may be, by a thin layer crystals of *pyrites*. This is called ," and the crystals generally are e "drusy." Let us suppose this to en place on a cube of fluor, and coating has been completed sup- supporting cube to be entirely by the solvent action of waters ig underground.[2] In this case a ibical box is formed, which is called *e*[3] pseudomorph—*i.e.*, formed out-

s particular case, as both *pyrites* often occur as cubes, it might ossible at all times to trace the stages of this formation, but kind of drusy coating might be for instance, on a rhombohedron onal prism of *calcite*, in which case essive steps will be much more

The hollow boxes, or natural so formed, are subsequently re- a new deposit of matter—say, In this case we should have a rystal of quartz supporting a druse s; and a student not on his guard uch deceptions might announce in LISH MECHANIC or elsewhere that und *quartz* crystallising in the form be. He would be, perhaps, still ely to do so if the whole coating of ad happened to be removed after osition of the quartz. Crystals in this way are termed *esogene*.[4] true natural casts. If both cast ld are preserved, the whole com- is sometimes called an *amphigene*.[5] pseudomorphs are often found ly with water or with mineral solu- r containing a little loose dust, the portion of the mineral removed ion.

tasomatic Pseudomorphs.[6] — These most common as well as the most important pseudomorphs. They are due to chemical actions which have changed part only of the original substance, by removal or substitution, so gradually that the form has not been affected. The original crystals seem to have been under the influence of such media as air, water, hydrofluoric acid, fluoboric acid, &c., by which (*a*) some ingredients have been removed, or (*b*) new ingredients have been added, or (*c*) an exchange of certain ingredients have taken place.

Such changes of substance, unaccompanied by changes of form, have often taken place on a very large scale—for instance, veins of carbonate of iron (chalybite) are usually changed into *hematite* or *limonite* to a greater or less depth from the surface, by the action of the air and moisture. Pyrites near the outcross of a vein is usually converted into oxide of iron, the "iron hat," "chapeau de fer," or "gozzan" of the vein, and over large tracts of country —for instance, many square miles in Cornwall and Devon, the felspar of granite rocks has been converted into kaolin; there is good reason to believe from the action of hydrofluoric acid or soluble fluorides rising in fissures from below.

A great many of these *alteration pseudomorphs* have been formed—by Sorby and others—in experimenting with weak solutions, vapours, or fluids, at high temperatures or under pressure, &c. When the result of the chemical actions, whether natural or artificial, is to form a more highly oxidised or more *electro-negative* substance—as in the case of *chalybite* or *pyrites* converted into *hematite*, the new bodies are called *anagene*[7] pseudomorphs; when the change is in the opposite direction, as when *orthoclose* is converted into *kaolin*, or *rock-salt* into *gypsum* they are called *katagene*[8] pseudomorphs.

3. *Petrifactions.*—These are results of pseudomorphism. The most general kind of petrifaction is that in which a thin layer of mineral matter is deposited upon an organic substance so as to preserve its external form. This is what happens when birds'-nests or eggs are subjected to the spray of the petrifying springs at Matlock —a thin coating of carbonate of lime is deposited which preserves the original form. These may be compared to the *exogene* pseudomorphs already described. If, now, the organic substance in the interior of such a petrifaction should be removed by solution, or should shrink and fall to powder by decay, and the cavity be filled up, say, with sulphate of barytes or carbonate of iron, or silica, and if, finally, the first coating of carbonate of lime should be removed, a cast, having the form of the original substance, would be left a true *esogene*. Of this nature are the sandstone tree-stems, which occur so abundantly in the coal measures, and the pyritous casts of ammonites found in the gault.

There is a third kind of petrifaction, which is apparently or really more analogous to the *metasomatic* pseudomorphs. This results from the infiltration of mineral matter, usually carbonate of lime or silica, into and between the cells of organic substances before decay has set in. In such cases the minutest details of structure are sometimes preserved, and the character of a piece of wood, a coral, or a sponge may be readily determined. Most fossils have been more or less *petrified* in this manner—sometimes by a mere infiltration of foreign matter into minute empty spaces, at others by apparently an actual replacement of carbon by silica.

To the scientific student no part of the science of mineralogy is more interesting than the study of pseudomorphs, and none throws so much light on the origin of minerals. Dwellers in the metropolis have a fine opportunity of taking up this line of study, as several cases of the noble collection of minerals in the British Museum are entirely filled with pseudomorphs.

The following list of naturally-formed pseudomorphs, which includes the great majority hitherto observed, will be useful for reference, and it will at the same time suggest the necessity of caution to all students who may happen to come across unusual forms.

In distinguishing pseudomorphs from true crystal forms very great caution is often necessary. The following hints, however, will much aid the observer:—

a. Metasomatic pseudomorphs have usually somewhat roughened faces, and little or no lustre, or a lustre foreign to the mineral indicated by the form.

b. Metasomatic pseudomorphs are often cellular or cavernous in the interior.

c. Hypostatic pseudomorphs often bear traces of peculiar striations or other surface markings indicating their true origin. In this way casts after or moulds over *pyrites* and fluor may be usually detected.

d. The internal structure, cleavage, &c., of a pseudomorph is unlike that of the mineral indicated by the form.

e. The matrix often bears traces of chemical action.

f. Some crystals may frequently be found in which the change is partial only. Thus many felspar crystals are changed only on the exterior to kaolin, the interior retaining all the characters of felspar.

Hypostatic Pseudomorphs.

Graphite	*in the form of*	Pyrites.
Salt	,,	Magnesite.
Anhydrite	,,	Salt.
Gypsum	,,	Salt, Cerussite.
Polyhalite	,,	Salt.
Quartz	,,	Fluor, Gypsum, Calcite, Barytocalcite, Magnesite, Scheelite, Galena, Cerussite, Hematite, Pyrites, Chalybite, Felspar, Copper.
Prase	,,	Calcite.
Eisenkiesel	,,	Calcite.
Chalcedony	,,	Barytes, Fluor, Calcite, Magnesite, Pyromorphite.
Carnelian	,,	Calcite.
Hornstone	,,	Fluor, Calcite, Mica, Chalybite.
Semiopal	,,	Calcite.
Lithomarge	,,	Fluor.
Pyrites	,,	Quartz, Stephanite, Pyrargyrite.
Marcasite	,,	Pyrargyrite.
Chalybite	,,	Barytes, Calcite, Magnesite, Selenite, Fluor.
Malachite	,,	Calcite, Cerussite.
Chrysocolla	,,	Cerussite.
Felspar	,,	Calcite.
Meerschaum	,,	Calcite.
Pyrolusite	,,	Calcite, Magnesite.
Hausmannite	,,	Calcite.
Manganite	,,	Calcite.
Psilomelane	,,	Barytes, Fluor, Pharmacosiderite.
Smithsonite		Fluor, Calcite, Magnesite, Galena, Pyromorphite.
Cassiterite	,,	Pyromorphite, Felspar, Bismuthinite.
Cerussite	,,	Barytes, Fluor.
Stilpnosiderite	,,	Magnesite, Calamine.
Hematite	,,	Fluor, Calcite, Chalybite, Cinnabar.
Limonite	,,	Barytes, Fluor, Calcite, Magnesite, Quartz, Comptonite, Blende, Galena, Pyromorphite, Cerussite, Cuprite.
Pyrites	,,	Barytes, Calcite, Chalcocite.
Marcasite	,,	Fluor, Calcite.
Calcite	,,	Limonite.
Barytes	,,	Chalybite.
Celestite	,,	Blende.
Fluor	,,	Galena.
Opal	,,	Chalcopyrite.
Talc	,,	Erubescite.

Metasomatic Pseudomorphs.

a. By Loss of Components.

Calcite	*in the form of*	Gaylussite.
Quartz	,,	Heulandite, Stilbite.
Kyanite	,,	Andalusite.

ις (*hypostatos*), to be sustained.

Successive solutions and depositions are found tantly going on, so that there is nothing in the positions more than has been proved over and l.

without, and γινομαι (*ginomai*) to be formed.

within, and γινομαι.

mphi) both; and γινομαι.

ta) together with—used sometimes in the nsposition—and σωμα (*soma*) a body or sub-

[7] ανα (*ana*) upwards.

[8] κατα (*kata*) downwards.

Steatite	*in the form of*	Hornblende.
Copper	,,	Cuprite.
Argentite	,,	Pyrargyrite.

b. By Addition of Components.

Gypsum	*in the form of*	Anhydride.
Mica	,,	Pinite.
Valentinite	,,	Antimonite.
Anglesite	,,	Galena.
Hematite	,,	Magnetite.
Limonite	,,	Hematite.
Malachite	,,	Cuprite.
Erubescite	,,	Chalcocite.
Chalcopyrite	,,	Chalcocite.

c. By Exchange of Components.

Barytes	*in the form of*	Witherite and Barytocalcite.
Fluor	,,	Calcite.
Gypsum	,,	Calcite.
Calcite	,,	Gypsum.
Magnesite	,,	Calcite.
Chalcedony	,,	Datholite.
Jasper	,,	Hornblende.
Opal	,,	Augite.
Cimolite	,,	Augite.
Lithomarge	,,	Topaz, Felspar, Nepheline.
Kaolin	,,	Felspar, Porzellanspath, Leucite.
Mica	,,	Andalusite, Felspar, Scapolite, Tourmaline, Cordierite.
Hard Fahlunite	,,	Cordierite.
Aspasiolite	,,	Cordierite.
Fahlunite	,,	Cordierite.
Esmarkite	,,	Cordierite.
Bonsdorffite	,,	Cordierite.
Chlorophyllite	,,	Cordierite.
Weissite	,,	Cordierite.
Praseolite	,,	Cordierite.
Pyrargillite	,,	Cordierite.
Gigantolite	,,	Cordierite.
Pinite	,,	Cordierite.
Prehnite	,,	Analcime, Mesotype, Leonhardite.
Talc	,,	Chiastolite, Kyanite, Couzeranite, Felspar (?) Pyrope.
Steatite	,,	Magnesite, Spinel, Quartz, Andalusite, Chiastolite, Topaz, Felspar, Mica, Scapolite, Tourmaline, Staurolite, Garnet, Idocrase, Augite.
Serpentine	,,	Spinel, Mica, Garnet, Augite, Chondrodite, Hornblende, Olivine.
Hornblende	,,	Augite.
Chlorite	,,	Felspar, Garnet, Hornblende.
Pyrolusite	,,	Manganite.
Hausmannite		Manganite.
Valentinite	,,	Antimonite.
Stibiconite	,,	Antimonite.
Kermes	,,	Antimonite.
Bismuthocre	,,	Aikinite.
Minium	,,	Galena, Cerussite.
Galena	,,	Pyromorphite.
Pyromorphite	,,	Galena, Cerussite.
Cerussite	,,	Galena, Anglesite, Leadhillite.
Wulfenite	,,	Galena.
Magnetite	,,	Chalybite.
Hematite	,,	Gothite, Pyrites, Pharmacosiderite.
Limonite	,,	Chalybite.
Stilpnosiderite	,,	Marcasite, Scorodite.
Pyrites	,,	Vivianite.
Melanterite	,,	Mispickel.
Green Earth	,,	Pyrites.
Pseudotriplite	,,	Augite.
Wolfram	,,	Triphylline.
Erythrite	,,	Scheelite.
Melaconite	,,	Smaltite.
Pitchycopperore	,,	Chalcocite.
Covellite	,,	Chalcopyrite, Fahlerz.
Malachite	,,	Chalcopyrite.
Chessylite	,,	Chalcopyrite, Fahlerz.

Petrifactions.

Pyrites	*in the form of*	Ammonites,	Wood, &c.
Blende	,,	,,	,,
Galena	,,	,,	,,
Hematite	,,	,,	,,
Limonite	,,	,,	,,
Chalybite	,,	,,	,,
Calcite	,,	,,	,,
Barytes	,,	,,	,,
Vivianite	,,	,,	,,
Flint	,,	,,	sponges, &c.
Opal	,,	Wood,	sponge, &c.
Chalcedony	,,	,,	,,

NOTE.—Owing to a delay in the transmission of the proof, the former article (April 5) went to press without the author's corrections and some small additions. The more important corrections are the following:—

Paragraph 2 *a*, second line, for "cleared" read "cleaved."

Par. 3 *f*, for "macrodome" read "macrodome and brachypinacoid."

Par. 3 *g*, for "brachydome" read "brachydome and macropinacoid."

Par. 3 *h*, for "brachyprism" read "brachyprism and basal pinacoid."

Par. 6, add "This is the combination which has recently given rise to a discussion in the ENGLISH MECHANIC on Kentish ragstone crystals."

Par. 7. After the word "prisms" read "a pyramid and the basal plane 110,100,101,001 or 100,110,111,001.

After par. 13 add—

Par. 13 *a*. "Oblique prisms of *orthoclase* and other minerals often much resemble rhombohedrons."

Par. 14. After "cubical forms" add "especially when the cleavages are rectangular."

In (B). *Determination of the True Crystal System.*

Par. 14 (which should be 15). After "cannot" in fourth line add "always;" after "cubical system," line 10, add "similarly three sets of cleavages all equally inclined as in *calcite* will almost certainly indicate an hexagonal (rhombohedral) form.

CHEAP HEATING GAS.

DURING the early part of the year 1873 (see p. 502, Vol. XVI.) a method of making gas from water by decomposing that liquid and passing the hydrogen through a petroleum spirit, was introduced to the notice of the public, and received some little attention from scientific men. The price at which this gas could be made was said to be about 1s. 8d. per 1,000 cubic feet, and we believe that it was actually employed in lighting some portions of one or more towns. Owing, however, to causes of which we have no definite information, the "new gas" went the way of many others, and latterly but little has been heard of it. The possibility of splitting up water into its component gases, and obtaining therefrom a cheap and readily utilised heating medium, has been kept in view by more than one or two inventors, and at a recent meeting of the Society of Arts Mr. S. W. Davies read a paper describing a method of producing cheap heating gas for domestic and manufacturing purposes, which, if we may accept the statements made, shows that the problem is solved. The improved process is based on that patented by Mr. Joshua Kidd, the principle of which was a combustion of the gases from ignited coal with the hydrogen obtained by the decomposition of water. The complete gasification of the fuel was the most remarkable and the most promising feature in Kidd's process, the patent rights in which were acquired by a few gentlemen, who in the interim have been unceasingly experimenting until they have succeeded in producing a cheap gas, the advantages of which are so pronounced that they no longer delay in introducing it to the public. The chief difficulties experienced at the commencement of the experiments have been overcome, and although the process is not yet so perfect as could be desired, it has reached a stage at which it is advisable to make the results of the investigations known. When steam is passed over incandescent carbon it is decomposed, the hydrogen being liberated in company with carbonic oxide and carbonic anhydride. According to Langlois there is also a small quantity of marsh gas present in the resulting gases—his analysis giving a percentage composition by volume of H 54·52, CO 31·86, CO_2 12, and CH_4 1·62. Those acquainted with the value of chemical symbols will see at a glance that, provided the water can be decomposed economically, a very important heating agent would
become available for use. M
have been taken out for metho
posing steam, but owing m
complicated nature of the ma
posed, the production of a com
or mixture of gases, has no
mercially successful. The a
quired divides broadly into t
the one, in addition to the ret
rator in which the gas is produ
generator is required for the s
other, where only one fire is u
blowing arrangement is necess
and air must be urged alterna
the bulk of the fuel, the air be
to revive the fire, the temperat
is, of course, much reduced b
its heat in splitting up the
new machinery is self-contain
compact, and by no means co
be easily worked by a laboure
intelligence. The generator
hollow cylinder closed by
bottom, having a hole in the
pying about a half or a third
meter. Below, and forming
bottom casting, is a second hol
equal in internal diameter to th
it. In this lower cylinder t
placed, the blast-pipe opening i
The grate is a loose fit in the
is attached to it on one side by
other side being supported whe
by a pin screwed through the
arrangement which permits
being moved up and down, an
the withdrawal of the charge.
is being made, the bottom of
cylinder is closed air-tight by m
hinged plate kept up to its sea
lever, or else by a cap held on b
bayonet joint. The upper c
tains a coil of thick wrough
protected from the fierce heat
the bottom by a thin layer o
Both ends of the coil pass out
der by gas-tight joints throug
the lower end being connecte
supplying water under pressu
upper to a piece of steam-pipe
in a nozzle tap in front of the
The top of the apparatus is a c
taining a hollow inverted tru
projecting into the interior of th
the largest diameter of the cone
9in. At the apex is a heavy co
fitting gas-tight, while above
cone is a short cylinder, surmo
hopper containing fuel, the con
between the two being closed
sliding plate or a valve. To the s
or fuel-box a flue is attached,
lighting the fire, but closed w
the gas. Two smaller opening
casting are respectively a gas-
peep-hole, the latter provided
tight cap. The whole appara
ported on three legs connected
under side of the bottom castin

The description of the a
almost sufficient explanation of
A fire being lighted in the int
cylinder, the water in the coil
heated, steam is produced wh
lating in the upper coil, bec
heated; this steam is then
through the blast pipe into th
it is converted into gas, which f
out by the pipe leading to the g
will be understood that in this a
the steam jet drags in with it
to keep the fire burning fierce
principal difficulty in connecti
further improvement of the p
get rid of the large quantity
thus mixed with the heating
starting the apparatus the valv
main is shut, the plate closing
of the ash-box turned back, and
valve in the head lifted off its sea
of the lever projecting outside.

of water, the coals and wood are ad the furnace chamber being in a with the flue in the fuel-box, n proceeds with the rapidity due d draught. The hopper being rith fuel in the shape of medium-ps of coal, the fire is gradually until steam having been produced, is put on, gently at first, but in-as the fire itself increases, until ntensity is reached. When the becomes from one-third to one-of incandescent fuel, good gas can antly produced, and can be at once to the main. To do that, the lve is dropped into its seat, thus ff the communication with the ash-box opening is closed, and the opened. The manufacture thus he cycle of operations consists the supply of water and of fuel. r, already in the hopper, is per-enter the fuel-box by removing g plate for a moment; it thus fills ated inverted cove, resting on the lve, and filling the fuel-box, which seen should be of about the size for ." In replenishing the fire, care taken to see that the upper part eady in the generator is becoming hich can be done by means of the already described. The pressure n the coil is preferably maintained of an accumulator provided with ump and a gauge, so as to vary the if desired. Obviously, a tank a sufficient height would give an ssure, and by either arrangement munity from explosion is obtained, the steam become of higher pres-the water it would become con-being driven back into the cold Vith a water-pressure in the accu-f 15lb. on the square inch, a gas-n the generator of over 1in. of water ned; and with a water-pressure of gas-pressure was 2½in. of water, considered a good working pres-e chemical reactions which occur blast of air and steam is forced he fuel may be thus stated: Car-ydride is first formed by the action ygen of the air upon the carbon of that passing upwards through the el takes up another equivalent of coming carbonic oxide (CO_2 + C the nitrogen passing off unchanged nt of the gas. The steam is de-l, as mentioned above, into hydro-onic oxide, carbonic anhydride, and a, thus adding materially to the value of the gas by enriching it bonic oxide and hydrogen. The ion of the gas produced by the varies slightly with the pressure ter and the kind of fuel, but as it ed to use a kind of coal (anthra-is now comparatively unutilised, the analysis of the gas obtained t substance at two different pres-water:—

	15lb.	60lb.
O ...	22·6 ...	26·4
H ...	10·0 ...	13·5
H_4 ...	4·9 ...	1·4
O_2 ...	4·5 ...	3·9
N ...	58·0 ...	54·8
	100·0	100·0

for the quality of the gas; the s obtained were carefully measured g the gas through about 100ft. of which its temperature was reduced 70° or 60° Fahr. before passing rge meter. It was found that the te and a water-pressure of 15lb. 5 cubic feet of gas per pound of le a pressure of 40lb. increased the 100 cubic feet and more—a result believed to be due to the higher pressure forcing more steam and air into the fuel, and producing, at the same time, better or more perfect combustion. Peat-charcoal, wood-charcoal, coke, steam-coal, and other non-caking fuels, may be employed with good results, but, on the whole, anthracite yields the best, and as there are vast quantities of that coal in Wales and Ireland the home supply is practically unlimited. Should the new gas come into use as a means of heating marine boilers its advantages will be fully appreciated by steam vessels trading to those parts where immense quantities of anthracite are lying unused, while bituminous, or steam-coal, is exported for the use of vessels calling at adjacent ports.

As to the cost of the gas, and its comparative value, Mr. Davies stated that, burnt under any of the usual well-known conditions, one cubic foot of coal-gas was equal to five cubic feet of the new gas; but he has good reason to believe that when the new gas is consumed under conditions better adapted to its peculiar nature, the economy obtained from it will appear to greater advantage still. A No. 2 generator, consuming about 35lb. of coal, produces 3,500 cubic feet of gas per hour, or 35,000 cubic feet in a day of ten hours. The cost may be put down at about 8s., made up in the following way:—

	s.	d.
¾ cwt. of anthracite............	3	6
Wages of attendant, ...	4	0
Wood and coal used for lighting fire	0	4
Total.........	7	10

In heating power the 35,000 cubic feet would be equal to 7,000 cubic feet of ordinary London gas, which at 4s. per thousand would amount to 28s., showing a very large margin to cover any experimental inaccuracies. The heaviest item, it will be seen, is the cost of labour, but Mr. Davies says that in a series of experiments he made with the apparatus, lasting over several weeks, one man attended to three generators with the greatest ease. It is further stated that not the slightest difficulty has been experienced in using the freshly-prepared gas direct from the generator, without the intervention of a holder or pressure regulator of any kind, and the fact is justly regarded as a very important one, and a high recommendation to the new gas, which is especially adapted for use in clubs, hotels, hospitals, barracks (it has been used at the Wellington Barracks), workhouses, prisons, &c., not only on account of economy, but also of cleanliness and quickness in obtaining the required temperature. There are many other advantages connected with the use of a pure and cheap heating medium which will occur to the reader, and which need not be here recapitulated; but, assuming the practicability of the process to be as stated by Mr. Davies, we are led to believe that the new gas may be used for many purposes in the laboratory, as temperatures of 3,000° F., and even higher, may be readily obtained; while by passing it through a carburetter containing gasoline an illuminating agent superior to London gas would be procured. If it is intended to use the gas for lighting as well as heating purposes, a holder or some means of controlling and regulating the pressure would be required. The drawbacks connected with the large quantity of nitrogen, and the fact that hydrogen in burning forms water, which must be subsequently evaporated, were pointed out at the meeting, as also the danger from carbonic oxide; but Mr. Davies replied effectively that he had given the figures as the matter really stood, and if the nitrogen could be eliminated economically the new gas would be still better than it is represented. We shall see.

ASTRONOMICAL NOTES FOR MAY.

The Sun.

Day of Month.	Souths.	At Greenwich Mean Noon.		
		Right Ascension.	Declination North.	Sidereal Time.
	h. m. s.	h. m. s.	° ′ ″	h. m. s.
1	11 56 58·55a.m	2 34 6	15 7 26	2 37 7·37
6	11 56 28·35 „	2 53 18	16 34 50	2 56 50·14
11	11 56 11·94 „	3 12 45	17 55 18	3 16 32·93
16	11 56 9·40 „	3 32 25	19 8 15	3 36 15·71
21	11 56 20·96 „	3 52 19	20 13 9	3 55 58·50
26	11 56 46·24 „	4 12 28	21 9 27	4 15 41·28
31	11 57 24·08 „	4 32 48	21 56 39	4 35 24·07

There will be no real night after May 22nd, as the Sun never descends 18° below the horizon subsequently to that date. The Sun's surface is now absolutely quiescent, weeks passing without any trace of a spot.

The Moon

Is New at 50·3m. past Noon on the 2nd; and enters her First Quarter at 10h. 32·4m. p.m. on the 9th. She will be Full at 2h. 31·2m. in the afternoon of the 16th; and enter her Last Quarter at 1h. 41·6 a.m. on the 24th.

Day of Month.	Moon's Age at Noon.	Souths.
	Days.	h. m.
1	28·6	11 2·9 a.m.
6	4·0	3 22·6 p.m.
11	9·0	7 46·2 „
16	14·0	12 14·3 „
21	19·0	4 4·3 a.m.
26	24·0	7 37·0 „
31	29·0	11 22·8 „

The Moon will be in conjunction with Mercury at 3 a.m. on the 3rd; with Mars at 7 a.m. on the 6th; and with Venus 4 hours later; with Jupiter at 11 p.m. on the 21st; with Saturn at 4 in the afternoon of the 26th; with Venus again at Noon on the 28th; and, lastly, once more with Mercury at 7 a.m. on the 30th.

Occultations of (and Near Approaches to) Fixed Stars by the Moon.

Day of Month.	Name of Star.	Mag.	Disappearance.	Moon's Limb.	Angle from N. Point.	Angle from Vertex.	Re-appearance.	Moon's Limb.	Angle from N. Point.	Angle from Vertex.
			h. m.		°	°	h. m.		°	°
6	ι Geminorum	3½	†11 10 p.m.	S. by W.	347	22				
16	4 Scorpii	6	9 27 „	Bright	58	34	10 35 p.m.	Dark*	263	248
16	π Scorpii	3	†11 32 „	N. by E.	164	157				
23	42 Capricorni	5	† 2 34 a.m.	N.N.W.	206	179				
23	44 Capricorni	6	2 41 „	Bright	56	30	3 17 „	Dark	1	339
27	51 Piscium	6	‡ 1 13 „	Bright	132	95	2 7 „	Dark	282	243

† Near approaches. ‡ Star below the horizon. * But apparently bright.

Mercury

Is an Evening Star (in the sense of crossing the Meridian after the Sun) up to the 6th, on which day he comes into inferior conjunction; and, as intimated below, crosses the Sun's face. After this he becomes a Morning Star, and may be seen before sunrise towards the end of the month.

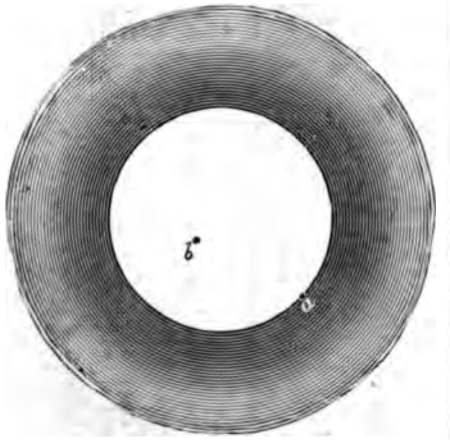
Day of month.	Right Ascension.	Declination North.	Souths.
	h. m.	° ′	h. m.
1	3 4·3	18 54·6	0 27·1 p.m.
6	2 52·8	16 24·7	11 58·1 a.m.
11	2 45·0	14 38·2	11 28·5 „
16	2 38·7	12 52·9	11 2·6 „
21	2 38·6	12 0·8	10 42·9 „
26	2 45·2	12 7·3	10 29.8 „
31	2 58·1	13 5·4	10 23·0 „

Starting thus from a point quite close to δ Arietis, Mercury will travel in a south-westerly direction in Aries until about the 18th of May, when he will begin to retrace his path (which will now, however, trend less towards the North) through a barren part of that constellation.

We have briefly referred above to the phenomenon of chief astronomical interest which will occur during the month of May—the

Transit of Mercury,

a little more than half of which will be visible in England. Although, of course, possessing less scientific importance than a Transit of Venus, the passage of Mercury across the Sun's disc presents much that is interesting to the amateur. Especially will the earnest student avail himself of the opportunity to investigate the phenomenon of the "black drop," or "ligament," visible at the ingress of the planet: a phenomenon which, in the case of Transit of Venus, has introduced such discordance in observers' estimations of contact between the limbs of the planet and the Sun. Should the afternoon of May 6th be fine, Mercury may be watched from his entry upon the Sun's face until sunset (which takes place in London at 7h. 28m.); at which time, as we have intimated previously, he will have got rather more than half way across the Solar disc.



As viewed in an ordinary inverting astronomical telescope, the planet will enter on to the Sun's disc at the point marked *a* in our figure (45° towards E. from the N. point), and at Sunset at 7h. 20m. will have arrived at that marked *b*.

	h. m. s.
The First External contact at Ingress will occur on May 6th	3 12 25 G.M.T.
Internal contact at Ingress	3 15 32 „
Least distance of Centres of Mercury and the Sun...	7 0 4 „

And, as we have said above, the Sun will set at 7h. 28m. The egress of the planet will not occur until nearly 10h. 48m. p.m.

Venus

Is a morning Star during the whole of May, but is waxing in phase and decreasing in diameter; thus, pro tanto, becoming a less interesting telescopic object. She attains her greatest elongation West (46° 7′) at 6 a.m. on the 2nd. She will be in conjunction with Saturn at 11 a.m. on the 6th.

Day of Month.	Right Ascension.	Declination	Souths.
	h. m.	° ′	h. m.
1	23 41·4	2 33·3S.	9 4·8 a.m.
6	0 0·1	1 0·3	9 3·8 „
11	0 19·2	0 39·6N.	9 3·2 „
16	0 38·7	2 24·8	9 2·9 „
21	0 58·5	4 13·9	9 3·0 „
26	1 18·7	6 5·3	9 3·5 „
31	1 39·3	7 57·6	9 4·4 „

A path extending through a considerable part of Pisces, but in a region entirely destitute of any conspicuous stars.

Mars

is invisible.

Jupiter

Is a morning Star during the entire month, but rises a little before midnight at the end of it. He continues in a very bad position for the observer.

Day of Month.	Right Ascension.	Declination. South.	Souths.
	h. m.	° ′	h. m. a.m.
1	20 34·9	19 5·2	5 58·7 „
6	20 36·3	19 1·0	5 40·5 „
11	20 37·3	18 58·0	5 21·9 „
16	20 38·1	18 56·1	5 3 0 „
21	20 38·6	18 55·4	4 43·8 „
26	20 38·8	18 55·9	4 24·3 „
31	20 38·6	18 57·6	4 4·5 „

Starting thus from a point somewhat to the South of the two 5 mag. Stars π and ρ in Capricornus, Jupiter will travel, approximately in the Ecliptic, through a void part of that constellation.

Jupiter's Satellites.

Day of Month	Satellite.	Phenomenon.	—
			h. m. s.
1	*I*	*Ec D*	2 35 51 a.m.
2	*I*	*Sh E*	2 11 0 „
2	I	Tr E	3 31 0 „
7	II	Sh I	3 24 0 „
9	*I*	*Sh I*	1 45 0 „
9	I	Tr I	3 3 0 „
9	*II*	*Oc R*	3 48 0 „
9	*I*	*Sh E*	4 4 0 „
10	I	Oc R	2 34 0 „
15	*II*	*Ec D*	12 53 32 p.m.
16	IV	Sh I	2 8 0 a.m.
16	*I*	*Sh I*	3 38 0 „
16	*III*	*Tr E*	4 2 0 „
16	*I*	*Ec D*	12 51 55 p.m.
17	*II*	*Tr E*	12 44 0 „
18	*I*	*Tr E*	1 42 0 a.m.
23	III	Sh E	2 49 0 „
23	*II*	*Ec D*	3 27 16 „
24	I	Ec D	2 45 49 „
24	*II*	*Tr I*	12 17 0 p.m.
24	*II*	*Sh E*	12 51 0 „
25	*I*	*Tr I*	1 11 0 a.m.
25	IV	Oc R	2 0 0 „
25	I	Sh E	2 19 0 „
25	*II*	*Tr E*	3 13 0 „
25	*I*	*Tr E*	3 31 0 „
25	*I*	*Oc R*	12 44 0 p.m.
30	*III*	*Sh I*	3 17 0 a.m.
31	*II*	*Sh I*	12 32 0 p.m.

Ec. Eclipse; Oc. Occultation; Tr. Transit of Satellite; Sh. Transit of Shadow; D. Disappearance; R. Reappearance; I. Ingress; E. Egress. The printing of a phenomenon in *italics* indicates that its visibility is rendered doubtful, either by the brightness of the twilight or by the proximity of Jupiter to the horizon.

Saturn

Is still very close to the Sun, and will be hardly visible until next month.

Uranus

Is now approaching the West; and should be looked for as soon as ever it is dark He is in quadrature with the Sun at 1 the 16th.

Day of Month.	Right Ascension.	Declination North.	So
	h. m.	° ′	h.
1	9 51·5	13 48·1	7 1
6	9 51·5	13 47·8	6 5
11	9 51·6	13 47·0	6 3
16	9 51·8	13 45·8	6 1
21	9 52·1	13 44·2	5 5
26	9 52·4	13 42·1	5 3
31	9 52·9	13 39·6	5 1

An exceedingly short path described a the North of the 5th magnitude Star

Neptune

Continues to be invisible.

Shooting Stars

May be expected on the night of the 1

Greenwich Mean Time of Sout Eleven of the Principal Fixed Sta Night of May 1st, 1878.

Star.	Souths.
	h. m.
α Ursæ Majoris	8 17 46
δ Crateris	8 34 4
β Leonis	9 4 1
η Virginis	9 35
β Corvi	9 49 1
α Canum Venaticorum ...	10 11 34
Spica Virginis	10 39 56
η Ursæ Majoris	11 3 51
Arcturus	11 31
α Libræ	12 5 4
β Libræ	12 31 1

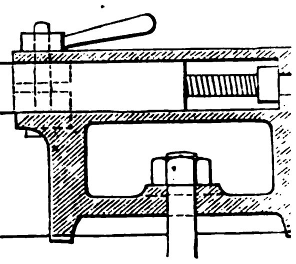
The method of determining the Lo Time of Transit of either of the Star above list will be found on p. 60 of Vol. and that of finding the instant of its Passage on any night in May on p Vol. XXII.

THE LATHE.—I.

By Fred. Hoffman, Enginee

THE consideration of the lathe incl that of boring, tapping nuts cutting, brass-finishing, polishing, fa lapping, and of all chucks and device

FIG. 1



these processes. A lathe may be desc a circular revolving shaft, to which a may be fixed and made to revolve, eac the material thus fixed coming successi contact with a cutting, polishing, or ot It consists of a bed of about the h a man's elbow from the ground, gener double I section, securely fixed by two each end to two legs of any desired leng according to the length of the wor *slided* on the lathe. Next there are t stocks, one fixed and one movable, to length of the work to be turned. T headstock consists of a casting, which i form, being bored or filed out for bra adjustments for the spindle. The headstock fits the bed closely at the b as not to shake sideways, and has spindle in its upper part parallel and to the other shaft in the fixed headst capable of being screwed nearer or f the other to any degree of nicety. Thi by a hand wheel, either on the *centr* movable spindle or a couple of inche it (Fig. 1). The spindle of the lathe supported in straight or conical bearings, and with or without back gearing. A tail-pin is necessary to prevent back-lash or end-long play. A bolt secures this headstock to the lathe-bed. There is usually a cone of three or four pulleys on the shaft to vary the speed, and there must also be some contrivance for throwing the wheels of the back gearing out of gear. Each headstock has a steel centre fitting taper (1 in 16) in the headstocks. The end of the spindle nearest the rest is screwed for a face-plate, jaw, or bell (sometimes called a bottle) chuck to fit on. The speeds of lathes vary with the material to be cut, and some lathes, especially those for screw-cutting and brass-finishing, have a *driving apparatus* (Fig. 2) arranged to give two speeds to the lathe, and besides this many screw-cutters are arranged to be driven either by a crossed or open belt, so as to reverse the motion and send the saddle back without unlocking the nut at all. It is needless to say that this is a safeguard against locking on to the wrong thread of the leading screw. The back gearing gives a slower motion, and consequently increased power to a lathe. Most pulleys, particularly those running at a high speed, have their peripheries convex, to prevent the strap coming off. A common slide-rest is a rest arranged so as to give any desired motion (in a straight line and given horizontal plane) to a cutting tool, at the same time *affording it a secure support*. First of all, there is a piece of cast iron of this section (Fig. 3), having four bolts fastened in the top for holding down the tool. The bolts are turned with a collar, which fits in a corresponding hole in the top piece of the rest. The slipping round of the bolt when the tool is tightened is prevented by the little pins underneath, as shown, which fit half in the pin and half in the rest.

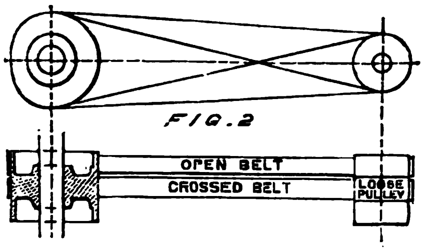


FIG. 2.

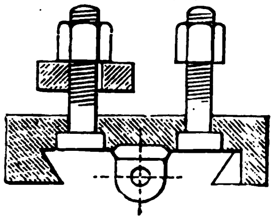


FIG. 3.

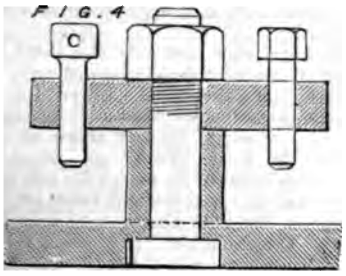


FIG. 4.

Now a few words as to the difference among makers of lathes in the details of their top rests. Some make their rest flat at the top, as shown, others have a square platform on the top, with a ledge all round for the tool. This plan, though probably of great use in some special cases, has the disadvantage that the tool cannot be turned at any angle to suit the work. It also makes the packing underneath the tool hang over the rest, and so often get in the way of the carrier. Other makers, as Whitworth and Hand, use a triangular clamp (Fig. 4), held down by a large bolt with a fine thread at the top, and incapable of turning round at the bottom. In every case the set screws should be steel, not iron; they may be cut with a stock and die if the scale is taken off and the steel well softened.

(To be continued.)

DESCRIPTION OF A PHONOGRAPH.

By Shelford Bidwell, M.A., LL.B.

Several articles on the phonograph have already appeared in the English Mechanic—I shall therefore assume that readers are acquainted with the nature and principle of the instrument.

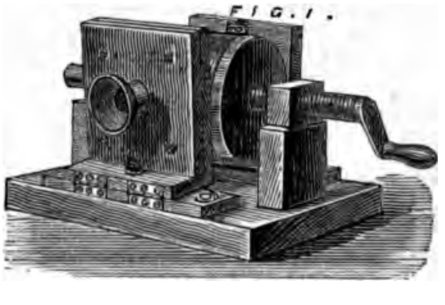


FIG. 1.

The most important part of it is the cylinder. This, in my phonograph, is a hollow brass casting, 4½in. long and 4½in. in diameter. It is mounted upon an iron spindle, ¾in. in diameter and 16in. long, at one end of which is a winch handle. Upon that part of the spindle which lies between the handle and the cylinder a screw is cut, having eight threads to the inch. The other end of the spindle is left plain. The cylinder having been turned perfectly true, a screw is cut upon its surface of exactly the same pitch as the screw upon the spindle—*i.e.*, eight threads to the inch. The depth of the spiral groove thus formed is 1-16in., and its breadth is 1-16in. It is better to cut it square, and not V-shaped. Two brass bearings for the spindle are made of the following dimensions—length, 2¼in.; thickness, 1¼in.; height, 1¼in. One of these has an inside screw corresponding to the screw upon the spindle. Each bearing has two holes for screwing it to the support, as may be seen in Fig. 1, which is engraved from a photograph of the instrument.

The cylinder, spindle, and bearings being completed, ten pieces of wood must be prepared as follows:—

A is 12in. × 9½in. × 1¼in.
B is 3in. × 3in. × 1¼in.
C is similar to B.
D is 5½in. × 5½in. × ½in., and has a circular hole, 2¾in. in diameter, cut in its centre.
E is similar to D.
F is 5½in. × 5½in. × ¼in., and has a hole, 1in. in diameter, in its centre.
G is 5½in. × 2¼in. × ¼in.
H is similar to G.
I is 8in. × 2¼in. × ¼in.
K is similar to I.

B and C are the upright supports for the bearings, one of them being shown in Fig. 1. The position of the others is indicated by the letters corresponding to them in Figs. 2 and 3.

The uprights B and C are fixed near the ends of the baseboard, A, by means of 2¼in. screws. D and F are screwed together (see Fig. 1), and the two are then fixed perpendicularly upon G. G is joined to I by a pair of hinges. The two ends of I are screwed to the baseboard, but the holes in I are ¼in. larger in diameter than the screws which pass through them. The heads of the screws are effectively enlarged by iron washers ¾in. in outside diameter. The object in this arrangement is to allow a certain amount of play in the board, I, for purposes of adjustment. When properly adjusted the screws may be tightened, and the board firmly fixed in position. E is attached perpendicularly to H, and made rigid with two small triangular pieces, which are not shown in any figure. H is hinged to K, and K is fixed to the base in exactly the same manner as I. Through the middle of I is passed a brass screw-bolt, the square head of which is fixed in I. The screw goes through an elongated hole in G, and is fitted with a round milled brass nut. It is well to place a washer under the nut. Screw-bolts of this description are used for fixing the expanding bodies of ordinary photographic cameras, and may be had of any optician. H and K are fitted with a similar bolt. Two rather stiff pieces of steel spring are attached to the ends of I, and extend for a little distance underneath G. These springs tend to separate G and I, or rather to cause G to turn backwards, like the lid of a box when opened. One of the springs may be seen in Fig. 1. The nut, of course, works against the springs. When the nut is screwed up tight G and I approach, and may be made almost to touch each other. When the nut is loosened the spring causes G to rise. Very delicate adjustment is thus rendered possible. H and K are fitted with similar springs for a similar purpose.

We come now to the diaphragms and points. The diaphragm which receives the voice is fixed over the circular hole in D, as shown in Fig. 2. It consists of a circular plate of very thin iron 4in. in diameter. Ferrotype plate will answer the purpose very well, but thin charcoal iron is better. It is, however, possible to have the iron too thin. I should say that about two-thirds the thickness of an ordinary ferrotype plate is the best. The point is made from a knitting-needle about 1-20th of an inch in diameter, which must be very hard—one which can be bent is of no use. The original point had better be broken off, and a new one ground upon an oilstone. For this purpose the needle is held at an angle of about 30 degrees with the stone, and is constantly turned round. The point, having been made tolerably sharp, is polished and cut off with a file. The part so cut off is 3-16ths of an inch long.

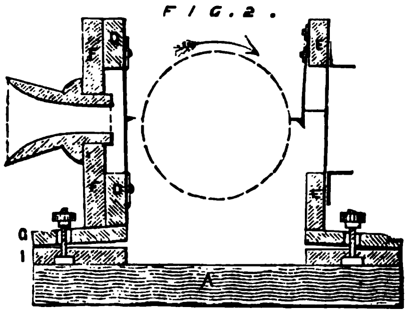


FIG. 2.

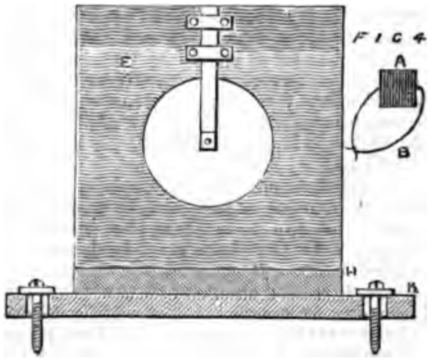


FIG. 3.
FIG. 4.

This has now to be attached perpendicularly to the centre of the diaphragm, and the method of doing so is as follows:—The diaphragm is laid upon a sheet of glass, and a little spot in its centre—about ⅛in. in diameter—is scraped clean with a knife. This must be done carefully and gently, or a bulge will be produced. The fragment of knitting-needle is then taken up with pliers, and its blunt end, having been moistened with soldering fluid, is held above the flame of a spirit-lamp, and touched with a piece of tinfoil. With a little manipulation a small bead or globule of tin may thus be made to adhere to the end. The scraped spot on the diaphragm is now moistened with soldering fluid, and the diaphragm is supported at some distance above a small spirit flame. The ring of a retort stand forms a convenient support. The butt end of the point, with tin globule attached, is then applied to the scraped spot with pliers. In a few seconds the globule melts, when the lamp is instantly removed, and the point manipulated with the pliers, so as to be perfectly upright when the tin hardens, which will take place in a few seconds more. The point will then be found to be firmly attached. The diaphragm and point must, after this operation, be thoroughly washed with soap and water, and slightly oiled—otherwise they will rust. The only precaution to be observed is to apply no more heat than is just necessary for melting the tin. Too much heat will warp the disc and, if it is a ferrotype, blister the japan. The soldering fluid consists of equal parts of hydrochloric acid and water, in which is dissolved as much zinc as possible. A pile of books will be found useful for steadying the arm while manipulating the point. The diaphragm is fixed in its place by means of a brass flange (like a camera flange), 4in. in outside diameter, with a 2¾in. opening. Four screws are used.

The second diaphragm is made of parchment paper, like that used for covering jam-pots. It is 4in. in diameter, and is gummed over the hole in E on the side remote from the cylinder (see Fig. 2). When the gum is dry the diaphragm is moistened, and again allowed to dry, when it will be found to be as tight as a drum.

The second point is exactly like the first, though it may with advantage be a trifle sharper. It is not attached directly to the paper diaphragm, but to a steel spring, which may be seen in Figs. 2 and 3. This is a piece of mainspring $\frac{5}{16}$in. wide and 2¾in. long. It is fixed above the hole in E by means of two strips of brass, as shown in Fig. 3, and is just so much bent that the end of it, when free, is ⅜in. distant from the plane of E. The power of this spring may, however, be varied within considerable limits without appreciable difference in its performance. The point is fixed to the spring in the same manner as to the iron disc, but the same care as to over-heating is not requisite, and the operation is consequently easier. Before the spring is screwed in its place a loop of sewing silk is attached to the centre of paper diaphragm by means of a piece of court plaister ¼in. square (see Fig. 4, where A is the piece of plaister, B the loop). The length of the loop must be such that when it is drawn over the spring just above the point, the end of the spring may be nearly in the plane of E. The spring is thus caused to draw the paper drum even tighter than before, and its inner surface is rendered slightly convex.

Another flange carrying a short rim or spout is now screwed round the paper drum. A paper resonator is made to slip over the short rim or spout. It is a cone made of two or three thicknesses of stout drawing paper. Its length is 18in.; diameter at small end 2¼in., and at large end 7in. The resonator greatly reinforces the sound when the phonograph is speaking. A wooden mouthpiece like those used for speaking-tubes is inserted into the hole, F (see Figs. 1 and 2.)

The instrument is now complete, but it will require careful adjustment before it can be used. In the first place the screws which attach I to the base must be loosened, the milled nut on G screwed up tight, and the piece, I, shifted about until the point on the iron disc is exactly in the middle of one of the grooves on the cylinder, and barely touches the bottom of it. Then the screws must be tightened, and this part of the apparatus is finally adjusted. The same process is repeated on the other side, but in this case the adjustment is not quite final, as will hereafter be seen.

The next thing is to procure suitable tinfoil. This should be rather stout—about 15 square feet to the pound—and should be cut into pieces 14¼in. by 4½in. Before putting a tinfoil upon the cylinder the two nuts are removed, and the diaphragms turned back out of the way. A little gum brushed along one end of the tinfoil will be sufficient to keep it firmly in its place; the join must be carefully smoothed. The diaphragms are then turned back to their places, and the nuts screwed on. The nut on G is screwed up just far enough to cause the point on the iron diaphragm to touch the tinfoil very lightly. The handle is then turned about a quarter of a revolution, causing the point to make a short scratch on the tinfoil. The nut on G is thereupon loosened, withdrawing the point from the tinfoil, and the nut on H being screwed up, another turn is given to the handle. If the scratch thus produced exactly coincides with the former one, well and good: if not, the screws attaching K to the base must be loosened, and K shifted about until absolute coincidence is attained. The utmost accuracy on this point is essential.

The instrument may now be considered fit for use. Loosen the nut on H, so that the point on the spring may be well away from the tinfoil, and screw up the nut on G, so far that the point on the iron diaphragm may score a well-defined furrow on the tinfoil when the handle is turned. Turn the handle with as great regularity as possible, at the rate of about one turn per second, or a little slower. Speak loudly and distinctly into the mouthpiece, putting the mouth as near as possible to it, without actually touching. When you have finished, withdraw the point by loosening the nut, turn the handle backwards until the cylinder is in its original position, and screw up the second nut until the second point presses lightly but steadily upon the bottom of the furrow. Then put on the paper resonator, and turn the handle at the same speed as before. If the adjustments are perfect, the result will be astonishing.

I will conclude with a few general remarks and hints.

It will be observed that this instrument has two diaphragms, whereas Edison's latest have only one, which does both the receiving and the speaking. I have made many experiments with the object of dispensing with one of the diaphragms, but I have never, under any circumstances, obtained so good results with one as with two. Mr. Preece told the Physical Society that the employment of only one was a "retrograde step." Reason and experience lead me to concur in his opinion.

I do not believe that iron and parchment-paper are the best possible materials for the diaphragms, though they are better than any others which I have hitherto tried. The great fault in the iron appears to lie in its tendency to resound forcibly to certain overtones in certain vowel sounds. I have tried to overcome this by coating the diaphragm with indiarubber, but with no great success. I think, however, that a ring of indiarubber between the diaphragm and the flange has an undoubted effect in diminishing the nuisance. The steel spring is subject to independent vibrations of a similar nature. These may be damped by causing a piece of soft indiarubber to press lightly upon it at a point about ¼in. below the lower strip of brass. I have also found it an advantage to wrap indiarubber round the top of the spring before screwing it on.

I believe that the mouthpiece of a telephone would give better results than that of a speaking tube. A long resonating mouthpiece like that which Edison first used is worse than useless.

The point on the steel spring should be made to turn very slightly upwards instead of being perpendicular. In the latter case it is liable to produce a squeak something like that of a slate-pencil when drawn upright across a slate.

If the points are too sharp, they will cut and scrape the tinfoil: if too blunt, the articulation will be muffled. After the points have traversed the cylinder 200 or 300 times, they will require sharpening. This can be done with a small oil-stone, without removing them.

In conclusion, I may mention, for the encouragement of those who wish to make a phonograph, that the performance of the instrument here described is at least equal to that of any which has hitherto been exhibited in London.

THE ORGAN: A COMPREHENSIVE TREATISE ON ITS MANUFACTURE, PROCURAL, AND LODGMENT.*

By John Watson Warman,

Associate of the College of Organists, London.

PART I.—GENERAL TREATMENT IN MANUFACTURE.

f. It will be seen that, in the instances given, there is no provision for separate wind for Pedale to keep it distinct from the Manual for fear of disturbing the intonation of the latter. The simple reason is, that such treatment is founded on insufficient information. The Ped. will disturb the Manual *less* in the proportion of 1 *to* 2 than one part of the Manual will disturb the other. *See* fully in Determination of Number of Pressures (12, j.)

g. *Great Organ.* (*See* Swell Organ, also Reeds.) It is a very grave mistake to have the Great on too heavy a wind; its dignified character is likely to suffer. Its Pipes are generally the nearest both performer and audito and its Registers usually numerous, powerful, and large enough for the Touch to b perilled. A heavier pressure for the Grea *Reeds*, particularly if there be no Solo Organ, i good; but it must be remembered that there i here no means of rendering this treatmen available to improve the Great to Ped. Couple as a supplementary of the Pedale, for it woul not do to deprive the latter of the benefit o the Reeds of Great, unless it—Pedale—of suc size as is rare indeed in English Organs.

See further in Aug. of Treble (1, y.), als Borrowings (26, e. to end).

h. *Reeds.* These are the first that shoul receive the increase of pressure—first, becaus they acquire a great addition of splendour b such treatment; second, because they ar radically liable to weakness in the uppe notes, therefore the increase can be applie to that portion; third, from the fact that separate Pallet for the Reeds enables these t be taken off the coupling of that Manual t Pedale (*see* more fully in Swell Organ, d., *ante*) this applies with more force to that than to an other Manual—scarcely at all, indeed, to th Great (*see* g. preceding). It may, therefore, b laid down that the application of addition wind-weight to Swell Reeds is one of the fir uses to which the increase of pressure may b legitimately applied, particularly when there i *no* Solo Organ.

Scarcely inferior is the importance heavier wind to the Pedale Reeds, partic larly where there *is* a Solo, only it must b borne in mind here that if these latter b numerous enough one or more should remai on the lighter wind, the Pedale having to sup plement the *entire* Organ.

With regard to the Choir it may be laid dow that the Reeds should never be on a heavie pressure, except, perhaps, sometimes in ve large instruments; for it is important to retai variety in the Reeds as well as in the othe Registers, and this is greatly aided by varyin the pressures, as just pointed out with referen to the Pedale.

i. With reference to the Solo Organ, when has two pressures the Tubas will of course b on the heavier; but it is of the highest importance that one or more Reeds be kept on th lighter wind, which latter will, or ought to b here quite strong enough to give them fu justice.

There remains now only the Great Orga this must be treated more according to circumstances than either of the other Manuals. large Organ will obviously better have its Ree on a heavier wind; also, if there be a stro Pedale 16 Reed, the Great Reeds shou always be brought to match it; but note, t *necessity* of this ceases when there are suitab Reeds on the Solo that can be united to t Great. On the other hand, when the Peda is feeble, or the touch of the Great is feared, there is but one Reed on Great, then the pre sure for latter may well be *unincreased*. Th last objection (the presence of only *one* Reed Great) only has weight in this way, that just the sake of one Register the parting-off seem waste; on the other hand, when there is b one there is all the more necessity in ma cases that it may be made the most of.

See further in Aug. of Treb. (1, y.), al Borrowings (26, e., to end).

j. It must be borne in mind that in lar instruments two Pallets at bottom beco almost a practical necessity; and, by having separate one for the Reeds, not only may t two pressures be easily secured, but all t large Registers have a Pallet under them.

k. *Couplers.* It is obvious that these m exert a very important influence on the App tionment of pressure; thus, if there be Choir Great in action at same time as Swell to Gre it is manifest that pressure of both Swell a Choir stand affected, and this is, in fact, one the cases in which a light wind for Choir is ve valuable. Octave couplers also must alw be taken into consideration with great caref ness, for they virtually double the resistan Manual to Ped. Couplers also make a differen though of a more varying character; thus, most cases, all the Manuals admit of bei coupled to the Pedale, but in Specificatio see that *Depart.*) it will be conclusively shown now that, with a commensurate Pedale, this is often not necessary, and sometimes mischievous. I have divided the Couplers (structurally) into three kinds—viz., *Ordinary*, *clearing* or *clear*, and *partial* or *part*. The first is the usual kind. The second are of author's contrivance; they are simply such as are kept independent of some other Coupler that would otherwise be *involved* in their use; thus, the Great to Ped., as it ordinarily exists, is an *involved* Coupler, for the drawing of the Swell to Great of course virtually brings on Swell to Ped., and this in practice is often found exceedingly inconvenient (*see* Specifications). The Coupler is transformed into a *Clear* one by simply rendering the action independent of the Swell to Great (*see* Touch and Coupler actions, and Claviers), so that if Swell to Ped. be required that actual Coupler must be drawn.

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l. A *Part* Coupler (this also is an idea of the author's) is one which acts on only a *part* of the particular section to which the attachment is made; thus, when the Swell Reeds are on a separate Pallet, the Swell to Ped. may well be constructed to avoid this Pallet, thus adding much to the utility of that Coupler (*see* Specifications), the full Swell being thrown on to the Pedale *only* by the drawing of the Swell to Great. It will be obvious that these last-mentioned two particular Couplers should not both exist in one instrument, or the Swell Reeds will be cut away from the Pedale entirely; neither is it necessary—either will most materially and sufficiently reinforce any fairly commensurate Pedale. But the most important Part Couplers are those which give Sub or Super-oct. to Pedale; the former is, as will by-and-by be realised, of immense value, particularly to a C Clavier, but the terrible break involved has hitherto prevented its use, except in a very few cases (*see* Deps. of Couplers). This offensiveness is practically veiled by making the Coupler a Partial one — viz., operating only on the deepest Registers, the Chorus and Reeds for the most part remaining untouched. The Pipes should also run deep enough to still further veil the break, G G G (that is, the G G Ped. Key) furnishing the best limit. If we add a Part Super-octave, this taking just those Stops (or or in a small Pedale only one Stop) which the other avoids, the break of the Sub is hardly to be detected without searching for, and it itself will perform the same *covering* office for the Super.

m. It is manifest that all these Couplers may exert a modifying influence on the Apportionment of Pressure. Thus, with reference to the Part Coupler, if the Pedal be incommensurate, and there be no Solo, the allotting a separate wind to the Swell Reeds (and generally Swell Mixture also, if present) may be looked on as almost a matter of course. So, on the other hand, in the instance of the Clearing Coupler, if the Great be by the use of this rendered so much more valuable to supplement the Pedale, there will be less necessity to trouble about heavier wind for Swell Reeds, particularly as the Swell to Ped. now involves these on the Ped. (at same time bear in mind that additional pressure for Swell Reeds is always valuable). Thus, also, as in the Part Coupler as applied to the Pedale, its value in that Section is so great that it may well be considered almost a regular thing to have two pressures to the Pedale where two exist in the Organ, always bearing in mind that access to the two Ped. Front-boards (*see* Wind-chest) must be provided for.

n. Hitherto the Couplers have been assumed as not thrown on any Pneumatic; where they are there is not, of course, the same risk of heaviness to the finger, but it must not be forgotten that resistance has not ceased—being merely, in fact, *transferred* to the Pneumatic; and the power and promptitude of the latter must be borne in mind, just as in the former case the resistance to the finger had to be considered.

o. *Touch.* This, involved with Pallet and Pneumatic, has, of course, been partly considered in what has already been said. *See* more at length in Pallets (on *Depart.*) and Pneumatic Action (*Dep.* of Touch-action). It will be sufficient here to remark that Box, Compound, Elastic Face, &c., Pallets, do materially lighten Touch, and, therefore, render consideration of latter less involved in that of Apportionment. The Counter-Butt and Rocking kinds being balanced, obviously render the particular pressure a matter of little, if any, moment; but the first of these is suitable only for the Pedal Organ, and the second, though of the greatest real value, can hardly command *universal* adoption, as it is rather more elaborate, is not removable, and demands a Sound-board bar of as much as ½in. thick.

p. It must be borne in mind that all the Claviers are not at all times under precisely the same rules as regards Touch-weight; thus, in, say, a Cathedral instrument, the Pedal may be, perhaps, a little heavy, comparatively; the Choir and Great must be light, as constantly in use and often for rapid work; the Swell—as being less defined in its nature, and therefore, hardly so suitable for rapid play—may, perhaps, be allowed a little more resistance (and here again is the heavier pressure favoured); the Solo, being in the Cathedral instrument comparatively little used, may, perhaps, also be allowed a little more resistance. All these are as supposing the *Full Organ* insure light by the throwing of the Couplers on the Pneumatic. Observe, they are to be viewed only as *permissible defects*; very perfect Organ should have all its Touches right, and at all powers; and it may also be laid down that in Concert Instruments the Solo touch must be as perfect as any, as likely to be in many cases very largely required. *See* fully under Head of Touch in *Depart.* of Claviers.

q. *Bellows.* When Combined Bellows (*see* 7, f.) are used, or Double-feeders (*see* 6, u.), endeavour so to arrange that the heavier pressure does not have a disproportionate amount of Feeder area driving upon it while lighter is not in operation to relieve; *see* on (11, z). Double-feeder may be said to be imperative only by reason of confined space (*see* 6, v.); also Borrowings (21, w.).

r. *Augmentation of Treble.* This, of course, will exercise an influence over the distribution of the pressures; go over all that has been said in own Head (commencing at 9, x.). It has not hitherto been gone into in considering the Apportionment, and it will be distinctly understood that the author is strongly in disfavour of Augmentation of Treble by pressure, except in such cases as it can be done without sacrificing any other desirable effect—that is to say, supposing there be but two pressures in an Organ, it will manifestly be a more effective plan to give the heavier, say, to the entire Reeds than to expend it in a mere augmentation of the Treble, particularly as the latter can be obtained otherwise (*see* 1, y.). It is quite true that the Flue upper portions might be comprehended in the heavier pressure; and where both effects can be secured there can, of course, be not the least objection—only care must be taken. Thus, in case just stated, the Trebles of Reeds and Flues would obviously be on same pressure. Only, as the Organ enlarges and pressures increase in number, may there well be one apportioned for Augmentation of Treble, if latter be found desirable.

s. With regard to the departments to which increasing Treble pressure may be applied the following general rules may be laid down:—The Pedale may be said never to require it, being too short in its range for any weakening upwards to become palpable. The Choir may be said not to require it as a *rule*, for if correctly compounded (*see* Spec.) it should have—according to author's views—a good proportion of 4ft. Flute tone, and this will prevent tendency to weakness in Treble. The Solo certainly does not require heavier Treble pressure, for, as will be seen in Synopses (*see* own *Depart.*) and Specifications (*see* that *Depart.*), the difficulty here is to get the lower portion commanding enough: (this, of course, only applies to the Flues).

t. With that regard to the Swell its composition ought properly (*see* Specifications), combined with the slow bias so frequently and conveniently used in that Section (*see* 3 p.), to prevent any weakness at top. There remains only the Great, and this, as will have been seen (2. c and d, and on), is, in fact, the Section which has most frequently and fully received it. A very good way will be to give one wind—the heavier—to the whole of the Reeds (and perhaps Mixture), and upper half of the Flue work; and the lighter to the remainder. This, of course, is not in conformity with what has been said about the Reeds being more in need of Augmentation of Treble than the Flues, but it has the great convenience of making the Swell nice for coupling to Ped, and yet without involving two Pallets throughout; the cutting off Reeds from Swell to Ped much removes the disadvantage of their increasing downward power.

u. In instances following will be given as many Exemplary Arrangements as is practicable in a matter in which treatment must obviously vary much in special cases, and with each of these is incorporated direction with reference to Augmentation of Pressure.

v. It will be seen in these Examples that the Arrangement just instanced at last part of parag. s is freely used. Where the Reeds are sufficiently strong, or the utmost economy is desiderated, the two Pallets may be applied *only* to the portion corresponding with the Pedale. Or the Reeds-Basses, and, perhaps, Chorus-Basses, may be apportioned off on the lighter wind; the heavier thus for tops of Reeds and whole of Flue, except, as just said, such portion as accompanies Reed-Basses.

* Instances Exemplary.

w. For actual Selection of the number, or exact amount, of the pressures *see* Determination, a little on (12, h.). The following Instances are placed as nearly as possible in author's estimation of merit.

x. Two Pressures. *One Man.* 1. Heavier to Trebles of Reeds; 2. Heavier to whole of Ped.; 3. Heavier to Reeds. No. 1 is the most admissible, and might be applied to a Chamber Organ. No. 2 will be useful when Pedale is weak. No. 3 is only recommended in a public Organ, and where a small Instrument has to fill a large space.

y. *Two Man.* 4. Heavier to Swell Reeds and Chorus (*see* also 11, a.), and Ped. Reeds and Chorus; 5. Heavier to Ped. Reeds (and Chorus, if any) and whole of Swell; 6. Heavier to whole of Swell and whole of Pedale; 7. Heavier to all Reeds both Man. and Ped.; 8. Heavier to whole of Pedale; 9. Heavier to all Reeds of Great, and all Reeds of Ped.; 10. Heavier to Trebles of all Manual Reeds; 11 Heavier to Great Manual Trebles generally; 11 *a.* Heavier to whole of Swell except bottom of Reeds and bottom of Chorus, the exact amount being made to correspond with Pedale. (*See* also at end of these Instances (11, z); also also Borrowings (26, e, to end).

(To be continued.)

CANOES AND CANOEING.—III.

(*Continued from page* 55.)

IN the last part of my article on the above a slight mistake occurs in reference to the centreboard: it should occupy that part of the canoe between the foremast and forward end of the well; by placing it in this position it is entirely out of the way of the canoeist. It should be of ¼in. iron plate, instead of ⅜in., the latter being too heavy. I now proceed to describe the rigs mostly used.

Rig.—There are many kinds of rigs adepted in canoes. For instance, the standing lug, sprut, lateen, sliding gunter, China lug, &c., but the best for all purposes is the lug, as it holds a good wind, is easily managed, and, when the halliard is let go, comes down with a run. Perhaps the most handy for cruising is a kind of revolving lug, having a light batten let in a hem across the sail, formed by sewing a piece of wide tape over the batten, as in Fig. 1, by attaching a light line to the fore end of batten, and bringing it down the edge of the sail through rings, thence through a block on the boom along the latter, and made fast to a small cleat on the after end; by this means the sail can be reefed by hauling on the line, and two or three reef-points on the after end of the batten may be tied to keep the slack of the sails out of the way. The dotted lines show the sail when reefed. This plan was introduced on the

Humber by one of the members of the eastern branch of the canoe club. For the mizen sail a modified form of the sprut I consider best, as it can be easily reefed by hauling on a small line without turning round; it is shown on Fig. 2. The sprut is made fast to the sail in the same way that the batten is on the mainsail, by means of a wide tape. Along the top of the sail rings are sewn, and a line passes from the top of the sprut through the rings, thence through a small block on the masthead, and down to the well. When this line is hauled tight the sail is reefed up, and a small triangular sail remains, which is very useful when lying-to, fishing, &c. All lines should lead to the well, within easy reach of the canoeist, cleats being fixed to the side decks.

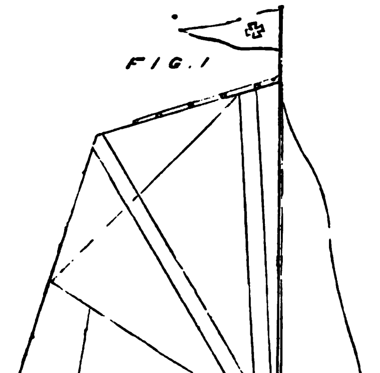


FIG. 1

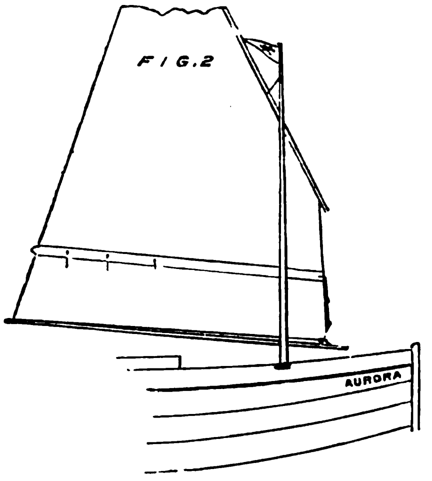


FIG. 2

The best cleat for canoes is Paget's patent, made by Fisher, ironmonger, Fleet-street, London, one turn being sufficient to hold a line perfectly tight. When running before a stiff breeze or heavy sea, the mizen should always be furled close, or even taken in, as a canoe will always sail better and be more under control. The best material for sails is strong cotton sheeting, which may be had wide enough to cut the sail in one piece; the mainsheet may be fast to the boom at any part convenient. All lines should be of woven cord, which is made by Good, King William-street, London; this kind does not harden when wetted. The painter is best made fast to the stern-post, and brought along the deck to a cleat near the right hand, round which it is made fast. A very useful article when on a long cruise is a pair of wheels for transporting the canoe overland. These may be easily constructed of some hard wood. Each wheel should be 12in. in diameter, with brass boxes running on iron axles fastened to wooden axle-trees, to the centre of which a kind of wooden trough is fixed by means of a strong screw. This forms a support for the keel of the canoe. A line is made fast on each side from the deck to the axle-tree, so that she sits firmly on her keel, being balanced in the middle of her length. The whole arrangement may be pushed before the traveller like a truck. When the wheels are not in use the linch pins may be taken out, and the wheels and fittings stowed under the deck, which will serve as ballast. The writer has found them very useful while cruising on a rocky coast and on tidal rivers. Amongst the various fittings a cruising canoe requires the following will be found useful:—A brass or galvanised iron boat-hook (useful when coming alongside a vessel or pier); a strong woven cord towline, about 30ft. or 40ft. in length; a light galvanised anchor, with folding stock and woven cord cable; a small compass swinging on gimbals, with Singer's patent dial—the northern half black with white points, the south half vice versâ. This is very useful when crossing lakes or channels, especially when in a fog or at night. A small powerful lamp is very useful, when on tidal rivers especially. Clothing should be warm, and carefully protected from water when not on the wearer. When on strange waters, charts, and sailing directions to accompany them, will be found necessary.

I have now come to the end of my brief article on canoes. If any of my readers have been induced to invest in a canoe, I can only hope they may enjoy a cruise during the coming season with safety and pleasure. If any information is required on any particular part of my subject I shall be quite willing to answer any queries through the columns of this journal.

E. H. J.

THE ANALOGY BETWEEN LIGHT AND SOUND.—II.

By Prof. W. F. Barrett.

WE must now pass on to consider the progress of sound and light waves through space. Obstructions are met with, and the waves may be either quenched or bent aside or thrown back. Now these separate motions go by the name of absorption, refraction, and reflection. Let us take the last named first. When a ray of light strikes a polished surface it is reflected in such a manner as to make the angle of reflection equal to the angle of incident, and in the same plane with it. This is shown on this diagram (Fig. 1.

If R R be a reflecting surface, and C O perpendicular to it, then a ray of light striking the reflecting surface in the direction of B O will make the angle, B O C, with a perpendicular falling on the polished surface equal to the angle, C O B′; that is, the angle of reflection will be equal to the angle of incidence; and if it falls at any other angle, it will make the angle of reflection precisely similar to the incident angle. If it falls perpendicularly on the mirror, it will be reflected back in the same direction. An experiment is arranged here by which you will be able to see the equality of these angles of incidence and reflection. Here is an oxyhydrogen lamp, and in the front of it a mirror, and on the mirror is now falling a beam of light. You will see as the direction of the beam falling upon the mirror is altered, so also is the angle at which it is reflected; and the scale attached shows that the angles made by the incident and reflected ray with the normal always correspond. Exactly the same law holds good with regard to sound. I have here two tubes, A and B (Fig. 2), which are for the purpose of preventing the decay of sound in the manner I explained just now. The tubes are now placed at right angles to one another. In front of the tube, A, is a source of sound, S, muffled except so far as the open end of the tube is concerned;* in front of the other tube, B, is a sensitive flame, F, and at present you perceive no action upon the flame, though the sound (an electric bell) is going on. As soon, however, as a reflecting surface, R, is placed at the base of the tubes, then we find that the sound which travels down the first tube, A, is reflected from the mirror, passes back through the second tube, B, and now powerfully agitates the flame. If, instead of using a polished surface, such as this mirror, I simply use my hand, I dare say we shall obtain sufficient reflection for the flame to make evident. Further you observe that a "batswing" gas flame, or even a sheet of unignited gas, forms a sound reflecting surface, and able therefore to replace the solid reflector, R. But whatever the reflector may be, it is only in one position that it produces the maximum effect on the flame, and that position, when found, is such that the axis of each tube makes corresponding angles with the surface of the reflector. Precisely the position, in fact, in which the light from a candle at the end of one tube would be reflected along the other.

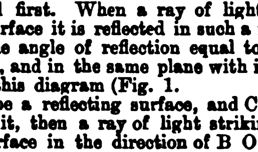
FIG. 1


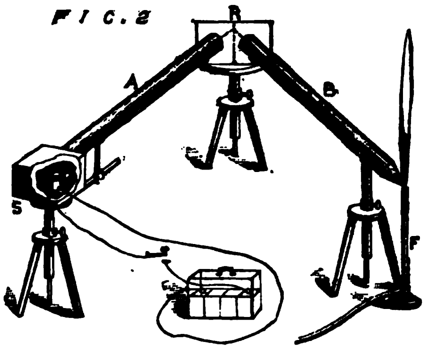
FIG. 2


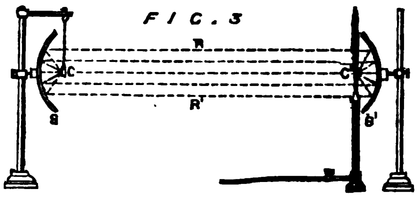
FIG. 3


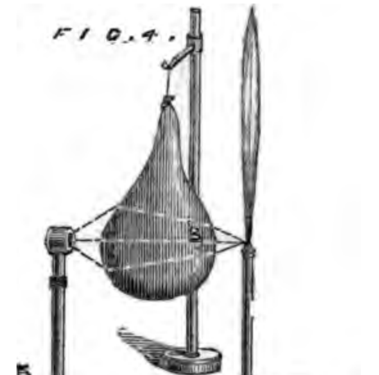
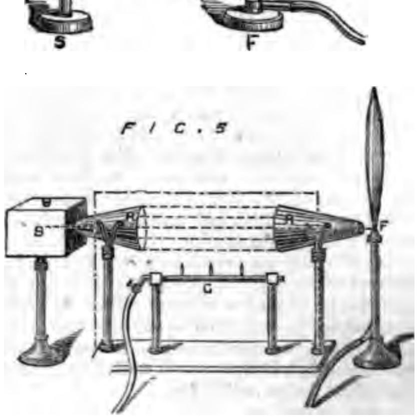
FIG. 4.


FIG. 5


So far we have dealt with plane mirrors. With curved reflectors sound is affected in the same way as light. In this diagram (Fig. 3) S S′ represents two concave mirrors; at a certain spot, C or C′, in front of either mirror, termed the focus, a source of light or sound is placed. Divergent rays emitted from the focus and falling on the mirror, are reflected as a sheaf of parallel rays, which striking the second mirror, are there converged to a corresponding focus in front of it. As concerns light this fact is probably familiar to you all. It is easily illustrated by this large pair of concave, or rather parabolic mirrors on the table before you. The mirrors are some thirty feet apart, and yet you see a lighted candle placed in the focus of one gives us a very bright spot of light—in fact, an image of the candle—on the little transparent screen held in the focus of the other. At any other intermediate spot the light is more diffused, and therefore less brilliant. Using the electric light in place of our little candle, the light scattered from the dusty air enables the course of the reflected rays to be readily traced by every one in this large audience. In like manner a sound focus or a sound image may be obtained in place of the luminous ons. Inasmuch as only one person at a time could ascertain this fact, we must fall back upon a sensitive flame to reveal it to us all simultaneously. Moreover, the great advantage of the flame is the small surface it exposes, and its extraordinary power of acoustic discernment, if I may use the expression. The source of sound I shall use is a loud ticking watch enclosed in a padded case which has a movable cap on one side. In one focus of the pair of mirrors we have a sensitive flame; and we shall find, I trust, that as soon as the watch is brought between the focus of the distant mirror, we shall have the flame beating time to the ticking of the watch. It is so, as you see. Placing the little cap over the watch immediately you find the flame is silent. Taking the cap off again, the effect is renewed. Even by turning the face of the watch towards the flame, that is, away from its adjacent mirror, or moving it slightly out of the focus, the effect ceases; but placing it in the focus once more, you have evidence of the reflection of sound. I think that is sufficient evidence of the fact that both light and sound can be converged by reflection to a focus.*

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* The box is broken away in the engraving to show the interior.

Not only do light and sound obey the same laws of reflection, but they obey similar laws when refracted Light on passing obliquely from a dense medium to a rare one, or *vice versâ*, is bent out of its original course—it is refracted. So also is sound. Passing a beam of light through this convex lens, you see by the smoke in the air that the light is brought to a focus, just as it was by the concave mirror. If we take a thicker lens, the light is brought to a focus much nearer. Now what I want to show you is a similar experiment as regards sound. This can be accomplished not by passing sound through glass lenses, which are much too dense for the purpose, but by passing rays of sound through convex lenses of some medium slightly denser than air, such as carbonic acid gas. I have here a collodion balloon which is being filled with that gas; this, when it is inflated, will form a double convex lens. If we now take our sensitive flame, F, (Fig 4), and place the collodion balloon, B, between the source of sound, S, and the flame, we shall have the refraction of sound made evident by the convergence which takes place when the waves of sound pass through the balloon. I will place the watch at such a distance that it does not affect the flame, and then introduce the balloon, so that the focus falls on the root of the flame, which will cause the ticking to be made evident. Taking the sound lens away there is no action; putting it between again you see a considerable action. Even with an ordinary child's indiarubber balloon sold about the streets, you may, by filling it with the air from your lungs, produce a denser medium, and obtain a very fair refraction of sound in this way.*

Now, if we pass from the reflection and refraction of sound to the absorption of light and sound, we shall find that similar laws hold good here. When a ray of light passes through a coutinnous medium, it undergoes neither refraction nor reflection; but when this medium is broken up by any other medium of a different density, then every beam of light which enters the second medium undergoes reflection at the surface. If, therefore, we have a ray of light frequently passing from one medium to another, it will be frequently reflected and refracted, and every time it undergoes this reflection the transmitted ray will be weakened. This accounts for the fact that if you take some perfectly transparent crystal like rock salt, and crush it into powder, it becomes opaque in the same way as transparent ice is perfectly opaque when in the form of snow. I have now to show you that we can produce this opacity by two perfectly transparent substances in the case of light and in the case of sound. I have here a trough containing water focussed upon the screen. In this trough I will pour a clear solution of tartaric acid, and then add also a clear solution of bicarbonate of soda. The moment they come together we shall obtain an effervescence, and the bubbles of transparent gas will be so numerous that opacity will result, and the screen, you observe, becomes quite dark. The bubbles are perfectly transparent in themselves, but owing to their number they reflect the light so frequently that it is entirely obstructed from the screen, and scattered back towards the lamp and the audience. When the bubbles clear away the light is again able to pass through. Now I want to show you an exactly similar phenomenon in the case of sound. The apparatus consists merely of a source of sound, S (Fig. 5), in the case of stunted metronome, enclosed in a padded box with a hole on one side, and a row of gas jets, C, between the sound source and the sensitive flame, F. Two conical reflectors of tin or cardboard, R R, are advantageous additions. The gas is now turned off, and the flame is loudly beating time to the strokes of the metronome. I will now light three small jets of gas, and keep their flames considerably below the lower edge of the reflectors. You see the flame instantly stops its motion, though the metronome is still going on. The reason of this is as follows:—The jets of gas produce columns of heated air, and these columns have a different refractive power to the cool air, and hence the pulses of sound, passing through the space between S and F, undergo reflection at every surface of hot air, and we have the sound so weakened by these successive reflections that very little or no effect is produced on the flame.* Thus we have exactly an analogous case to that which we had a moment ago in the effervescing liquid. So far, then, for the analogy we have traced in the general absorption of light and sound waves.

THE NEW METAL GALLIUM.

THE metal gallium, which is the latest discovery amongst the recognised elements, was first seen by M. Lecocq de Boisbaudran in the autumn of the year 1875, and so named by him in honour of the land of its discovery, France. Like its four predecessors made known within the last 20 years, gallium was discovered by the process of spectrum analysis, applied in this instance in a special manner contrived by the ingenuity of M. de Boisbaudran himself, long eminent as a spectroscopist. The spectrum of gallium is characterised by two marked violet lines, the less refrangible of them being especially brilliant. Hitherto the new metal has been recognised only in certain varieties of zinc blende, that of Pierrefitte in the Pyrenees having furnished the chief portion of gallium hitherto obtained from any source whatever—nearly half a ton of this ore having been employed by M. de Boisbaudran to furnish the dozen grains or so of metal wherewith he has been able to establish the leading properties of the element. In its appearance gallium manifests a general resemblance to lead, but is not so blue-tinted or quite so soft, though it is readily malleable, flexible, and capable of being cut with a knife. Like lead again, and unlike zinc, gallium is not an easily volatile metal. Unlike lead, however, it acquires only a very slight tarnish on exposure to moist air, and undergoes scarcely any calcination at a red heat. The specific gravity of gallium is a little under 6, that of aluminum being 2·6, that of zinc 7·1, and that of lead 11·4. A most remarkable property of gallium is its low melting point. It liquefies completely at 86° Fah., or below the heat of the hand; and, still more curiously, when once melted at this temperature, it may be cooled down even to the freezing point of water without solidifying, and may be kept unchanged in the liquid state for months. Indeed, in the original communication of its discovery to the French Academy, it was described as a new liquid metal, similar to mercury; but on touching with a fragment of solid gallium a portion of the liquid metal in this state of so-called sur-fusion it at once solidifies. Unlike lead, again, gallium is a highly crystalline metal, its form being that of a square octahedron. In its cehmical habitudes the rare element gallium shows the greatest analogy to the abundant element aluminum. In particular it forms a sort of alum not to be distinguished in its appearance from ordinary alum, but containing oxide of gallium instead of oxide of aluminum or alumina.

But the chief interest of gallium, from a scientific point of view, is connected with the history of its discovery. All previously known elements have been discovered, so to speak, accidentally, and their properties have been not in any way foreseen, but rather met with as subjects of surprise; but the blende of Pierrefitte was deliberately taken up for examination by M. Lecocq de Boisbaudran in the expectation of finding a new element. The existence of an element having the characteristic properties of gallium was, moreover, upon entirely different grounds, predicted very definitely by a Russian chemist, M. Mendelejeff, in 1871, and in a more general way several years earlier by an English chemist, Mr. Newlands. This double prediction was based on a study of the relations of the known atomic numbers of the elements. These numbers have only lately been perceived to form a tolerably continuous seriation, which, again, is associated in a remarkable manner with the seriation in properties of the elements themselves. In the series of numbers, however, certain terms are here and there missing, and in particular a number was missing which should belong to an element having properties intermediate between those of aluminum and iridium. What these properties would be was predicted in most minute detail by M. Mendelejeff in 1871. He predicted, for example, that the specific gravity of the missing metal would prove to be about 5·9. Operating on very small quantities, M. de Boisbaudran, in the first instance, found the specific gravity of gallium to be 4·7; but on repeating his determination in 1876, with special precautions and on a somewhat larger though still very small scale, he found it to be exactly 5·935, certainly a most remarkable fulfilment of the prediction with regard to it.

In a recent number of *La Nature*, M. G. Tissandier gave the following account of the extraction of a quantity of gallium by M. de Boisbaudran, accompanied by a description of some of its properties:—Without shriaking from the delicate and frequently troublesome operations necessary in

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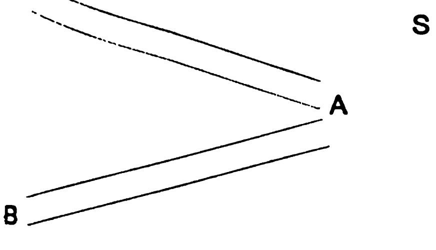
* This experiment, together with other practical applications of a sensitive flame in illustrating the reflection, refraction, and interference of sound, were first demonstrated by the lecturer in a paper he read before the Royal Dublin Society in January 3, 1868, an abstract of which was printed in the proceedings of that Society and reproduced, it may be convenient to state, in the *Chemical News* and other scientific journals. In an article on the analogy of light and sound published in the *Quarterly Journal of Science* for January, 1870, these experiments are referred to, and from that article is taken the Fig. 3, in the lecture. The beautiful experiment with the tubes, Fig. 2 (communicated to the Royal Society by Dr. Tyndall, on February 2, 1874,) is due to Mr. Cottrell, from whose note in the proceedings of the Royal Society I have pleasure in making the following extracts:—"A vibrating bell contained in a padded box was directed so as to send a sound-wave through a tin tube, BA (38in. long, 1¼in. diameter), in the direction BS, its action being rendered manifest by its causing a sensitive flame placed at S to become violently agitated (see figure). The invisible heated layer immediately above the luminous portion of an ignited coal-gas flame, issuing from an ordinary bat's-wing burner, was allowed to stream upwards across the end of the tin tube BA at A. A portion of the sound-wave issuing from the tube was reflected at the limiting surfaces of the heated layer, and a part being transmitted through it, was now only competent to agitate slightly the sensitive flame at S. The sound appeared elsewhere; reflected by the heated layer, it travelled through a second tube, AF; a sensitive flame at F becoming at once violently agitated. This agitation of the second flame, F, continued as long as the heated layer intervened; but as soon as it was withdrawn, there was no reflection of the sound, the flame at F remaning steady, while the one at S again became agitated. Exactly the same action took place when the luminous portion of a gas-flame is made the reflecting layer, but in the experiments above described the invisible layer above the flame only was used. By proper adjustment of the pressure of the gas the flame at S could be rendered so moderately sensitive to the direct sound-wave that the portion transmitted through the reflecting layer was incompetent to affect the flame. Then by the introduction and withdrawal of the bat's-wing flame, the two sensitive flames F and S could be rendered alternately quiescent and strongly agitated. An illustration is here afforded of the perfect analogy between light and sound; for if a beam of light be projected from B to S, and a plate of glass be introduced at A, in the exact position of the reflecting layer of gas, the beam will be divided, and one portion will be reflected in the direction AF and the other portion transmitted through the glass in the direction S, exactly as the sound-wave is divided into a reflected and transmitted portion by the layer of heated gas or flame."



* When we examine more closely this analogy in the case of refraction, we see that the following difference exists:—A sound-bearing wave encountering a second medium delivers up its vibration to the particles of the new medium, whereas a luminiferous wave is, in every case, propagated by the same medium; the ether, which is assumed to pervade transparent bodies, and refraction is accounted for by the relative density of the ether within such bodies. In both sound and light, however, refraction is caused by the *change in the velocity of the wave-front*. Hence, both sonorous and luminous waves, passing from one medium to another, are bent towards the perpendicular or the reverse, according as the velocity of propagation in the former is greater or less than that in the latter. Accordingly, in both sound and light a certain angle exists, called the "*limiting angle* of refraction," whose *sine* is found by dividing the less by the greater velocity. If the angle of incidence exceeds the limiting angle, the ray, either of sound or light, is "internally or *totally reflected*," and is, therefore, unable to pass out of the medium. The velocities of sound in air and water are as 1,090 to, 4,700, so that the limiting angle for these media is about 15¼°; no sound, made in the water, however loud it may be, could be heard in the air if the obliquity of the incident rays exceeded this extremely small angle, measured from the normal to the surface of the water. In the case of light, the limiting or "critical" angle for the same two media is 48½°: the ratio of the velocities of light in air and water being approximately as 4 to 3. Many beautiful illustrations of the total reflection of light might be given; the metallic lustre, which bubbles of air in water often present, is due to this cause, or a glass rod made red hot at one end will apparently glow at the distant end, the light traversing the rod by repeated internal reflection. The internal or total reflection of sound has also been established by experiments on the Lake of Geneva.

* This form of the experiment has not been published before; it is advisable to have a screen of glass on each side of the flames, as shown by the dotted line. To Dr. Tyndall is due the first arrangement for exhibiting this effect, of which the foregoing is merely a simplification.

treating a mass of blende weighing 4,300 kilogrammes, he has succeeded, in collaboration with M. E. Jungfleisch, in getting out 62 grammes of gallium. "If," say these gentlemen, "we take account of inevitable losses and of a few grains of gallium remaining in the various products of our operations, we may estimate the proportion of gallium in Bensberg blende at about one part in sixty thousand, or 16 milligrammes per kilogramme. The small proportion of matter to extract will sufficiently explain the large amount of time consumed in its extraction."

The preliminary operations were carried out at the works at Javel, belonging to M. Léon Thomas, a successful manufacturer as well as patron and student of science. The 4,300 kilogrammes of blende were concentrated in a mass weighing about 100 kilos., containing the whole of the gallium. From Javel, this mass of concentrated stuff was transported to the laboratory of M. Lecoq de Boisbaudran at Cognac, and, after further concentration, was purified and reduced to a metallic condition at the Ecole de Pharmacie, at Paris. After a long succession of attacks by acids and alternative precipitations, the metals associated with gallium, such as zinc, iron, cadmium, iridium, &c., were eliminated. The gallium in the residue of the solutions from which the other metals had been separated was got in the metallic condition by the action of the electric current.

"The deposition of metallic gallium," say Messrs. Lecoq de Boisbaudran and Jungfleisch, "is only carried out successfully under certain special conditions. The intensity of the electric current, for instance, should vary with the state of the solution, but the surface of the negative electrode should always be small, relatively to that of the positive electrode. In one of our operations, by which we got 8 grammes of gallium in twenty-four hours, forty Bunsen cells (18 centimetres high) ranged in eight parallel rows, each of five cells in tension, acted on a negative electrode, the double surface of which did not exceed 15 square centimetres, while the positive electrode had a development of about 450 square centimetres. The metal, on being thrown down cold, frequently forms long threads of crystals which take on the appearance of needles, fixed normally to the electrode by one of their extremities; some few have reached the length of 3 centimetres. Above 30° the metal runs in drops, which coalesce at the foot of the electrode." Our illustration shows the appearance presented by the crystals of gallium presented on behalf of the operators to the Academy of Sciences by M. Berthelot, in its sitting of February 18th. These crystals, which have a distinct greyish-blue metallic lustre, belong distinctly to the octahedric system, but their angles have not yet been measured, their faces being slightly rounded. They are mounted on small glass stems, and kept under a glass globe from the contact of the air.

Crystallisation was effected by introducing a platinum wire carrying a particle of solid gallium into the metal cooled to 10° or 15° C. below its melting point. After the lapse of a very short period, varying, from 3 to 10 seconds, octahedric crystals show themselves, very slightly modified at their summits by traces of their base. The crystals shown in the accompanying drawing are the full natural size. If the crystals are not promptly withdrawn as soon as formed, the metal reacquires part of its lost heat, solidification slackens, and the base enlarges.

Gallium is a hard and malleable metal; it takes under the hammer the polish of the anvil, but rapidly grows harder and brittle, and is then liable to fly to pieces. In spite of its relatively considerable hardness, gallium leaves on paper strongly defined marks of a bluish-grey colour. It retains its lustre in the atmosphere of a laboratory constantly loaded with acid vapours, and undergoes no alteration in appearance in boiled water. In aërated water it tarnishes slightly.

Gallium, which melts at 30°, may be kept superfused in a tube hermetically sealed. MM. Lecoq and Jungfleisch have prepared a certain quantity of it in this condition. It remains fluid like mercury, and when the tube is inverted it creeps along the glass like melted wax. In a liquid condition, gallium has the brilliant whiteness of tin or silver. It would be of great value for the determination of temperatures rising to 300° or 400° C., but its habit of clinging to the sides of the glass vessel in which it may be contained constitutes at present an impediment in the way of its being used for thermometric purposes. It is possible that some means may be found for correcting this tendency, and that the new metal may thus be made capable of receiving various applications in the domain of experimental science.

Gallium leaf has also been prepared by running the melted metal between heated glass surfaces. On cooling, especially if the cooling is carried out under water, the metal is easily detached from the glass. This specimen melts in the hand: it retains its characteristic dull blue metallic reflection. A small bar has also been cast, the elasticity and malleability of which are easily demonstrable.

Crystallised gallium prepared cold by electrolysis of a potassic solution decrepitates on being thrown into hot water, and gives rise to bubbles of gas. By electrolysis of a liquor heated up to 30° C., say the experimenters, we have often obtained, especially towards the end of the operation, a puffy metallic mass swelling in warm water, and having the aspect of an ammonium amalgam. Kneaded in water at 40° C., this mass contracts and is finally resolved into ordinary fluid gallium.

Some new compounds of gallium, comprising the chloride, bromide, and anhydric iodide have been presented to the Academy. Chlorine attacks gallium in the cold state very actively, with an abundant disengagement of heat. The product is faintly yellow; it would probably be perfectly colourless if pure. It is well crystallised, very fusible, easily becomes volatile, and imbibes the ordinary moisture of the atmosphere. The action of bromine is less energetic than that of chlorine. To get the iodide it must be slightly heated.

COAL CLEANSING.

At a recent meeting of the Bristol Mining School Mr. M. G. Morgans delivered a lecture on cleansing coal, with especial reference to the methods practised on the Continent. In introducing his subject the lecturer remarked that, owing to having made arrangements for the accommodation of other gentlemen whose names were down for lectures, whereby his own now came off two months earlier than expected, he had been unable to complete the prosecution of experiments in two branches of his subject—viz (1), cleansing by means of centrifugal force, and (2) by means of atmospheric air as a medium for separation, and consequently his subject would be more or less limited to cleansing by means of liquid media. He proposed to deal first with the principles affecting the separation of different minerals by combined flotation and gravitation, and next to describe, with the aid of the numerous drawings and photographs exhibited, some of the most modern plant and machinery for carrying out those principles, directing particular attention to some practical details of construction upon which depended in a great measure the successful operation of various Continental coal-washing establishments, which are greatly superior to anything at work in this country. Samples of ceal, coke, and refuse products were exhibited, as well as specimens of the raw material treated in the various cases. These were the more interesting on account of being accompanied by particulars as to analyses, yields, and working costs. After illustrating the influence of form upon the descent of equivalent weights of the same description of material, the lecturer dwelt upon the importance of sizing coal, and described the best machinery for the purpose, special reference being made to "trommel," in which the various sizes of coal were discharged with the least possible travel and breakage. Of the various cases referred to, one related to an establishment where a quantity of 550 tons of coal is treated per ten-hour shift, in which the ash admixture was reduced from 18 to 3 per cent. at a working cost of 1·4d. per ton of mineral treated. The lecturer gave a very practical description of machines specially constructed for washing coal dust and slimes, which, until of late, have been discarded. In one case accumulated slimes from earlier washing operations containing 25 per cent. of ash are being successfully cleansed, so as to yield a useful product containing only from 4 to 5 per cent. of ash. A very good coke made from this product was exhibited. Great strides have been made in the successful use of the same water over and over again in coal washing. This is often important where, from the danger of river pollution, it is desirable to prevent the discharge of water holding mineral particles in suspension. In some cases referred to the escape of effluent water is entirely avoided, and the washed coal is so thoroughly drained of water that the quantity necessary to be added to compensate for loss in this direction (which is the only waste of water incurred) is surprisingly small. Time prevented the lecturer from dealing with the subject of freeing water from minerals in suspension without the aid of settling tanks. The lecture was concluded by reference to the subject of crushing coal and its effect upon the quality of coke as seen in various samples exhibited.

FRICTION OF JOURNALS.[*]

There is a great deal said about journal-friction, but in nine cases out of ten it is alluded to as *rolling* fricton, whereas it is nothing of the kind. The friction of a crank-shaft journal revolving in its box is as truly sliding-friction as is that of the cross-head brasses on the guide-bars, the only difference being that in the one case it is continuous and in the other it is reciprocatory. But the two cases are parallel with those of a sash saw and a circular, and are also similar to the saws in that they actually have a cutting action—lessened, quite happily, by the small amount of feed possible; that "feed" being obtainable by the wear of the bearing, causing the centre line of the journal to move towards the kerf line. Inasmuch, however, as the journal generally has a length much greater than its diameter, and hence does not cut a "kerf," we might perhaps compare it more accurately to a milling cutter which is working out a strip of metal narrower than the length of the cutter. The finest surface on a hard steel bearing appears, under the microscepe, to be pitted with depressions—not indeed arranged in serried lines as in a milling cutter, nor even having "pitch" so as to cut equally well when running in either direction, but still capable of exciting a cutting action in metal softer than themselves.

Now if we were to take a circular saw or a milling tool, and fill up the space between the teeth with lead or other material—even resin—we should diminish the useful cutting effect of the rotary body as a tool. If there were a strong feed, it might be made to cut a little; at any rate, if the teeth were of such an acute pitch and rake as to be greedy—that is, to force themselves into the work. But if we take our rotating journal—the "teeth" of which have inappreciable "rake" and "pitch" both ways—clogging up the tooth spaces with a soft, solid material completely neutralises the cutting action, and brings the friction down to a minimum. The friction between a journal and a bearing in which the asperities of surface have been thus filled up, is naturally much less than where the particles of the surfaces are interlocking and cutting or tearing.

If we put a film of oil between such rubbing surfaces, we diminish friction by keeping the roughnesses apart—that is, when they are of a size not greater than half the thickness of the oil-film. The friction in such case approximates that between metal and oil. But such mode of lubrication has this marked disadvantage, that great pressure between the rubbing surfaces squeezes out the film until it becomes thinner than double the height of the surface roughnesses, and the lubrication is then of no avail. If the lubricating fluid be made less fluid, to avoid such pressing out, it is apt to be less frictionless; and in any case, when fluid lubricant is used there is the disadvantage of constant renewal being required. It is not generally practicable to catch and re-use the oil that (literally) has "been through the mill," as it is apt to hold in suspension minute metallic particles which act as grinding material the second time they go between the rubbing surfaces. Now it is not yet practicable to employ "anti-friction wheels," substituting true rolling friction for rotary sliding friction, under railroad axles, car spindles, planer heads, fan-blower shafts, and the like. We can, however, largely mitigate the evil of friction by employing a lubricant that cannot be squeezed out, as graphite, or by using an "anti-friction bearing" which shall fill the minute depressions in the journal up to their tops, and shall gradually wear smoother and smoother, not holding grit, and acting as "laps" in grinding away the harder surfaces. Among the advantages resulting from having dry bearings, running coolly and smoothly, or saving in power and in time, increase in capacity of machine, quiet, freedom from dirt and grease, saving of bills for lubricating material, freedom from loss from stoppages, &c.

ROUND v. SQUARE.[*]

When any mechanical end is to be accomplished, the more simple the means employed, the greater the ingenuity which devised them. Our tools now-a-days are tools of precision, and much of their completeness lies in the simple substitution of round in place of square forms in their details, the lathe and its modifications producing the several parts with almost mathematical precision, combined with the least possible amount of labour.

The machine which has drawn out these remarks is the common foot lathe. Upwards of thirty years ago, when I first learned to handle a turning tool, the lathe was almost a combination of square parts. The mandrel had been forged out of a bar of square iron,[†] with a steel collar and a steel tip for centre welded on, the pulley having a square centre hole, and wedged true up, and a square hole in nose of mandrel for square shanked centre or drill; the back centre also was of square section, and fitting a square hole. The shifting poppit head had a square bar, with a square hole to carry square-stemmed centres, and the crank shaft was made out of a square bar, with good forged square corners at the cranks, and wedging into a square hole in fly-wheel. From this style of thing we have been gradually drifting to a better form, better from the simplicity by which true results are obtained. Yet it seems we are still in the transition state. We still, in the ornamenaal lathe, cling to square-stemmed tools and tool-holders, while there is more perfect adjustability to be obtained from the round form, even to the saving of having to heat and alter cutting angles; this was brought forcibly home to me, in fitting an eccentric cutting frame stem to the well or tool receptacle of an ornamental slide rest. Before it was half done I was asking myself why was this receptacle not made to take in a round stem? Independently of the advantages of adjustability, how easy and simple would it have been in this case to have turned all up true to the hole inside; it could have been done in a tenth part of the time.

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[*] From the *Polytechnic Review.*

[*] From the *Journal of the Amateur Mechanical Society.*

[†] Workmen then pinned their faith to the square form, as I can remember asking the tool man why he did not forge some taps he was making, out of round steel; his reply being that the forging in of the square corners made the heart of the tap solid.

To many amateurs it will be a matter of indifference what form the stem may be, seeing they don't made their own tools—though their pockets must feel—while to that class who, like myself, like to make their own appliances, a simplifying of any part is a gain, and the increased accuracy resulting from the alterations in the form in this case would be a great gain.

Has the square stem any advantages besides the increased price to the maker? May I be bold enough to ask our worthy master, "G. C .C.," to say why we should prefer the square stem to the round one? J. G.

NICKEL PLATING.*

THE plant necessary to commence nickel plating consists of a battery, preferably of the Smee type, with carbon negative; a well-bolted oblong wooden tank, of a size to suit the articles to be plated, coated on the inside with good asphalte, and nearly filled with the nickel solution; nickel plates for anodes, and brass rods to suspend the plates and work in the bath; suitable vessels for an alkali, an acid, and soft water for cleaning the work before placing it in the nickel bath; polishing and buffing lathes, rouge, crocus, &c. The bath may be composed either of the chloride of nickel and ammonia or the corresponding sulphate, dissolved in pure water. If the latter is used, the solution must be kept neutral and up to about 6° of hydrometer. It is prepared by dissolving ¾lb. of the salt in each gallon of water. This salt is generally considered the best for nickel plating, and costs only 1 30dols. per pound. From this bath the nickel can be profitably deposited at 2dols a pound. The chloride bath requires about four ounces of the salt per gallon, and works better with a slight acid reaction, the tendency in working being towards alkalinity, even with great exposure of anode. The intensity of battery current must be proportioned to the bath, and remain constant. Large baths offer less resistance to the electric current than those of smaller dimensions, and can therefore be worked with a current of somewhat less tension. For a bath of 10 gallons or less, the tension of the current should be equal to that of from 2 to 3 Smee cells (carbon and zinc) in series. The exposed surface of the nickel anodes should in no case be less than the surface to be coated, but may with advantage be greater. The amount of battery power for a given amount of work should be in zinc surface equal to the surface to be coated, with care to preserve the normal tension of the current. If the current is too intense the coating will present a dull white or frosted appearance. The anodes must be in connection with the negative plate (carbon) of the battery. Damage is not unfrequently done to the bath and work by misconnection. The work should be scrupulously clean when entered to the bath, and should be carefully moved about after entering to free it from any adhering air bubbles. If the finished work is to have a smooth polishing surface it must present such a surface before entering the bath. Nickel is hard and cannot well be burnished. Traces of oil and grease are removed by a hot soda solution. After dipping in clean water the surface is freed from films of oxide by an acid bath. If the work is of iron the acid may be hydrochloric diluted with three or four volumes of water; if of copper or brass, of nitric acid diluted with about twenty parts of water. Brighten the work in the acid dip, then immerse momentarily in water; go over it with a clean stiff brush and very fine sand; again dip in the acid, then quickly in soft water, and place immediately in circuit. The hand must not come in contact with the surface of the work after removal from the alkali, as the slighest touch may spoil all. On removal of the work from the plating bath it should be immediately dipped in cold water and transferred to hot water, which will cause it, when taken out, to dry quickly and perfectly. The bath should be covered when not in use, to keep out dust and prevent as much as possible its evaporation.

By a little practice and proper attention to these simple rules the nickel bath may be worked continuously, month after month, and the metal deposited smoothly and with certainty. Magneto-electric machines, such as those of Gramm and Weston, are now gradually replacing galvanic batteries in large electro-plating establishments.

Peter Cooper, of New York, who has just entered his eighty-eighth year, is worth £2,000,000. He began life as a coachmaker's apprentice; but, having invented a superior kind of glue, he rapidly made an immense fortune.

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* From the *Scientific American.*

SCIENTIFIC NEWS.

THE death is announced of the Rev. James Booth, LL.D., F.R.S., vicar of Stone. The deceased was known as an accomplished mathematician, and was elected to the Royal Society in 1846, in recognition of his work, "A New Method of Tangential Co-ordinates," and as the inventor of a new system of parabolic trigonometry. He was also the founder of the modern system of competitive examinations, which he first advocated in 1846, and put into practice ten years afterwards when chairman of the Society of Arts. In 1859 he was presented by the Royal Astronomical Society to the living of Stone, Buckinghamshire. He died on the 15th inst., aged 71.

Messrs. Ismay, Imrie, and Co., the owners of the White Star line of Atlantic liners, have announced their intention to convey properly qualified observers of the forthcoming eclipse of the sun to New York and back for the sum of £20—less than the single first-class fare. As the Pennsylvania Railway Company will carry European observers from any of the ports of arrival to Denver and back for £14, the cost of the whole trip, so far as conveyance is concerned, will be only £34.

The Council of University College have determined to establish, at a cost of £23,000, an engineering laboratory, to be placed under the directorship of Prof. Kennedy.

Edison's carbon telephone has been eclipsing the performances of its rivals by carrying spoken messages from New York to Philadelphia in perfectly clear and distinct tones. The new telephone derives its name from a small circular cake of carbon fixed in the mouthpiece between two metallic plates, to which the positive and negative poles of a small battery are respectively connected. Complete details of the apparatus have not yet been published, but it appears to have answered remarkably well at the first practical trial.

At a meeting of the Royal Society of Edinburgh, last week, Sir W. Thomson read a second paper on "Beats of Imperfect Harmonies"—a consideration of the dynamics of the subject of Helmholtz's theory of the beats of harmony; Prof. M'Kendrick read a paper on "The Theory of Vowel Sounds," which experiments with the telephone have done much to qualify; and Prof. Forbes described some apparatus with which he hopes to be able to detect the presence in dangerous quantities of fire-damp in mines. The mechanism from which he expects the best results consists of a tuning fork and a resonant tube.

Prof. R. Weber has been investigating the causes of mill fires, with especial reference to dust explosions, and the Verein für Gewerbefleiss of Berlin has awarded him a prize. He confirms the conclusions of Mr. Galloway as to some explosions in coal mines being occasioned by the firing of clouds of coal-dust, and states that all kinds of flour, when in the shape of dust clouds, are inflammable.

According to the *Gardeners' Chronicle* the wood of the Shola (Æschynomene aspera) is useful for lining the bearings of delicate machinery. It is better than cork, being softer and less gritty, and is useful to close a joint or to prevent friction.

M. van der Hurst, of Utrecht, has found in the lobes of the germinating seed of the kidney bean (Phaseolus vulgaris) a ferment which can be extracted by means of glycerine, and which is capable of transforming albuminous matter into peptones, and starch into glucose.

The German Geographical Society celebrates its 50th anniversary at the close of the month. There will be a festival meeting on the 30th inst., and a banquet on May 1, to which the principal geographical societies of Europe have been invited to send representatives. Baron F. von Richthofen is the president.

The Dutch Arctic expedition is being rapidly prepared. Instead of a couple of powerful vessels, the Dutch will send out only a small schooner of 80 tons, built of oak protected by pitch pine, and coated fore and aft with iron plates. The Willem Barendsz has no hold proper, but is fitted up for the comfort of her passengers. Lieut. De Bruyne is the commander, with two sub-lieutenants of the Dutch navy, two pilots, two experienced herring-fishery men, and a mate as his officers; a naturalist will be on board, and Mr. Grant, an English gentleman, will join the expedition as photographer.

A new method of heating tramcars has been tried in New York, with the view of applying it to the Elevated Railway carriages. On each side of the cars, under the seats, steam pipes 1¼in. in diameter are placed, and are inclosed by galvanised-iron tubes 5in. in diameter, the intervening space being filled with lead. The steam pipes are connected with the boiler of the locomotive, and steam is passed through them while the train is stopping at the stations. It is found that the heat taken up by the sand is slowly radiated, and is sufficient to warm the carriages.

A new repeating carbine has been invented by Captain Valmisberg, of the Austrian army. The mechanism is said to work with wonderful precision, and can be adapted to any of the usual types of barrel. The cartridges are contained in a chamber holding nine, which are successively pushed into the barrel by a slight motion of the finger. The whole charge—that is, the nine cartridges—can be fired in 18 seconds, and the chamber can be re-filled in 9 seconds.

The death is announced of Mr. H. Disston, the maker of the well-known American saws. Mr. Disston was born at Tewkesbury, in 1819, and at the age of 13 accompanied his father to the United States. Having served his time to a saw-maker, he commenced business for himself, and by dint of hard work and technical knowledge he succeeded in building up the gigantic establishment whose productions are known throughout the civilised world.

The Phonograph has been exhibited at the Crystal Palace, and the newspapers give descriptions of its performances. In most of the reports it is said that the action of the machine "is reversed" to reproduce the speech. Of course, the action is exactly the same as when the indentations in the foil were made by the vibrations of the point connected to the diaphragm spoken against. It is only when a different diaphragm is used to reproduce the sounds that any change in the motion is required, and it is obvious that the reproducing point must traverse the foil in exactly the same way and at the same speed as the point of the transmitting instrument.

The dangerous properties of carbonic oxide have long been known. An atmosphere which contains only a little of this gas may produce poisoning and death. Some exact experiments on this subject have lately been described to the French Academy by M. Grehant. He concludes that a man or one of the lower animals compelled to breathe for half an hour in an atmosphere containing only $\frac{1}{770}$ of carbonic oxide absorbs the gas in such quantity that about one-half of the red blood corpuscles combines with the gas and become incapable of absorbing oxygen; in an atmosphere containing $\frac{1}{1450}$ of carbonic oxide, about a fourth of the red corpuscles combine with this gas. These are important results both for physiology and hygiene.

A series of interesting experiments on the comparative durability of iron and steel rails has lately been carried out on the Cologne-Minden Railway. (The chief results are given in *Annales Industrielles*, April 7.) In 1864 a number of rails of different manufacture were laid near the station of Oberthausen, on the most severely worked portion of the line. It is shown that the passage of 1,340,000 axles was necessary to wear the Bessemer rails 1 millimetre. Replacement of rails took place from time to time till 1874, to an extent which is shown in a table. Of the 1935 rails replaced, 1204 were broken in full section, 227 in a section at a fish-plate hole, and 504 were rendered useless through various causes. Since 1874 the number of rails requiring replacement has been constantly diminishing instead of increasing as previously. This is because most of the deteriorated rails have been such, not through lack of strength, but through some fault of manufacture, which became apparent only after some months of service. Lastly, while in 1870 it was necessary to renovate 7·75 of the total length, in 1877 the proportion is only 1·13, testifying to the advantage of steel over iron rails.

At the works of the Cockerill Company, in Seraing, two rails of 50 metres length have lately been rolled for the Paris Exhibition; before cutting down they were 53 m. At the Philadelphia Exhibition, in 1876, rails of 43m. length were exhibited.

In a communication to the Berlin Academy, Prof. Buff, of Giessen, describes the effect of lightning on a lightning conductor, which he had carefully tested. Prof. Riess said the result fully confirmed his opinion that the resistance of a conductor to lightning is very much less than its galvanic resistance. The earth connection of Prof. Buff's conductor offered to the current of a carbon-zinc battery a resistance 200 times greater than that of the lightning rod. Had its resistance to lightning been even distinctly comparable to this large resistance to a weak electric current the lightning would no doubt have passed from the iron conductor-rod through the copper branch wire to the gas tubes only two decimetres off. It went, however, without doing any injury, through the conductor into the moist ground.

We learn from *Les Mondes* that M. Weber, of Hummel-Radeck, in Prussia, has invented a useful machine, of simple construction, for levelling roads. It requires only two horses and two attendants, and it can accomplish in a short time work which has hitherto required 50 or 60 men. It can work as well on stones as on bare ground.

Rope lines, it is known, have come largely into use in these times for horizontal transmission. The invention is an old one, and is proved to have been in operation in Germany as early as the fourteenth century. From a drawing reproduced in the *D. Allg. Pol. Zeitung*, it appears that in Japan, too, the system has been known for centuries. This drawing represents two steep rocks (on either side of an arm of the sea), one a little higher than the other, connected by ropes, along which are slung baskets containing persons or goods.

The use of steam-engines in Prussia has rapidly increased of late years. Whereas in 1861 the united force of all the engines was equivalent to 167,193 horse-power, the force amounted in 1875 to 685,559 horse-power. Locomotives are not included in these figures.

One of the most curious recent applications of photography is its possible adaptation to the discovery of disease. Vogel mentions a case where the face of a sitter appeared in the portrait covered with spots, although none were visible on the skin. On the day following that on which the picture was taken, an eruption did appear, and the person afterwards died of varioloid. The feeble yellow of the incipient pustules had evidently affected the sensitised surface, and the disease had shown itself to the camera before it had been recognised by the doctors.

A fanciful genius has suggested to the *Scientific American* that it is now time to celebrate the completion of the first cubic mile of humanity, and gives a calculation to show that the bodies of all mankind, from the first Adam down to the present, if closely packed without diminution of volume, would exactly fill that space! The aggregate weight of all mankind to date is estimated at 4,212 million tons.

A new multiplex telegraph apparatus, differing considerably from that of Meyer, has recently been constructed by M. Granfeld, Commissioner of Telegraphs in Vienna. He calls it the "Hughes Perfecter"—Hughes' apparatus being employed in the system. M. Meyer says the perfects can be arranged for 4, 5, 6, on to 8-fold work. (An exact description is in preparation.) The apparatus is now at work between Vienna and Prague, and is said to have far excelled Meyer's multiplex—it gives more correct writing and better synchronism. The latest performances of the perfecter, with 106 to 107 rotations per minute, gave an average of 30 telegrams per keyboard an hour, while the average of Meyer's instrument was 21 telegrams; the maximum performances were 35 and 27·8 respectively.

LETTERS TO THE EDITOR

◆

[We do not hold ourselves responsible for the opinions of our correspondents. The Editor respectfully requests that all communications should be drawn up as briefly as possible.]

All communications should be addressed to the Editor of the English Mechanic, 31, *Tavistock-street, Covent-garden,* W.C.

All Cheques and Post-office Orders to be made Payable to J. Pasmore Edwards.

*** *In order to facilitate reference, Correspondents, when speaking of any Letter previously inserted, will oblige by mentioning the number of the Letter, as well as the page on which it appears.*

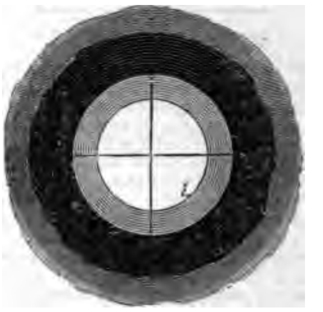
"I would have everyone write what he knows, and as much as he knows, but no more; and that not in this only, but in all other subjects: For such a person may have some particular knowledge and experience of the nature of such a person or such a fountain, that as to other things, knows no more than what everybody does, and yet, to keep a clutter with this little pittance of his, will undertake to write the whole body of physicks: a vice from whence great inconveniences derive their original." —*Montaigne's Essays.*

◆

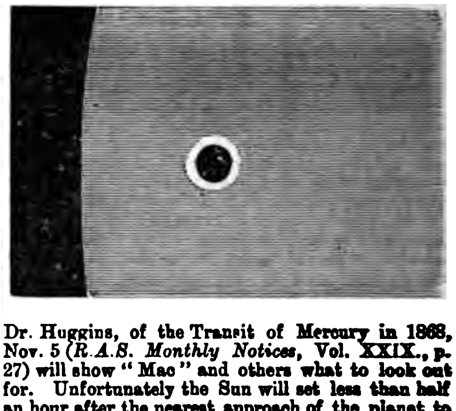
STELLAR PHOTOMETRY AND THE HARVARD OBSERVATORY — THE APPROACHING TRANSIT OF MERCURY—THE METEOR OF APRIL 2nd—γ LEONIS—THE ANTIQUITY OF MAN—THROWING COLD WATER ON SUN-SPOTTERY—PHOTOGRAPHY OF THE RED END OF THE SPECTRUM—THE BRITISH WORKMAN—THE MODERN JAPANESE AND THE ANCIENT EGYPTIANS—OBSERVATORY SITUATIONS: RATHER OUT OF PLACE.

[14245.]—Having (in common with several of my brother correspondents) had occasion more than once to deplore in these columns the present equivocal condition of Stellar Photometry, it is with no small satisfaction that I find in how philosophical a spirit that subject has been taken up by Professor Pickering, the able and energetic Head of the Harvard College Observatory in the United States. From the Annual Report of that Observatory, presented to the Visiting Committee on the 26th of last November, I learn that the Great Equatoreal of 15in. in aperture has been practically given up to the Photometry of various Celestial objects; and the ingenuity and originality of the methods adopted to secure strictly accurate measurable and comparable results are very striking. In addition to the determination of the relative magnitudes of various double stars, a most elaborate series of comparisons of the brightness of the two newly-discovered satellites of Mars was made after their detection by Professor Hall. The precautions taken to secure an equality of illumination in the two fields, in one of which Mars was, by a special arrangement, reduced to precisely the same brightness as the satellite under comparison, leave nothing to be desired. The comparison of the satellites themselves, inter se, was effected by another method; but one of equal ingenuity and simplicity. It is a noteworthy fact, discovered during the making of these determinations, that the outer satellite does not partake of the red colour of the planet itself. The relative brightness of Jupiter's satellites has also been measured, and, what will be a great boon to observers of variable stars, and of small stars generally, the eye estimations of the magnitudes of the more minute stars (to which we have now mainly to trust) will at no distant date be replaced by rigidly accurate measurements. I have referred chiefly to the subject of stellar photometry in connection with this Report of the Harvard Observatory as being one of the chief interest to amateur astronomers generally; but I may add that the entire work of the Observatory—undermanned and underpaid as it is—seems to be of the highest character, and to involve an amount of labour unsurpassed, so far as I know, upon either side of the Atlantic. A single example may suffice to justify this assertion; and it will be needless to say more than that, since the 8in. Meridian Circle was mounted in 1870, no less than 40,600 separate observations have been made with it.

I am very glad to respond to the request preferred by "Mac" (in letter 14195, p. 117), and certainly do not "grudge the trouble of writing," because I am perfectly sure that, were I to require information on any point on which it was in the power of "Mac" to supply it, he (in common with scores of my brother readers) would willingly furnish what I was in quest of. In the outset, then, I do not know whether my querist is the possessor of an equatoreal or not; but presuming him to be so, and that it is furnished with a micrometer, the first thing to do will be to determine the point of the Sun's limb at which ingress will take place, so as to know precisely where to look for the first indentation of the Sun's limb caused by the entry of the planet. We will assume that the micrometer is in adjustment—that is to say, that the Verniers read 360° and 180°, and that a star continues to be threaded upon one of the movable wires during its passage across the field. Turning, now, to p. 402 of the *Nautical Almanac* we find that the angle of contact at ingress is 45° from N. towards E.—*i.e.*, in the direction in which the position angle of double stars is always measured. We have then only to make the Micrometer Verniers read 45° and 225°, and the fixed wire bisecting the sun diametrically will pass through the point of first contact; or, perhaps more simply, either of the moveable wires may be made a tangent to the N E. portion of the Sun's limb, and the actual point at which it touches will be that of the ingress of Mercury. It may be, though, that your correspondent's instrument is simply mounted on an altazimuth stand, and that it is furnished with nothing beyond three or four Huyghenian eyepieces. In this case he had better stretch two spider threads accurately at right angles across the diaphragm in the focus of the eyeglass, in an eyepiece magnifying not more than 70 times (so as to take in the whole disc of the Sun). The field may then be represented thus—



As the time of ingress approaches, the whole eyepiece must be rotated until the horizontal wire touches the north or south point of the Sun's limb during its entire transit through the field. This adjustment being effected, and leaving it undisturbed, the telescope must be shifted until the wires cross in the centre of the Sun's disc, as shown in the figure, and then the ingress of the planet will take place at *i*, 45° from the north (or bottom) point of the Sun's limb, towards the right. The aperture of the telescope should be cut down to 2in. by means of a diaphragm, and a very deep blue or green (or preferably to either, "London smoke"-coloured) eye-shade be screwed on to the eyepiece. These arrangements being made, the instant at which the first indentation of the Sun's limb becomes apparent should be carefully noted, and at (and in fact before) this time especial attention should be directed to ascertain whether the body of Mercury itself is visible *outside of the Sun's limb*; and, if so, the precise appearance presented. This must be watched for until the planet is fairly on to the Sun. Then, as the planet advances, the formation of the "black drop" or ligament (concerning which, in connection with the Transit of Venus, there has been so much discussion) should be carefully looked for. With reference to this phenomenon, I may caution inexperienced observers that they are more likely to see it if they employ eye-shades of too light a tint—undue glare materially assisting it. Well, having got Mercury fairly on to the Sun, and watched for the rupture of the ligament, if any, the careful attention of the observer should be devoted to ascertaining whether anything in the shape of an aureola surrounds the planet, and also whether a very minute brilliant spot appears anywhere upon its black disc. The annexed figure, copied from a drawing by Dr. Huggins, of the Transit of Mercury in 1868, Nov. 5 (*R.A.S. Monthly Notices*, Vol. XXIX., p. 27) will show "Mac" and others what to look out for. Unfortunately the Sun will set less than half an hour after the nearest approach of the planet to its centre, so that there will be but little more of interest to watch for. One caution I would give to all who may be able to observe the coming transit, and that is, whatever you record or draw *do it on the spot*, with your eye at the telescope. Never trust to memory in such cases as this. Mental notes of phenomena are singularly unlike port wine, in the respect that they by no means improve by keeping.



It is needless to add that every one possessing an equatoreal, with a micrometer and a sidereal clock or chronometer, should make measures of the exact position of the planet from time to time on the Sun's disc, and that a high power will be advantageous in such a case, since means will exist of accurately determining the point of the Sun's limb at which ingress will take place.

As I did not see the *Times* of the 4th instant I, of course, know nothing as to the locality whence the Meteor, described in letter 14197 (p. 117), appeared to have "remained stationary between Orion's belt and Sirius." I am, moreover, equally ignorant of Mr. Mawe-Smith's position; but, assuming it to be separated by any considerable interval from that of the *Times* correspondent, it is tolerably obvious that parallax might displace a meteor which was near the earth to almost any extent upon the face of the celestial vault, and that therefore such an object might very well appear near Cassiopeia to one observer, and between Orion and Sirius to another.

"Argus" (query 32612, p. 127) is certainly right about γ Leonis being a closer double star than Castor. The components of the latter star are about 5·7" apart; while those of γ Leonis are only separated by an interval of ± 3". I do not possess Slugg's "Observational Astronomy," but 4in. seems a funny distance for the components of Castor.

"Iscatel" (query 32654, p. 128) should get that fascinating book, Geikie's "Great Ice Age," of which a review appears on p. 421 of your XIXth Volume; Croll's Climate and Time in their Geological Relations," or Sir Charles Lyell's "Antiquity of Man." Any or all of these books will furnish him with approximate chronological data concerning the existence of Man upon Earth.

The stars in their courses seem to be fighting against Sisera, and the (I believe) unprecedented rainfall of nearly 3in. in 22 hours, measured at the Royal Observatory on the 10th instant (at a time when no trace or vestige of a spot has appeared upon the Sun for very many weeks) would almost appear to have descended in rebuke of the ignorance or presumption displayed by Dr. Lyon Playfair in his speech during the recent Indian debate. In connection with this subject, by the way, there was an admirable paper read before the Royal Institution, by Sir R. Strachey, on the 18th of last May, which may be read in their *Journal*, and which is eminently worthy of perusal.

In connection with the attempt of Messrs. Christie, Brett, and Co. to oust Mr. Ranyard from the secretaryship of the Royal Astronomical Society, and to replace him by Captain Abney, I had occasion to criticise, pretty sharply, the claims of the gentleman last named to displace our present admirable senior secretary. It is with the more pleasure, therefore, that I express my appreciation of the very great value and importance of Captain Abney's recent most remarkable researches and success in the photography of the least refrangible end of the Spectrum, of which a condensed account appears on p. 135. Of the worth and originality of this work there cannot be two opinions; and I certainly bear my own ungrudging testimony to the very great advance which has thus been made in spectral photography, and to the great future which it appears to open.

Premising that the object which I had in view in penning the eighth paragraph in letter 14134 would appear to have been somewhat misunderstood, I will notice, very briefly indeed, the criticisms upon my remarks which appear upon p. 142. In the outset then, I do hope that "Sigma" (letter 14229) does not attribute to me, personally, the hopeless fallacy of the supposition "that there exists some right in those who claim to be the *upper* classes to acquire, on their own terms, services from those they consider the lower classes." Merely as an elementary fact in Sociology, every contract must be a mutual one; and every man has a distinct right to appraise his labour (or whatever else he has to sell) in accordance with his own conviction or interest. At the same time, though, I deny his right to dictate to any other man the wages which he is to demand, or to interfere, in any shape or way, with any one who may be contented to accept lower remuneration than that fixed by a Trade Union or other association. Admitting, however, to the full, the right of the individual to make the very best bargain he can, I think that the person with whom such bargain is made has an equal right to claim that the work shall be fairly well done within a reasonable time; and that he shall not be called upon to pay exorbitantly for perfunctory labour, or absolute idleness. Why, what should we say to a Clergyman with a large living—and a Canonry, perhaps to boot—who declined to have more than one service of a Sunday, and who never visited in his parish at all? Or what, I wonder, would be thought of an officer who, being in orders for Guard, were to exclaim, "Oh, I was up after Mess until half-past two this morning, and I must lie in bed and have my sleep out?" I say that any one, be he peer or be he peasant, who accepts money in return for services to be rendered, is morally (and in a large proportion of cases legally) bound to execute the work for which he is paid—well and punctually; and, whether "Leidhold" (letter 14231) likes it or not, I must reiterate my belief that the man who deliberately built a great iron pipe into the substance of a stone wall was a rascal. The mention of "Leidhold," by the way, suggests to me to say that that gentleman does me (doubtless unintentionally) grievous wrong in asserting that I acknowledged that I "only cared for noticing working men at all so long as I required their labour." Certainly he may search my letters through and through without finding a single sentence to justify any such statement; and, equally certainly, it is wholly without foundation. All I did say was, that I was not an employer of labour, in the sense of carrying on any trade or business. I should no more expect an absolutely impartial opinion from a Master Builder than I should from a Journeyman Mason; although the superior Education of the former would probably give more weight to such opinion than in the case of the latter. It was because my personal (by which I mean pecuniary) interest in the question was somewhat remote that I claimed to be a tolerably impartial judge. I should never have written a line on the subject, but for the vehement denial of the facts advanced by Sir Edmund Beckett. So far from my being indifferent to the working man, it may probably astonish "Leidhold" to learn that I have always taken a lively interest in his welfare; that I am consulted by him on a variety of points, social and legal*; that there is no cottage within a radius of a mile and a quarter from the spot whence I am writing this, within the walls of which my wife is not to be found if the family are in trouble or distress, and that, in my very small way, I have possibly done in my time quite as much for the British Workman as even "Leidhold" himself. If I cared less for him I might well sit silent, while he is using his best endeavours to drive trade out of the country; and to encourage the importation of German masons, Swedish carpentry, and Belgian locomotives. The fact is that the whole question is tersely summed up by "Sigma" in his peroration, where he says "the working classes are, no doubt, endeavouring to exercise their just right to claim a larger share of the fruits of their labour. *Whether they are doing so wisely or not is another and wider question.*" It is indeed; and it is just because I sincerely believe that the Organs of Labour are luring the workman on to ultimate ruin by representing him as the very salt of the Earth, and by proclaiming that Capital exists merely for his behoof, that I have offered this short explanation of the motives which actuated me in writing my original letter. Otherwise I should have been content to rest under the covert imputations contained in the letters of "Old Ploughman" and "Leidhold," that I am a mere bloated Aristocrat who regard my social inferiors as having been solely created for my personal behoof, and to minister to my ease and enjoyment.

Reply 31875 (p. 145) reads almost like a paraphrase of secs. 35 and 36 of the "Euterpe" of Herodotus.

In answer to query 32714 (p. 151) "M." must have a curious idea of the nature of the employment of the staff of the Royal Observatory, if he imagines that any single member of it could or would ever have been appointed who did not possess a thorough knowledge of arithmetic; to say nothing of mathematics generally. There is moreover, I believe, no vacancy at Greenwich now. The only Government situations for which "M." is apparently qualified are that of a "Boy Writer," for which post there are frequent (I think weekly) examinations in London, the fee being 2s. 6d. The pay is 4d. to 6d. an hour, or that of a Post Telegraph boy or newspaper sorter; the telegraph boys getting 6s. a week, and the newspaper sorters 9s. These, however, are scarcely "science branches."

A Fellow of the Royal Astronomical Society.

DOUBLE STAR NEAR CASTOR.

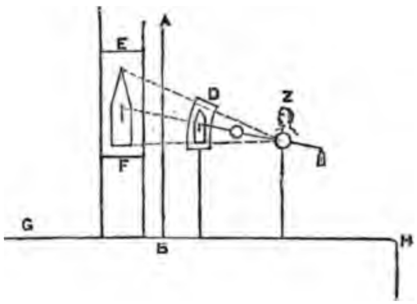
To M. Gaudibert and Others.

[14246.]—I do not recollect having paid much attention to O Σ. 175, and am pretty certain that I never divided it. The weather has here been very unfavourable, except on April 4, when I had a very fine view of ζ Cancri, and would have looked at the other had I thought of it. Can any one oblige me with a recent measure of ζ Cancri.

T. W. Webb.

ZOE.

[14247.]—I cannot allow the explanation of "W. C. P." (14213, p. 121), to pass without a few remarks. He starts upon the hypothesis that the figure is in some way connected with the floor by means of rods. Now to any one who like myself has been upon the stage and inspected the figures, and can believe the evidence of his senses, this is simply absurd. The cleverness of the whole thing (and this applies also to Psycho) rests upon the absolute certainty to an intelligent observer that no tangible or visible connection exists between the figure and the floor, and I can only suppose that "W. C. P." has seen them from the back of the hall or from the gallery, and cannot have been upon the stage.



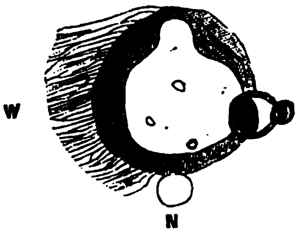
Z. Zoe. D. Drawing paper, A B. Screen. E F. Board with copy of sketch, over which magnet is moved. G. H. Stage.

I am convinced of two points—viz., that the operator is behind the screen at the back of the stage, and that the force applied is electricity or magnetism, the sketch being drawn upon a larger scale by a magnet, and the pencil held by Zoe follows the movements of this magnet (like the point of a compass) behind the screen, and I feel confident that the drawing could not be produced if the paper were turned towards the spectators. The only difficulty in the way of this theory is whether a sufficiently strong battery or magnet can be made to move the hand at the necessary distance. **H. H.**

THE LUNAR CRATER THEBIT.

To "F.R.A.S." or Mr. Birt.

[14248.]—On Thursday last, April 11d. 8h., I turned my instrument on the triple crater, Thebit. I had on one or two previous occasions looked unsuccessfully for the smallest of the three craters, but on this evening it was beautifully distinct. I picked it up easily, and I feel almost certain that I detected the central cone which it is said to contain. If so, it is not centrally placed, but situated close to the wall of the small crater, where it abuts on the middle one, or crater number two. That part of the small crater was filled with dark shadow, in which a bright speck of light appeared, as shown in the sketch. I assumed this to be light reflected from the summit of the central cone, and shall be glad if "F.R.A.S." or Mr. Birt will kindly inform me whether my surmise is correct or not. I do not know in what part of the crater the cone is situated; but, if in the position indicated by the bright point of light in sketch, there is no doubt I saw it.



The sketch I send was roughly taken at the instrument, and having no map with which to compare it, I should consider it a great favour to be informed whether the other features figured by me are correctly placed. On the floor of Thebit I noticed three objects, the lower one being a small craterlet, close to the end wall, particularly sharp and distinct; the other two were apparently prominences, the lower one being well marked; but the upper one was not so clearly defined. The western wall of Thebit was crossed by three dark shadows, and on the S.E. wall was a long ridge, extending nearly to the point where crater number two breaks into Thebit. A short distance outside the S.E. wall of Thebit I observed another small crater, exceedingly well defined, deeply filled with shadow; also, a little below the N. wall, I noticed a white patch, perfectly circular in shape, but am unable to conjecture what it was, unless it may have been a low circular prominence or hill. I feel a diffidence in submitting this letter to you, but shall fully appreciate any remarks from "F.R.A.S." or Mr. Birt respecting it. **E. Mawe Smith.**

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* This is no mere vain boast or empty rhetorical flourish. Less than 72 hours prior to penning these lines I had a bricklayer consulting me with reference to an unhappy domestic difference, which I am pleased to hope I have succeeded in smoothing over; and I was actually interrupted while writing them by a shoemaker, who came to ask my advice with reference to a brother of his who is deranged. Surely the fact of people in this rank of life making me their confidant in their most private matters is hardly consonant with the supposition that I regard them with the supercilious contempt, and treat them in the *de haut en bas* style, with which "Leidhold" credits me.

THE METEORS OF APRIL 2nd AND 7th.

[14249.]—Mr. E. Mawe Smith (letter 14197) seems to think that the person who wrote to the *Times* was mistaken in saying that the meteor of April 2nd "remained stationary between Orion and Sirius;" and also concludes that the meteor described in the *Times* is the same as that he himself observed. Now, though the times at which these meteors were observed nearly coincide, there are several important differences in the descriptions. Mr. E. Mawe Smith notes that the meteor which he saw had *no tail*, while that described in the *Times* disappeared behind a cloud (when it approached the horizon), *leaving a long track behind it*, I do not think that any person at all acquainted with the constellations could mistake Orion and Cassiopeia, or place Sirius among the circumpolar constellations. These meteors seem to have a common radiant point, possibly η Ursæ Majoris. This meteor (not the one described by Mr. E. Mawe Smith) was observed in the Isle of Man, where it appeared in the "East-South-East by East" (*Times*). Another fine meteor was observed here by three persons on Sunday, April 7th, at about 7h. 10m. p.m. Its diameter seems to have been about 10′. Motion from South by East to North by West. Travelled about 19° in a path inclined at some 40° to the horizon. It was not bright for its size. Colour, yellowish white. It began on the right, and burst on the left, of Polaris. When it began, its altitude was less than that of Polaris.

Vaughan Cornish.

Debenham Vicarage, Suffolk.
Lat.: 52° 13′; long: 1° 10′ E.

OBSERVATORY.

[14250.]—In conformity with "F. R. A. S.'s" advice I have ordered a telescope with clock motion, which Mr. Grubb, of Dublin, has now in hand for me. Perhaps "F. R. A. S.," who is so ready to assist beginners, would kindly further give me his opinion on the following—

1. Any objection to brick for the walls of observatory? I have made the design for wood, but brick is nearly as cheap and more secure against intruders.

2. In case of wooden walls is there any practical difficulty in having the 12½ft. dome revolve on three iron balls instead of rollers fixed in the bed-plate? Any sagging down of the plate would probably cause the balls to change their relative positions and prevent the easy revolution of the dome.

3. Which is preferable for the finder—three thick wires inclosing an equilateral triangle in the centre of the field; two cross wires at right angles to each other; or, lastly, one single thick pointer with its apex at centre of field?

I think Mr. Lancaster lately recommended very fine cross hairs. I should think it would be very difficult to see them at night, and I am not aware that it is usual to illuminate the field of the finder.

P.S. Which is preferable in practice—an iron or a stone pillar as support to an equatorial?

Edward M. Richards.

THE TELEPHONE—THEORY AND PRACTICE.

[14251.]—I have, almost from the first, read the articles and letters appearing upon the telephone in your invaluable journal, and derived much useful information from the various hints and suggestions from time to time made. In common with so many of your readers I have made numerous experiments with a view to improving the efficiency of this most interesting instrument; but so far, it is scarcely necessary to remark, with very little success. As the result of some of these efforts has seemed to throw light upon certain matters previously unnoticed in your columns, the facts may, perhaps, prove of interest. There has been, and perhaps still is in some minds, a doubt as to the cause of the sounds produced in the receiving instrument. In fact, a sort of molecular vibration and mechanical vibration theory controversy seems to have arisen. While admitting that there is some foundation for the former, the latter theory will, doubtless, be eventually adopted as the real explanation of the phenomena.

Experiment conclusively proves that magnets affected by even the weak induced currents, sufficient to produce sound in the telephone, also make a very faint effect upon the receiving magnet itself. A convenient means of proving this is to suspend a bar magnet, with its bobbin attached, in a cigar-box, from which the lid has been removed. The thread holding the magnet should be tied to thin bars of wood, having their ends resting on either side of the box. On passing a current from a very weak cell, filled with pure water only, a faint but unmistakable tick will be heard every time contact is made and broken. This sound is much increased on attaching a piece of iron or steel to the magnet. So much for the molecular theory. Mechanical vibration of the plate seems so probable from the facts already brought to light that a short résumé of them can scarcely fail to prove convincing. Experiment has proved that increased thickness of plate does not lead to augmentation of sound, and diminution of same makes but a slight difference. If the vibration were actually molecular, the thick plate should give the best result, owing to the larger number of particles in a given exposed surface, all of them influenced by the induced currents passing along the wire. A reasonable explanation of the action of the telephone, however, lies in a very narrow compass—proportion of thickness of plate, implying as a necessary consequence a certain natural elasticity capable of resisting up to a certain point, and within limits to be at some future date accepted as a law of the magnet, to overcome this inherent power of the plate, the most satisfactory results being obtained when these opposing forces are in a state of equilibrium.

This is readily proved by using plates of various thickness with the same magnet, the distance of diaphragm from magnet, remaining constant. It will then be found that, provided the magnet is of sufficient power to obtain good results from the stoutest of the series, its distance will have to be gradually increased to produce a like effect upon substituting the members of the series until the thinnest is used—the distance of magnet having been increased on the substitution of each diaphragm.

Quantity of wire on bobbin must also be varied for strength of magnet; but this, the actual source of power, is subject to infinitely greater variation than relative strength of magnet to thickness of plate—fifteen yards of No. 30 wire producing a sound equal to 250 yards of No. 36. Power of bar magnets compared with horseshoe form:—The best of the former are only capable of holding—say, twice their own weight. All lengths and diameters leave little to choose. After testing all those sold by best London makers, some cheap horseshoe magnets at 2d. each were procured. One of them sustained a weight of 8 ounces—length of magnet 1¾in. Three of these were bound together with thin No. 36 copper silk-covered wire, and compactly cemented, after winding, with gutta percha. Lifting power of this combination ¾ of a pound; on trial with ordinary 1¾in. diaphragm at distance 1·32in., no distinct sound was obtained; on distance of magnet being doubled, ordinary conversation could be heard, but not so well as with bar magnet. On increasing distance better result was obtained. Substituting a 4in. plate of ordinary tin, a splendid sound was obtained, the distance from magnet in this case being 1·32in. This points to another law regarding the transmission of speech—that the diameter of the magnet of a certain strength bears a proportion to size and thickness of plate exposed to its influence. These facts all point to the verification of the theory of mechanical vibration of the diaphragm. Another step in the same direction is gained by the combination of electrical and string telephone to which attention was directed by M. Brequet in the English Mechanic some weeks since.

Material for diaphragm seems to be of little consequence provided iron, steel, ferrotype, and tin plates are made use of, and the conditions of distance from magnet, &c., previously noticed, are carefully observed. The material of which the case is formed is again unimportant, provided means for holding plate firmly by its circumference and of adjusting and holding magnet are observed. Shape of mouthpiece is, however, a matter of first importance. The ordinary form of Bell's telephone is faulty as not possessing a sufficient aperture to include all vibrations arising from the utterance of the infinite variety of sounds comprising articulate speech. The exposed surface of the plate must be at least 1½in. A cone of this diameter next the plate, ¾in. long and 2in. at greatest diameter, will render even reading at ordinary rate perfectly clear—a result to be looked for in vain in Bell's most perfect instruments. Augmentation of sound:—It being allowed that very minute, in fact almost imperceptible vibrations of diaphragm will produce an effect upon the ear sufficient to give the effects of quality and timbre of voice. It is prudent that unless by some means not yet discovered, the amplitude of these vibrations can be increased, no greater sound can be obtained. Power of current:—This, as is already known, is almost inappreciable by any previously-known tests, but by a remarkable coincidence the telephone has proved itself a most delicate galvanometer.

The very small electro-motive force developed by two thin wires, one of iron the other copper, immersed in pure water for a depth of half an inch, producing a sound in the diaphragm on breaking and making contact, showing the passage of a current so feeble as scarcely to affect a delicate reflecting galvanometer, but yet audible in the telephone. Practical difficulties seem to have beset the path of many correspondents who have asked questions on the construction of the telephone. Attention to a few points necessary to be observed in the construction of all electrical apparatus would have prevented the occurrence of cases of disheartening failure. A most essential point is care in the winding of coil more particularly when very thin wire is used. Th may break, and the point of fracture pass unnoticed. Joints in wire should be carefully soldered, an wires soldered to binding screws. A small spoo of tin, holding half an ounce of solder melted ove a spirit lamp, will be found the most handy appliance. Wires should be scraped clean and rubbed with powdered resin. When solder is melted, insert the point of junction of wire and move gently about until the wire is just covered; a little practi will determine the proper moment for withdrawi it. Wide bobbins ½in. inside width seem best—ca board will do as well as wood for the material o which they are composed. Best material for pla seems to be ferrotype, carefully cut to a true circu form. Varnish on both sides left untouched. Li wire for short distances may be any size from N 40 (thin) to No. 16 thick. It is, of course, to borne in mind that thin wire offers a resistance the passage of currents increasing with smaller d meter; thus a wire ¼in. thick and one hundred ya long will offer no more resistance than 25 ya 1-16in. thick, insulation being equal. Earth wi instead of double line wire may be used with adv tage in most cases. Good earth connection m be obtained by thrusting an old knife in the gro in a damp place, and soldering end of wire to sa Distance of magnet from diaphragm, as alre noted, must be determined by experiment in e case, and no particular rule can be safely adhered

The question of size of instruments is again on which wide limits may be observed. Plates o inch in diameter, fitted in the top of small boxw boxes, give satisfactory results, especially in transmission of whispers; louder sounds are bey their capacity. As curiosities, for carrying in pocket they are, however, very interesting. Mag should be made to take out, and adjusted by a co of cardboard glued round them.

It is hoped these items, the result of a long se of experiments, may prove of interest and save time of fellow-workers in this most interesting f of research. That the telephone is destined, w brought to perfection, to effect a revolution in employment of telegraphic instruments, and, in means, social enjoyment, there can be little do There is, however, a great scientific value att to the discovery of so delicate an instrument fo detection of exceedingly weak currents of electri Besides this the telephone opens a wide fiel speculation, and the facts it has brought to light at no very distant future date lead to the ado of other instruments capable of assisting o senses besides that of hearing. **R. W.**

PHONAUTOGRAPH.

[14252.]—Nothing better than Swedish pitch your slides; it will hold very tenaciously. I this opportunity of thanking "J. R. H." fo kindness. I have shown the slide to a few sci gentlemen who have been much pleased with it.

Telescope T

CARL ZEISS'S NEW OIL-IMMERSI OBJECTIVE OF 1-8IN. FOCUS.—NO

[14253.]—Mr. Zeiss sent me, in the beginni March, a novelty—namely, an oil-immersion o tive, the second of its kind which he had then m and of which I would have sent an account to English Mechanic earlier had I not been willing to anticipate Mr. J. W. Stephe F.R.A.S., F.R.M.S., well-known as the invent an excellent stereoscopic binocular arrangemen high powers, who purposed reading a paper on new lens before the Royal Microscopical So and to whom the credit is due of having sugg the principle of the former to Professor Abbe, a six months ago.

Professor Amici was the first who employed on account of their greater refractive power, immersion fluids for microscopical objectives, his attempts do not seem to have been very succ ful. It has been reserved for Professor Abbe Mr. Carl Zeiss to produce, after numerous exp ments and failures, a microscopical objective on oil immersion principle, which, in regard to resolv power and brilliancy, far surpasses anyth hitherto attained, and which, in regard to definiti flatness of field, and other qualities, is equal to very best objectives made. This new oil-lens c stitutes, indeed, a vast advance in the construct of microscopical objectives, and inaugurates a era in their construction. The objective in ques is constructed to work with an immersion fluid refractive and dispersive indices of which are nearly as possible the same as [illegible] covers of those crown glass, of which both the front lens and micro. objects consist. After examining more t a hundred different liquids with regard to t refraction and dispersion, Professor Abbe discove such a fluid in the oil distilled from cedarwood ligni cedri). The use of this oil with the immersion objective practically neutralises the ferences in the amounts of refraction caused covers of different thick[illegible], and hence no sc ilar adjustment for various thicknesses of cover-g glass is required in this oil-lens. If the rrection has once been made for a certain thickness ' covering glass and a certain tube length, the lens ill work equally well with thicker or thinner vers, and any trifling errors still existing may be ctified by the means of the draw-tube—thick vers, exceeding 0·008in., requiring about ½in. to n. less draw-tube; and the thinnest covers, less an 0·004in. thick, about 1in. more. The pure Ol. ni cedri gives the best colour correction for oblique ght. For observations with central light a small antity about 1-6th of the more dispersive fennel ' anise-seed oil should be mixed with the former, d the refractive power of this mixture should be duced to that of the pure cedarwood oil by the dition of a little pure olive oil. Mr. Zeiss supplies test-bottle with two plane parallel sides, and a own glass prism cemented to the stopper, which rves for controlling the refractive and dispersive wer of this mixture. The oils of Copaiba balsam d of sandal-wood may also be used instead of Ol. ni cedri.

The most important advantage of a more refrac-e immersion fluid than water is, that by its use a ger angle of aperture can be given to an objective, out detriment to its definition, than can be ained when the lens is immersed in water. In-d, Zeiss's new ⅛th has the largest aperture herto attained, being equal to a balsam angle of °, and considered according to its numerical e it is larger in the proportion of 1·25 : 1 or 5 than that of a dry objective of 180° air angle, posing such a larger angle could be obtained. fessor Abbe calls the product of the size of the e of the semi-aperture and of the refractive x of the immersion fluid employed, the "nume-l aperture." The resolution or the power of rating fine lines of this new oil-objective is to of the best ordinary water immersion lenses as to 1·1, a very palpable increase. It will be ent, however, that to insure the best per-mance of this objective it is requisite that the ects should be mounted in balsam or in any other dium having a refractive index of at least 1·25, mounted dry, that they should adhere so closely he cover that there is no layer of air between n and the latter; that, in fact, object, cover, ersion fluid, and front lens should form one inuous whole of the same refractive power—else capacity of this lens is not any greater than of any other good immersion objective.

his new ⅛th magnifies at 10in. from the eye fully diameters with Ross's first or A eyepiece. It four-system contained in a setting of only ½in. ength. To this the optical part is screwed, a el-shaped adapter having the universal screw on pper end, which makes the whole system look an English objective without a screw-collar. s for the exclusion of certain spectra may be wed between the optical combination and the pter. This objective has no screw-collar, in equence of which it is very easy to use. It has rge front lens set in white metal, and it is essed of a great working distance. The con-ction of this certainly very simple-looking glass id to be one of extreme delicacy and difficulty, it is therefore expensive. Although prices ought to be mentioned in these columns, I am sure microscopical readers will be interested to learn the price of Zeiss's oil-immersion objective of lens will be from £12 to £14 sterling.

rding the performance of this lens, especially ed diatoms, I cannot find words enough for its , for I have no test in my large collection of class of objects which I cannot easily resolve by il. The smallest specimens of Navicula rhom-, and its allied forms of N. crassinervia and lia Saxonica, are easily dotted. Stauroneïs , as well as the finest and most pellucid valves Amphipleura pellucida, show their cross markings so beautifully and distinctly that it would an easy task to count them. Balsamed speci- of these diatoms, and those on Moeller's platte, and of Amphora arenaria, &c., are as and as easily resolved by transmitted light with lens if Wenham's reflex illuminator is used in manner described in my paper, which was read the Royal Microscopical Society on the 6th of ch, and demonstrated by Dr. N. J. Dickson, of dney. In fact this magnificent objective will ally "walk over" any good test-slide. Owing the large diameter of its front lens and its large ture it gives so much light that the finest maceous tests are still beautifully shown under 's F eyepiece, which magnifies eight times dia-rally—*i.e.*, 64 times superficially as much as first or A eyepiece. I consider that this fact itutes one of the greatest advantages of the new tive, because it can be used profitably with the t oculars, which, in conjunction with ordinary powers, become practically useless. Sunlight resolution of diatomaceous tests with Zeiss's il lens becomes superfluous; in fact, it is too nt, unless much modified.

definition, penetration, flatness, and brilliancy is lens are exquisite. I regret that circumstances prevented me from using it as much as I would have liked, and that I am not able to chronicle having made any new discoveries with it. In fact I have not seen anything with Zeiss's new oil immersion 1-8th which I have not seen with Powell and Lealand's excellent 1-8th on a new formula; but I have seen the finest tests far better and easier with the former than with the latter, and I have often been able to show the markings on the finest lined tests by a variety of modes of illumination, when other first-rate objectives would perhaps show them only by one special mode of illumination. In order to obtain an illuminating pencil of sufficient obliquity Mr. Zeiss sends a small hemispherical lens with the objective, which can be attached to the under side of the slide by means of a drop of water or of oil.

This objective has but one slight drawback, and this is the use of the essential oils into which the front lens has to be immersed, and which, besides smelling strongly, act as solvents on the varnishings and on the balsam if they are used carelessly and in needlessly large quantities. By ringing the slides with shellac varnish, which is not acted upon by essential oils, dangerous consequences to the micro. objects may be avoided. At any rate, such a trifling drawback cannot assume any importance when the extraordinary capacity of this new objective is considered.

Prof. Abbe has discovered by means of this oil lens a new and beautiful system of fine lines on Pleurosigma angulatum, parallel to its mid rib, that is on a test diatom studied more than any other. I find, however, that these markings can be seen perfectly well with any ordinary good immersion lens. On examining the spectra in the posterior lens of the oil immersion objective, whilst a valve of Pleurosigma angulatum was in focus, which was lying horizontally on the stage, and which was illuminated by very oblique light perpendicular to the mid rib, Prof. Abbe was struck by the prominence of a blueish spectrum in the upper part of the lens, and concluded at once that this must be caused by a system of lines parallel to the midrib. Having excluded two of the spectra by means of a strip of tinfoil placed horizontally and diametrically behind the posterior lens, and, having replaced the ocular, Prof. Abbe found his supposition confirmed. These lines, parallel to the mid rib on P. angulatum, are in the proportion of 1 : $\sqrt{3}$ finer than the ordinary three sets of lines, and can only be seen when some of the spectra forming the images of the latter are excluded.

To my inquiry whether he intended to patent these oil-immersion objectives, Mr. Zeiss replied that he did not intend to do so as he was unwilling to monopolise for trade purposes an invention which he hoped would prove of great scientific value. He also stated that, on the contrary, he would be glad to see other opticians adopt the principle of oil-immersion. This is, if not business-like, certainly most liberal, and opticians will, as may be expected, not be slow to take advantage of it. Nevertheless, Mr. Zeiss need fear but little from competition, as probably only very few opticians will be able to compete with him in the construction of so difficult and delicate an objective.

It is to be hoped that Prof. Abbe and Mr. Zeiss will soon construct some higher powers than the ⅛th, and of equal excellence, on the principle of oil-immersion.

Glasgow, April, 1878. **Adolf Schulze.**

KENTISH RAGSTONE AND CRYSTALS.

[14254.]—Hugh Clements, in his last letter, lays great stress on the crystals in question containing iron, and says that I "quite gratuitously assume that they are calc spar, calcic carbonate pure and simple," and that I "confound calcic carbonate with a compound containing iron." I do neither one nor the other, but I know perfectly well that the presence of iron in the crystals does not make the least difference, and that calcic carbonate very often contains iron, and that it never makes any difference in the form in which it crystallises. Hugh Clements goes into one of his theoretical arguments to prove that it might make a difference, but it comes to simply this—iron pyrites crystallises in the cubical system; therefore calc spar containing iron may crystallise in that system; but, independently of the fact that calc spar containing iron crystallises as regularly and invariably in the hexagonal system as the pure calcic carbonate, the argument is even theoretically bad. Iron pyrites is a bisulphurate of iron, the composition being generally given as sulphur 54·26, iron 45·74, whereas magnetic pyrites—the composition of which is somewhere about iron 59·6, sulphur 40·4—crystallises in the hexagonal system, as does also specular iron ore or red hematite, a nearly pure peroxide of iron, which sometimes contains as much as 69 per cent. of metallic iron; and carbonate of iron is isomorphous with carbonate of lime. Carbonate of iron, with a little carbonate of lime, forms a well-known ore of iron, from which an immense quantity of iron is smelted in England, as well as in Styria and Carinthia. Those facts show the value of this argument even in a theoretical point of view, but it seems evident to me that it was suggested by "Daghbert's" coined word, "Ferrocalcide," in his letter, 14187, p. 96.

I took no notice of the iron in Hugh Clements' crystals because I supposed that the isomorphism of carbonate of iron and carbonate of lime must have been well known to him, but the more he writes on the subject the more he displays his ignorance of practical crystallography and mineralogy, as well as the very superficial nature of what knowledge he possesses of theoretical crystallography. Still, "J. H. Collins seems to know nothing" about those crystals, and "'G. J. H.' is entirely at sea," but the faintest suspicion of the possibility of Hugh Clements having "found a mare's nest," or made a blunder of any kind, seems never once to have entered his head.

In his last letter (14217, p. 122), in which he first tries to make an argument out of the presence of iron in the crystals, Hugh Clements says:—"I agree with him that it is utterly impossible for calcic carbonate to crystallise in the monometric system." It is really worth while to turn to his second letter on this subject (13956, p. 530); it begins, "I have endeavoured to follow the remarks of 'G. J. H.,' stating his reasons against the possibility of calcspar crystallising in the form of the pentagonal dodecahedron, but I am sorry to state that I cannot agree with him." "I cannot, among the numerous crystals, discover any trace of a six-sided prism," &c., &c. And, again, "Perhaps 'G. J. H.' will also kindly explain why it is utterly impossible that calcic carbonate should crystallise in the form of the pentagonal dodecahedron." Hugh Clements has certainly learned a little crystallography since he began this correspondence, and, when he has realised the fact that it is just as impossible for carbonate of iron, or any compound of carbonate of iron and carbonate of lime, to crystallise in the monometric system as it is for calcic carbonate to do so, he will have learned a little more.

Further on, in this last letter, Hugh Clements says, "I observe from an article of Mr. Collins's, p. 81, that the pentagonal dodecahedron very closely resembles the six-sided prism. This close resemblance was referred to by me, when I asked 'G. J. H.' could the six-sided prism become so modified as to be undistinguishable from the pentagonal dodecahedron; but 'G. J. H.' seemed to think that if they were exactly alike it would be easy to distinguish the one from the other." Now (besides crediting me with a "bull" which I never made) Hugh Clements mixes up things so much that I really must again refer to the earlier part of the correspondence. In my first letter (13917, p. 503), Feb. 1, I said, "Hugh Clements will find that his crystals are not pentagonal dodecahedrons, but what are called six-sided prisms, the remaining parts of the primary faces (those forming the vertical angles of the crystal) are pentagonal, the secondary faces are also pentagonal." Hugh Clements, in his letter (13956, p. 530), Feb. 8, says, "perhaps 'G. J. H.' will explain more fully how the pentagonal form is formed by the planes passing through the six lateral angles of the rhombohedron, and how the remaining parts of the primary faces (those forming the vertical angles of the crystal) are pentagonal." In let. 14019, p. 579, Feb. 22nd, I did so, and for that purpose "introduced diagrams," Fig. 6 being the pentagonal dodecahedron, and Fig. 8 the six-sided prism, and, notwithstanding all Hugh Clements had said to the contrary, very strongly expressed my adherence to my original opinion that his crystals were six-sided prisms. Now comes Mr. Collins's first letter, 14078, p. 629, March 8, he says "G. J. H." is probably right. There is, however, another explanation possible, Mr. Clements' crystals may be pseudomorphs after pyrites. This is very unlikely. Hugh Clements' next, let. 14093, p. 15, March 15, says, "Of course it is possible, and perhaps, I may say, probable, that the crystals are six-sided prisms, so very much modified that it is utterly impossible to distinguish between them and the dodecahedrons," and he would fain believe "that they are six-sided prisms with pentagonal faces, so far modified that they merge into the form of dodecahedrons. Does 'G. J. H.' think that this metamorphosis would be extremely improbable or even utterly impossible?" In let. 14154, p. 69, March 29, I answer this question thus: "I have not the least hesitation in saying that any mineralogist, with practical knowledge of the subject, would at once distinguish between calcspar in the form of six-sided prisms with pentagonal faces, no matter how they might be modified, and pentagonal dodecahedrons." That is plain enough speaking, one would think, though not very complimentary to Hugh Clements as a mineralogist. And still he says, "'G. J. H.' seemed to think that if they were exactly alike it would be easy to distinguish one from the other." Seemed to think, forsooth!—there was no seeming to think; I said what I thought plainly enough. Next comes Mr. Collins's article "On Some Difficulties in the Study of Crystals," p. 81, April 5, in which he gives diagrams of the pentagonal dodecahedron, Fig. 9, and of the form of six-sided prism in question Fig. 10. In my diagram of the same crystal I made the prismatic part of the crystal of the normal or usual lengths whereas Mr. Collins made it shorter, so as to give it the appearance most likely to deceive the inexperienced eye, and which I should think must be almost identical with the form of Hugh Clements' crystals. See Mr. Collins's last letter (14218, p. 122).

Now, a few words more about theoretical systems of crystallography. I do not think it is of much consequence what particular system one adopts provided it is in strict accordance with laws derived from long and close observation of natural crystallisation. My "cart-before-horse" system has stood me in good stead now, and ever since I learned it, thirty years ago, from the late Mr. Oldham, then professor of geology and mineralogy in Trin. Col., Dublin, and afterwards head of the Geological Survey of India. I am old enough to look on the system which I have learned, and which is that used by Dana, as *a* system which, though it may perhaps be looked on as antediluvian by some younger men, has long answered my purpose, and will continue to do so. Hugh Clements is evidently young enough to look upon the system which he has learned, as *the* system, and to think that any other system must be wrong, or, at least "topsy-turvey," and that every one who uses any other system can know nothing of crystallography, or at least must have "inverted ideas" of it; but he is also young enough to learn, and he evidently is learning. I am very glad if I have assisted him, but really sorry that circumstances have obliged me to do so in so unpleasant a manner. I new, as I hope, finally winding up the discussion, must say that I have not evaded any question which Hugh Clements has put to me as to primary and secondary forms, and repeat that I do not think any system of crystallography which makes the rhombohedron a hemihedral secondary form of the isosceles dodecahedron or hexagonal pyramid, is in accordance with the laws of nature as observed in actual crystallisation, for the reasons given by me at length in letter 14155 (p. 69), in answer to a question put to me by Hugh Clements. As I do not live in London, or even in England, I cannot accept Hugh Clements' kind invitation to call on him and see his crystals, though if I could have done so I feel sure that an oral discussion of the matter with him would have been much pleasanter to both of us than this correspondence has been.

Thanks to "Daghbert" for his kind offer to send me some of the crystals, but as they are not a new form of ferro-calcite it would be hardly worth his while to take the trouble. He certainly deserves the thanks of all concerned for having sent them to Mr. Collins. I think that Hugh Clements and I have between us done good service to the MECHANIC if we have been instrumental in inducing Mr. Collins to write his papers on "Some Difficulties in the Study of Crystals," which I trust he will continue, and go into the very interesting subject of double refraction, now that the attention of your readers has been in some degree attracted to crystallography, a most interesting science, the practical value of which to mineralogists is often underrated. G. J. H.

ORGANIC SUBSTITUTION.

[14255.]—SUBSTITUTION products are formed by the deplacement of an element, radical, or group, in a compound by another element, radical, or group of elements.

A very important class of substitution products is obtained by replacing one, two, or three atoms of H in NH_3 by an organic radical. Thus we have the amines divided into monamines, diamines, triamines, and tetramines. The monamines are divided into primary, secondary, and tertiary. There are primary monamines of the methyl, vinyl, and phenyl series, having the general formula—$NH_2(C_nH_{2n+1})$, $NH_2(C_nH_{2n-1})$, and $NH_2(C_nH_{2n-7})$, in which one atom of the hydrogen in NH_3 has been replaced by the methyl, vinyl, or phenyl radical. Methylamine, $NH_2(CH_3)$; ethylamine, $NH_2(C_2H_5)$; butylamine, $NH_2(C_4H_9)$; amylamine, $NH_2(C_5H_{11})$, are primary monamines of the methyl series. Allylamine, $NH_2(C_3H_5)$, belongs to the vinyl series, and phenylamine, $NH_2(C_6H_5)$, and tolylamine, $NH_2(C_6H_4Me)$, to the phenyl series.

These may be formed by the action of potassic hydrate on the product formed by the action of the haloid compounds of the monad positive radicals on ammonia, thus—$NH_3 + EtI = NEtH_3I$ and $NEtH_3I + KHO = NH_2Et + OH_2 + KI$; or by treating cyanic ether with a boiling solution of KHO, thus: $CNEtO + 2KHO = NH_2Et + COKO_2$.

The secondary monamines of the methyl, vinyl, and phenyl series, in which two atoms of the hydrogen in NH_3 are displaced by positive monad radicals of the methyl, vinyl, and phenyl series respectively. Dimethylamine, $NH(CH_3)_2$; diethylamine, $NH(C_2H_5)_2$; dibutylamine, $NH_4(C_4H_9)_2$; methylethylamine, $NH(CH_3)(C_2H_5)$; ethylamylamine, $NH(C_2H_5)(C_5H_{11})$, belong to the methyl series, and ethylphenylamine, $NH(C_2H_5)(C_6H_5)$, belongs partly to the methyl and phenyl series. Piperdine, $NH(C_5H_{10})''$, and conine, $NH(C_8H_{14})$, are also secondary monamines. They are produced by the action of KHO on the product formed by the haloid compounds of the monad positive radicals on the primary monamines, thus: $NH_2Me + MeI = NMe_2H_2I$, and $NMe_2H_2I + KHO = NHMe_2 + OH_2 + KI$. They may be formed containing two different radicals by using the iodide of a radical different to that contained in the primary monamine, thus: $NH_2(C_6H_5) + EtI = NH_2C_6H_5C_2H_5I$, and $NH_2C_6H_5C_2H_5I + KHO = NH(C_6H_5)(C_2H_5) + OH_2 + KI$.

In the tertiary monamines the three atoms of hydrogen in NH_3 are displaced by one, two, or three positive monad radicals; thus we have trimethylamine $N(CH_3)_3$, triethylamine $N(C_2H_5)_3$, tributylamine $N(C_4H_9)_3$, and triamylamine $N(C_5H_{11})_3$, in which the hydrogen is replaced by three of the same series of radicals, but in methylethyl phenylamine $N(CH_3)(C_2H_5)(C_6H_5)$ the hydrogen is replaced by different radicals.

Dimethylaniline $N(C_6H_5)Me_2$, dimethyltoluidine $N(C_6H_4Me)Me_2$, dimethylxylidine $N(C_6H_3Me_2)Me_2$, dimethylcumidine $N(C_6H_2Me_3)Me_2$, and dimethylcymidine $N(C_6HMe_4)Me_2$ are tertiary monamines, in which the radical C_6H_5 enters. These monamines are produced by acting on the secondary monamines with the iodides of the positive radicals and treating the product with KHO, thus: $NMe_2H + MeI = NMe_3HI$, and $NMe_3HI + KHO = NMe_3 + OH_2 + KI$. These tertiary monamines when acted on by the iodides of the monad, positive radicals produce iodides that cannot be decomposed by KHO. A secondary monamine produces an iodide which becomes a tertiary monamine when acted on by KHO, and a primary monamine requires a further application of the iodide and KHO to produce the tertiary.

In the diamines the hydrogen of the two molecules of ammonia is displaced by a radical. In the primary diamines, one molecule of hydrogen is replaced, thus: $\left\{\begin{matrix}NH_2\\Et''\\NH_2\end{matrix}\right.$; in the secondary two molecules are displaced, thus: $\left\{\begin{matrix}NH\\Et_2\\NH\end{matrix}\right.$ and in the tertiary the three molecules are displaced, thus: $\left\{\begin{matrix}NEt''\\Et'\\NEt''\end{matrix}\right.$.

Ethyl diamine $Et''(NH_2)_2$ ethylene diethyl diamine $Et''(NHEt)_2$, urea $CO(NH_2)_2$, ethyl urea $NHEtNH_2CO$, sulphur urea $CS(NH_2)_2$, and sulph phenyl urea $CSNHPhNH_2$, are well-known diamines.

The diamines are produced by acting on ammonia or primary or secondary monamines with a bromide of the diad radical, and decomposing the product by KHO.

The triamines contain three atoms of nitrogen, and the hydrogen of the three molecules of ammonia is replaced by various radicals. Rosaniline is one of the most important triamines. Its formula is $N_3(C_6H_4)''(C_7H_6)''_2H_3$, and perhaps it is formed by the abstraction of three molecules of hydrogen from one molecule of aniline and two of toluidine, thus: $2NH_2(C_7H_7) + NH_2(C_6H_5) = (NH_3)(C_7H_6)''_2(C_6H_4)'' + 3H_2$. By replacing one, two, or three of the atoms of H in rosaniline $NH_3(C_7H_6)''_2(C_6H_4)''$ by phenyl C_6H_5 we obtain phenyl rosaniline $N_3PhH_2(C_7H_6)''_2(C_6H_4)''$, diphenylrosaniline $N_3Ph_2H(C_7H_6)''_2(C_6H_4)''$, and triphenyl rosaniline $N_3Ph_3(C_7H_6)''_2(C_6H_4)''$.

By replacing the H_3 by three of the tolyl radicals we obtain tritolyl rosaniline $N_3(C_7H_7)_3(C_7H_6)_2(C_6H_4)''$, and, by replacing by Et_3, we obtain triethyl rosaniline $N_3Et_3(C_7H_6)_2(C_6H_4)''$.

Chrysaniline $N_3C_{20}H_{17}$, and lake aniline $N_3C_{20}H_{21}$ are other triamines.

Rosaniline itself is prepared from toluidine and aniline by arsenic acid or other reagents.

There are also arsines, bismuthines, phosphines, and stibines, in which the hydrogen in AsH_3, BiH_3, PH_3, and SbH_3 is either partially or wholly replaced by radicals. Trimethyl arsine $AsMe_3$, triethyl arsine $AsEt_3$, triethyl bismuthine $BiEt_3$, methyl, dimethyl, and trimethyl phosphine $PMeH_2$, PMe_2H, and PMe_3, and ethyl, diethyl, and triethyl phosphine $PEtH_2$, PEt_2H, and PEt_3, and trimethyl, triethyl, and triamyl stibines $SbMe_3$, $SbEt_3$, and $SbAy_3$. From the above it may be observed that there are only tertiary compounds of arsenic, bismuth, and antimony, while the H in PH_3 may be replaced in the same manner as in NH_3, producing primary, secondary, and tertiary compounds.

The amides divided into the monamides, diamides, and triamides, so called because they are formed by the substitution of NH_2 amidogen (Ad) for the HO of the semimolecule of oxatyl $(COHO)_2$, or by the substitution of a monad positive radical with CO in the place of one, two, or three atoms of hydrogen.

Acetamide CH_3COAd or $NH_2(COMe)$, benzamide C_6H_5COAd or $NH_2(COPh)$, and chloracetamide $CH_2ClCOAd$ or $NH_2(COCH_2Cl)$ are primary monamides.

Diacetamide, $NH(COMe)_2$ and $NH(COCH_2)_2$, are secondary monamides.

Oxamide, $C_2O_2(NH_2)_2$ or $(COAd)_2$, and succinamide, $Et(COAd)_2$ or $(NH_2)_2(C_4H_4O_2)''$, are primary diamides. The diamides may be regarded as formed by the substitution of $(NH_2)_2$ for the $(HO)_2$ in the semimolecule of $(COHO)_2$ in dibasic acids, or by the substitution of a diad negative radical for two atoms of H in two molecules of ammonia.

Citramide, $N_3H_6(C_6H_5O_4)'''$ or $C_3H_5O(COAd)_3$, is a triamide. The triamides may be regarded as formed by the substitution of the residue of a tribasic acid in place of three atoms of H, or by the substitution of NH_2 for HO in the three semimolecules of oxatyl.

The alkalamides:—Ethyl acetamide $NHEt(COMe)$, ethyl diacetamide $NEt(COMe)_2$, diethyl oxamide $N_2H_2Et_2(CO)_2$ diphenyl oxatyl carbonyl diamide $N_2(C_6H_5)_2(CO)_2''(CO)''$, and citryl triphenyl triamide $NH_3(C_6H_5)_3(C_6H_5O_4)'''$, are derived from ammonia by the substitution of part of the hydrogen by positive, or a part by negative radicals. When the hydrogen in amines is replaced by bromine or chlorine, tribrominated and trichlorinated amines are formed—*e g.*, $N(C_6H_2Cl_3)H_2$ trichloraniline. The imides have the general formula $NH(C_nH_{2n-1}O)_2$.

Succinimide, $NH(COCH_2)_2$ or $NH(C_4H_4O_2)''$, is formed by the substitution of a diad negative radical for two atoms of hydrogen in ammonia.

The nitrides have the general formula $N(C_nH_{2n-1}O)_3$, and may be obtained by the action of chlor-acids upon amides, thus: diacetimide $NH(COMe)_2 + COMeCl = N(COMe)_3 + HCl$. The organo-boron compounds are produced by the substitution of a monad positive radical for methoxyl, &c., thus: $BEtO_3$ becomes BMe_3 by the substitution of Me for EtO. The hydrides of the prethyl series having the general formula C_nH_{2n+2}, form substitution compounds containing bromine, chlorine, &c.; thus we have CH_4, CH_3Cl, CH_2Cl_2, $CHCl_3$, and CCl_4, and C_2H_6, C_2H_5Cl, $C_2H_4Cl_2$, $C_2H_3Cl_3$, $C_2H_2Cl_4$, C_2HCl_5, and C_2Cl_6, &c., in which the hydrogen is replaced by chlorine.

In benzol or phenylic hydride, C_6H_6, we have C_6H_5Br, $C_6H_4Br_2$, $C_6H_3Br_3$, mono, di, and tribombenzol, the bromine displacing the hydrogen of the benzol. There are also similar chlorine substitution compounds, C_6H_5Cl, $C_6H_4Cl_2$, and $C_6H_3Cl_3$, the mono, di, and tri-chlorbenzol.

In introbenzol and dinitrobenzol, $C_6H_5(NO_2)$ and $C_6H_4(NO_2)_2$, the H is replaced by NO_2.

Orcin gives, with bromine chlorine and iodine, $C_7H_3Br_3HO_2$, $C_7H_3Cl_3HO_2$, and $C_7H_3I_3HO_2$.

Monobromorcin, $C_7H_5BrHO_2$, and trinitro orcinic acid, $C_7H_3(NO_2)_3HO_2$, are other compounds.

Carbolic acid, C_6H_5HO, gives the following substitution products—viz., C_6H_4BrHO, $C_6H_3Cl_2HO$, $C_6H_2Cl_3HO$, C_6Cl_5HO, $C_6H_4(NO_2)HO$, $C_6H_3(NO_2)_2HO$, $C_6H_2(NO_2)_3HO$, and $C_6H_2(NO_2)_2(NH_2)HO$.

By the substitution of oxatyl for hydrogen in C_6H_6, benzol, we obtain C_6H_5COHO, benzoic acid; $C_6H_4(COHO)_2$, phthalic acid; $C_6H_3(COHO)_3$, trimellitic acid; $C_6H_2(COHO)_4$, pyromellitic acid, and $C_6(COHO)_6$, mellitic acid. The haloid ethers are substitution products formed by replacing HO in the alcohols by bromine, chlorine, cyanogen, fluorine, or iodine. Thus there are MeCl, EtCl, EtI produced by replacing HO in MeHO, and EtHO by Cl and I; and $Et''Cy_2$ and $Et''Br_2$ by replacing HO_2 in $Et''HO_2$ by Cy_2 and Br_2.

Again we have $C_3H_5HO_2Cl$, $C_3H_5Cl_2HO$, and $C_3H_5Cl_3$ by replacing one, two, or three of HO in $C_nH_{2n-1}HO_3$ by Cl.

Methylenic and ethylenic iodides, CH_2I_2 and $C_2H_4I_2$; propylenic bromide, chloride, and iodide, $C_3H_6Br_2$, $C_3H_6Cl_2$, and $C_3H_6I_2$; butylenic bromide and chloride, $C_4H_8Br_2$ and $C_4H_8Cl_2$; and amylenic bromide and chloride, $C_5H_{10}Br_2$ and $C_5H_{10}Cl_2$; vinylic bromide, C_2H_3Br and C_3H_5OCl are other substitution products.

Chloral, CCl_3COH, is formed from CH_3COH by replacing H by Cl.

Chlorine converts the methyl series of acids into the chloro-substitution acids, thus: $CH_2(C_nH_{2n+1})COHO = CHCl(C_nH_{2n+1})COHO$.

The ketones are substitution products, formed by replacing the hydroxyl of the methyl series of acids by the monad positive radicals, thus: CH_3COHO becomes CH_3COMe, or $COMe_2$, when the HO of the acid is replaced by the radical CH_3 or Me. And by substituting a monad positive radical for the H of CH_3 in CH_3COMe we obtain $CMeH_2COMe$, methyl acetone, CMe_2HCOMe, $CEtH_2COMe$, $CPrH_2COMe$, and CEt_2HCOMe.

I have above referred to many of the substitution products that have been obtained. In fact substitution is one of the principal methods employed in the examination of the composition of organic bodies. The ordinary method of producing numerous inorganic compounds by double decomposition is merely a substitution of one acid or one base for another. Speaking generally organic substitution products are analogous in their properties to the compounds from which they are produced, the replacing element or group of elements merely supplying the place of the retiring elements, without disturbing the harmonious pre-existent relationship.

Hugh Clements.

INOFFENSIVE URINALS.

[14256.]—I THINK incrustation may be prevented by using thick glass plates in place of the metal, stone, or slate now in vogue. I have known this done with success, although the glass was speedily broken by mischievous persons, yet a zinc rim held it fast enough. It has been fixed about two years, and is as clean as at first. **Fiddler.**

THE ORGAN.

7.]—In the "Comprehensive Treatise" on an, now appearing in this journal, by Mr. n, in your issue of April 12 he alludes to the ge of placing the bellows in a cool chamber in hat the wind supplied by them, being also ay counteract the sharpening effect of an ated room. The organ at Exeter Hall is said its bellows "in the lower part of the case," refore not according to the above arrange- But in "The Scientific Bases of Music," a by Dr. Stone, just published, I find the fol- contrary statement:—"The organ at Exeter fed by wind from the cold stone corridors and es below it, which communicate almost with the outer air. Consequently, at the ıg of a performance, when the air of the well heated by the gas, the organ is very t is drawing a denser supply from below and whose undulations are calculably different ıose in the rarefied medium, in which the , contra-fagotti, and others are breathing iring. If all external apertures at the back ıt, and the bellows made to draw their wind e hot dry air near the ceiling by means of a trunk or wind sail, the organ would rise in My object, however, in writing is not so point out the disagreement of these two cts as to suggest a remedy in addition to the red by Dr. Stone. In all cases where the air drawn from a colder region, the organ might l to orchestral pitch, or nearly so (for I sup- n then a margin would have to be left)—the upply serving to preserve this pitch.

Tonometer.

THE ORGAN AT ULM.

3.]—Mr. Warman will, I am sure, permit oint out a slight inaccuracy in his very valu- interesting treatise on the organ. The bellows ker's great organ at Ulm, said to be the in Germany, are not placed in the crypt. n itself stands, like so many of the Continental er the west entrance, and the blowing nent, requiring 12 men, is placed at the back do not now recollect whether on the same omewhat beneath. I was present last year ccasion of a grand organ concert, and was leased with the quality of the instrument, rised at the absence of power and brilliancy non-employment of reeds till I heard that he "blowists" were absent. How such a y should have occurred on so great a public —the day after the solemn celebration of h anniversary of the cathedral—I did not nd, but I thought it not very creditable to orities. I was told that an idea was enter- substituting an hydraulic apparatus.

T. W. Webb.

E SO-CALLED HYPHARMONIC THEORY.

.]—I read the English Mechanic for on (among other reasons), and when strange are propounded with the earnestness and nce which characterises Mr. Jackson's of his theory, I am anxious that the value e demonstrated by the unbiased judgment who are acquainted with the subjects under n, so that any questions which may arise settled. For these reasons I would again opinions of our musicians on the above There can be no need of further explana- different points have been reiterated again n in your pages, and the subject presented every possible point of view. Comprehen- ted, the whole thing amounts to this: if al major diatonic scale be turned upside tones or intervals will correspond in one with the tones and intervals of the scale alt with, with the exception that "ray" is As I have before shown, this is merely a onsequence of the harmonic construction of

It matters not from what point of view at the matter, but for convenience I have ultimate result of the various operations armonic law as represented by tones and s, starting from a given generator.

ckson claims that the notes of the scale hown in nearer relation by his method, but ask, what need is there for all this? The the scale have all a certain fixed relation to r, and all the theories in the world cannot these relations. Because A is a near rela- C's, does that make C's relation to A any Yet this is the claim of the "Hyphar- theory.

I want to know is: Why should we be on to accept the "Hypharmonic" theory, ere is no proof that sounds are musically in this (the downward) direction, when, exigencies of the constitution of the scale, we are obliged to commence count- wards from such a comparatively distant of the tonic as ME; and when there is no y whatever, in the interests of musical mathematics, to promote what I may call a mere inevitable coincidence to the dignity of an indispensable musical law?

To conclude, the scale is constructed on harmonic principles. It consists (1) of sounds whose vibrations harmonise most frequently with those of DCH, and (2) of other sounds which harmonise most frequently with the rest. Rah is naturally sung with lah, and ray with soh, perfect fifths (or fourths) being formed in each case.

P. L.

L. AND N. W. RAILWAY ENGINES.

[14260.]—In answer to "L. L." (14175) the following engines should be running the trains named from Monday, April 22nd, to Saturday, the 27th:—

10.0 a.m. Ex. Euston (Euston to Crewe).

22nd, M. ...	Alma, 2185.
23rd, T. ...	Chillington, 2188.
24th, W. ...	Penrith Beacon, 2187.
25th, T. ...	Alma, 2185.
26th, F. ...	Princess Beatrice, 2190.
27th, S. ...	Chillington, 2188.

10.10 a.m. Ex. Euston (Euston to Crewe).

22nd, M. ...	Wizard, 872.
23rd, T. ...	Cambrian, 2194.
24th, W. ...	Reynard, 2184.
25th, T. ...	Cambrian, 2194.
26th, F. ...	Caradoc, 2192.
27th, S. ...	Cambrian, 2194.

8.50 p.m. Ex. Euston (Euston to Rugby).

22nd, M. ...	Condor, 868.
23rd, T. ...	Envoy, 865.
24th, W. ...	Balmoral, 862.
25th, T. ..	Llewellyn. 869.
26th, F. ...	Meteor, 863.
27th, S. ...	Courier, 866.

8.50. p.m. (Rugby to Crewe.)

22nd, M. ...	Avon, 2189.
23rd, T. ...	Avon, 2189.
24th, W. ...	Salopian, 2193.
25th, T. ...	Chillington, 2188.
26th, F. ...	Lowther, 2186.
27th, S. ...	Alma, 2185.

Up Trains.

12.18 a.m. (Crewe to Euston).

22nd, M. ...	Penrith Beacon, 2187.
23rd, T. ...	Lowther, 2186.
24th, W. ...	Princess Beatrice, 2190.
25th, T. ...	Avon, 2189.
26th, F. ...	Salopian, 2193.
27th, S. ...	Penrith Beacon, 2187.

4.25 p.m. (Crewe to Euston).

22nd, M. ...	Antelope, 2183.
23rd, T. ...	Caradoc, 2192.
24th, W. ...	Antelope, 2183.
25th, T. ...	Wizard, 872.
26th, F. ...	Antelope, 2183.
27th, S. ...	Antelope, 2183.

6.5 p.m. (Crewe to Rugby).

22nd, M. ...	Avon, 2189.
23rd, T. ...	Avon, 2189.
24th, W. ...	Salopian, 2193.
25th, T. ...	Chillington, 2188.
26th, F. ...	Lowther, 2186.
27th, S. ...	Alma, 2185.

6 5 p.m. (Rugby to Euston).

22nd, M. ...	Cambrian, 2194.
23rd, T. ...	Snowdon, 2191.
24th, W. ...	Caradoc, 2192.
25th, T. ...	Caradoc, 2192.
26th, F. ...	Snowdon, 2191.
27th, S. ...	Reynard, 2184.

The engines running from Crewe to Carlisle are Buffalo, Giraffe, Merrie Carlisle, Prince Leopold, Princess Louise, and Jakoob-Khan. and I believe Belted Will, 1220. Airy, 1678, Florence, 1217, Drake. 1526, and Phaeton, 1218, have the 6.5 p.m. from Crewe, 4.28 p.m. from Preston to Crewe. Can any one give me the engines running the Dutchman in the order they run? If "L. L." likes, I can give him the engines running most of the L. & N. W. expresses, with diagrams as to their working. No doubt some of the working will be altered May 1.

Egeria.

FAST RUNS OF EARLY LOCOMOTIVES.

[14261.]—Will "Itzaex" kindly favour us with some fast runs made by trains in the earlier years of railway enterprise, which, I think, he hinted in one of his letters he would be able to give? They would certainly be of great interest, especially when compared with his very admirable tables of speeds of recent runs.

I heard a "yarn" which I should much like to be corroborated or denied by "C. E. S." It is to the effect that a party of Americans made a very fast run from Liverpool to London one Sunday afternoon some time last autumn, in a Pullman car train. If true, will that gentleman give us the particulars, such as length of train, stoppages, speed, and time on journey?

I would, as a reader of the English Mechanic, take this opportunity of thanking "C. E. S." for the interesting and varied information which he so freely contributes to this paper, and would trespass so far on his kindness as to ask him to favour us with a diagram, showing the gradients on the Midland from St. Pancras to Leicester?

E. H. E.

CONTINUOUS BRAKES.

[14262.]—The subject of continuous brakes is still the "topic of the day" amongst railway engineers. In the House of Lords, on Thursday, the 14th of March, Earl De La Warr called attention to the recent correspondence between the Board of Trade and the railway companies. A most interesting debate ensued, in which Earl Cowper, Lord Henniker, Lord Carlingford, and the Duke of Somerset took part. On Friday, March 15th, in the House of Commons, Mr. Martin gave notice, that on the 26th of March he would move a resolution, "that it is desirable that the railway companies of the United Kingdom should be required within a reasonable time to supply their passenger trains, used for fast or heavy traffic, with efficient continuous brakes." No discussion was allowed to take place, as when Mr. Martin rose to move his resolution the "House was counted out."

In Vol. XXV., pages 634 and 635, I gave the particulars of the brake trials upon the North Eastern Railway, and also a table of comparative results between the Westinghouse automatic and Smith's vacuum brakes, as obtained by the locomotive officials of that line. This showed at once that the automatic was decidedly the best brake. The two trial trains were then worked for six months, to ascertain the cost of renewals and maintenance—the results given being almost identical with those obtained by Mr. Drummond on the North British Railway (and given in last volume, p. 288). And it again proved the well-known fact, that the vacuum brake is the cheapest in first cost, but that it is the most expensive to maintain. The North Eastern Railway Company have been considered by some to have been very slow in coming to any decision, or in adopting any system of continuous brake. It must be remembered that the North Eastern Railway is an important part of the east coast route between London and Scotland. At York it is joined by the Great Northern Railway. This company have adopted the Smith's vacuum brake, and fitted it to 87 engines and 476 carriages and vans. On the other hand it is joined at Berwick by the North British Railway. This company have adopted the Westinghouse automatic brake, and it is to be fitted to 300 engines and 1,000 carriages as quickly as possible; 25 engines and 300 carriages have already been fitted with this brake up to the present time. It will thus be seen, as one of the North Eastern Directors remarked a short time ago, "that their choice must be in opposition to one of these lines, and there seemed no way out of the difficulties which the difference involved." A few weeks ago, after careful consideration and a long series of experiments, the directors of the North Eastern Railway Company unanimously adopted the Westinghouse automatic brake for their line, and it is to be fitted to the whole of the passenger rolling stock forthwith, and 10 engines and 35 carriages have already been fitted with this brake. The directors of the North Eastern report that they have adopted the automatic brake for their line because they have proved it to be the best, and also because it fulfilled every one of the conditions considered necessary by the Board of Trade. This decision of one of the largest railway companies in the United Kingdom is of very considerable importance, and will do much towards the settlement of the continuous brake question. It will at once be seen that the great difficulties arise at York, as the Great Northern work their trains from London to York with the vacuum brake, and there is a very large interchange of traffic. These difficulties, caused by the difference of brake systems, have even already begun to make themselves seriously felt, and the Great Northern Company is at the present time considering what will be the best for them to do, so as to avoid this inconvenience. Clark's chain brake has been fitted to fifteen carriages intended for through traffic, but it does not work well, and has been abandoned. It is suggested by the North British and North Eastern companies that the Great Northern should fit all the carriages intended to run over their lines with the Westinghouse brake, and use the vacuum brake upon the trains running between King's-cross and Liverpool and Manchester, but no decision has yet been arrived at by the latter company.

Upon page 11, a description of Smith's "Firework brake," or "automatic attachment," is given. I have had an opportunity of examining the apparatus and witnessing trials with it. The results given were very unsatisfactory, and there is no doubt that the "firework arrangement will never come into general use.

Another means of attempting to make Smith's vacuum brake self-acting, in case the train becomes divided, is to attach the ordinary communication cord to the handle working the vacuum brake upon the engine. This plan is obviously unsuitable—as, if a train became divided, the cord would apply the brake upon the engine and first portion of the train; the second portion of the train, having no brake put on to stop it, would dash into the first part.

Several of the railway companies have sent in the returns asked for by the Board of Trade, showing what each is doing in the brake question, and also how many engines and carriages they have fitted with continuous brakes, and the names of the brake systems used. The returns have been printed in a tabulated form, but they are not complete, as some companies have not sent in any answer. There has been so much difficulty and delay in obtaining these returns from some of the railway companies, that on Thursday last, the 11th of April, Lord Henniker "brought in a bill" in the House of Lords, the object of which is to make it compulsory on railway companies to supply to the Board of Trade periodical returns as to the number, character, &c., of continuous brakes on their lines. This bill was read a second time last night, April the 15th.

The next meeting of the Institution of Mechanical Engineers is to take place at Paris next June. One of the papers is to be upon the subject of continuous brakes, and to obtain further information a series of experiments is to be made in a few weeks.

The Brighton Railway Company is fitting up an experimental van, with speed indicating and recording apparatus, also an apparatus to show and register the brake-block pressure exerted, and the time taken to apply each system of brake. The information thus obtained will be most complete. Trials are also to be made (like those lately conducted upon the Midland Railway) by running the trial trains upon two parallel lines at equal speeds, then apply both brakes, when it is perfectly clear to the most casual observer which is the best.

"L. L.," p. 94, mentions that the Westinghouse brake is in use upon the Lancashire and Yorkshire Railway. This company have been trying the automatic and the vacuum brakes for more than a year. They are in favour of the Westinghouse automatic, but I understand that they do not intend to spend much money upon continuous brakes till they know what the other large companies around them are going to do. The Great Eastern Railway Company have lately decided to fit several of their express trains with the Westinghouse automatic brake. I may also mention with regard to the subject of brake power upon goods trains, that the new goods engines on the Midland Railway, which lately commenced to run, have a powerful steam brake upon the engine and tender wheels, and a series of experiments is being conducted upon the Lickey Incline, Bromsgrove, to-day.

April 16. C. E. S.

SHIFTING SADDLES FOR BICYCLES.

[14263.]—Seeing a notice in the English Mechanic of a system of winding the saddle of a bicycle forward and back by the handle, I beg to ask you to publish that I have done the same thing independently, the first time I used the shifting saddle being about 20th August, 1877, in Sukkur. I contemplated such an arrangement as long ago as April, 1875. The only doubt on my mind was whether one could not have two saddles, and shift from one to the other when riding. For my own part I could not manage the latter. The use of the shifting saddle is to enable one to mount more easily and descend hills more safely, by causing the hind-wheel brake to hold. The brake, however, requires a second handle at least. I see no simpler way of arranging it. R. H. Froude.

Ex. Engineer, W.S.R.

Ahmadpur, Bahawalpur State, India, March 13, 1878.

PROFESSOR MILLS ON DESTRUCTIVE DISTILLATION.

[14264.]—I much regret that your anonymous correspondent, in the last number of this journal, cannot agree with your favourable notice of my "manualette" on the above subject. With regard to his criticisms I have to remark (1) that I have nowhere suggested, as he seems to imply, that naphthalin is the only cause of coal-tar being heavier than water; (2) I have not said that tar yields "10 per cent. of (light) naphtha," but "10 per cent. at most of light naphtha;" (3) I have expressly warned my readers that "rigorously pure ammonia cannot be prepared by any direct process from the watery liquor" in the paraffin industry, and have pointed out that there is still less chance with "ordinary gas-liquor;" I have not said that pure ammonia can be obtained thence, either by the lime process or any other. (4) The lime process is not mine; it has been worked for years with excellent results. Your correspondent's remaining allegations as to my statements are correct, and I must submit to the misfortune of his figures being different from mine. All I can do is, to enable your readers, if I can, to attach due weight to what we respectively say. He is an anonymous writer, having, as he asserts, 20 years' experience, and stands convicted, as above, of four misrepresentations. I have been for 15 years, more or less, a chemical student of destructive distillation. I know the practice, not of one manufacturer only, but of very many, and how it has changed from time to time with new demands; I am also familiar with the greater portion of ancient and modern literature on this subject.

The little work which he and you have characterised so differently is a summary of the average practice of many hundreds of manufacturers, and the inquiries of many scientific investigators. I should, I am aware, be the last to put the question; but, to use your correspondent's words, which of us is the more likely "to lead the novice astray?"

Anderson's College, Glasgow. Edmund J. Mills.

THE ELECTRIC PEN AND THE BLIND.

[14265.]—I have lately had occasion to use the patent electric pen, and the idea has occurred to me that this instrument could be very suitably used by or for blind persons. I mean that the punctured writing (at present used as a stencil, from which numbers of copies are printed) could be used as an original communication. Any one acquainted with the electric pen will understand this. The pen, while writing, makes about 150 punctures per second, and these punctures naturally make raised surface lines on the paper of the shape of the letters formed.

I think that such outlines could be easily felt and traced by the delicate and practised touch of a blind person. Thus any communications may be intelligibly conveyed to and from the blind. Jib.

UNFERMENTED BREAD.

[14266.]—I agree with "A Physician" that this subject has not received the attention it deserves. Some time ago I sent a query on the subject, hoping to elicit a good deal of diverse opinion; but it fell flat with only a few replies not much to the purpose. We have used this bread for about 4 or 5 years, and consider it much more wholesome than fermented, whether baker's or home-made; especially if whole wheat meal (ground at home to make sure you get it) is used instead of white flour, or added to it in the proportion of one-half or quarter. Our method is to keep the $NaHCO_3$ ready weighed in 110-grain packets, and the HCl in a dilute state (24oz. HCl of sp. gr. 1·16 + 56oz. H_2O), so that 8 fluid drachms of it is the right quantity for one packet of soda, and for 13lb. flour and meal. This is rather more than "A Physician" finds necessary; and, further, we use no salt. Unless the flour and soda are well mixed before adding HCl and water, there will be yellow spots in the loaf from the undecomposed alkali. The baking requires a good oven, or the crust will be very hard and the interior sticky. You must use good flour (when you can get it); nothing detects the bad article quicker than this process of bread-making. Has "A Physician" ever noticed his bread get moister when two days old than when new? It seems as if the NaCl in the loaf deliquesced: but ordinary bread containing perhaps as much salt, certainly gets drier by keeping. Is it that the NaCl formed in this way is more deliquescent than table salt? Has the HCl or the $NaHCO_3$ any action on the flour before they combine? That is a point well worth the most careful investigation by any one possessing the requisite delicate apparatus and power of manipulation and leisure.

Theoretically, the "Aërated" process of making bread is preferable to the above. There the CO_2 is generated separately and passed into flour and water, obviating any risk of contamination from impure chemicals, or the point just mentioned. But, practically, it is made so salt that we cannot eat it. The whole bread question wants overhauling, and I hope some of your correspondents, numbering representatives of all classes, and almost all countries, will give the world the benefit of a discussion thereon.

Daghbert.

Errata.—A Good Suggestion.—Letter 14234, p. 143.—"Wednesdays" should be "Tuesdays" and "also," in last line, "alas."—B. K. H.

Coal in Queensland.—A seam of coal of excellent quality has been found at Walloon, Queensland. The seam is 9ft. in thickness, and is expected to prove a good export coal. Mining, which had scarcely an existence in this colony at the date of separation in 1859, is now carried on extensively for gold, copper, tin, and other metals, besides coal, and the annual yield of gold alone is now worth considerably more than one million sterling. During 1877 the gold obtained from the Gympie goldfield amounted to 41,528oz. Gympie is situated about 116 miles north of Brisbane. Gold was discovered in the district about October, 1867.

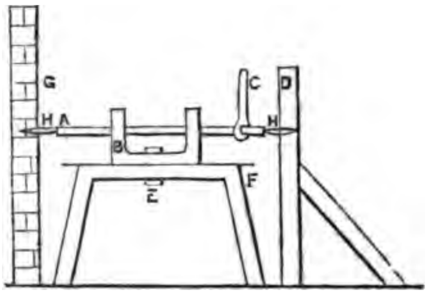
REPLIES TO QUERIES.

**** In their answers, Correspondents are respectfully requested to mention, in each instance, the title and number of the query asked.*

[31108.]—**Dresden China.**—I believe the peculiarity of this consists in its being ornamented all over with small four-petaled flowers, something like Forget-me-nots. I think the china groups of figures (milkmaids with solid china pails, &c.) are Dresden ware.—Murano.

[31161.]—**Tooth Powder.**—The best is, equal parts of Armenian bole and myrrh, powdered.—Murano.

[31758.]—**Lathe (U.Q.).**—As this query seems that it is never to be answered, I venture to help "H. A. H." First of all have your lathe-stand ready; fix in it, place the headstock, and bolt down; bore a hole in the wall the same height as centre of headstock, drive a plug of wood in; get two steel points, drive one in the plug of wood, erect a post, and drive in the other steel point at a true centre or



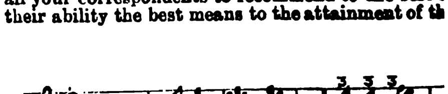
level with the first. Next procure a cutter bar and ratchet brace; fix ratchet brace on end of cutter bar, put it through the headstock, and fasten at both ends with steel points, and work away. A, cutter bar; B, headstock; C, ratchet brace; D, post; E, bolt and nut to fasten headstock; F, lathe-stand; G, wall; H, steel points.—Telescope Tele.

[31875.]—**Japanese Tools.**—"Anxious" can see a collection of Japanese tools at the South Kensington Museum. They are in a room under the National Portrait Gallery, in the Exhibition block of buildings. Some of them (the tools, not the museum buildings—*they* are anything but handy) have a very handy appearance. Some one mentioned the Japanese style of using a saw some time since, and some one else talked about sawing before a looking-glass, &c. I cannot see the necessity for that. I have found it very convenient myself to pencil the pattern on the upper side of the wood in the usual manner, and then saw backwards—i.e., make the upward pull-stroke the cutting stroke—of course using a frame saw, and reversing the blade. You are not so liable to split the wood in sawing this way, and it makes a cleaner cut; but it is rather a slower process.—Murano.

[31878.]—**Engines on S. and D. Joint Line.**—I do not see that any useful purpose can be served by continuing this discussion, as I can only again repeat that neither engines nor boilers have been built at Nine Elms for years past, and certainly none have been built there at any time for the S. and D. line. This fact is well known to every one at Nine Elms, and the London and South-Western Company's published accounts each half year will confirm the truth of what I say. I (in common with several others) have waited with great curiosity all the week to see whether your mysterious correspondent "S. D. J. R. Loco.," would put in his promised appearance; but I need hardly say that he did not; neither did he come on the previous occasion to which he refers, for the very sufficient reason that there neither were, nor are, engines or boilers under construction at Nine Elms for him or any one else to see.—The New Clock.

[31878.]—**Somerset and Dorset Line Engines.**—Without entering into this discussion I should lik to say that I have spent nearly every day for ver many years past in the Nine Elms shops, but I hav never seen nor heard of any engines being built ther for the above railway, and, although I am now get ting on into years, I am neither blind nor deaf.—Erector.

[31809.]—**The Flute.**—I believe it is the desire o all your correspondents to recommend to the best o their ability the best means to the attainment of th



end desired. I endorse "Old Amateur's" advice a to careful study and hard practice as the best lubr cators of a flute—that is, if it is really your instru ment. Referring to the late Charles Nicholson, to his music I owe my ability to play, and there are numberless instances in his "Beauties for the Flute" of the facile manner in which passages can be rendered by the long F♮ key, which could not be well rendered with the short F♮. I grant for general purposes the short F♮ is the most used. Let "Enquirer," or any one else acquainted with the flute, try the following passages in the different keys, and they will soon ascertain whether the long F♮ is best, or rather the only one suitable for such. Respecting long C keys, it should have been long C keys at the bottom of the flute. I care nothing about it, as it injures the tone, in my opinion, of the instrument, although at one time the flute, by means of keys, used to go down to middle G. See James's "Hour or Two on the Flute."—J. Cridland.

[31937.]—**Telegraph Dials.**—I think these are made of cardboard (hard and thin), with emerald-green paper pasted on one side.—Murano.

[31939.]—**G. N. Eight-coupled Engines.**—My answer on p. 433, No. 668, is correct. There are only two south of Finsbury Park—Nos. 472 and 473. Since I wrote that answer they have both been fitted with storm-boards and housing. The following is a list of the shunting engines south of Finsbury Park:—Nos. 111, 117A, 134, 139, 140, 144, 149, 162, 472, 473, 603, 498, 499, 604, 605, 612. The first eleven belong to King's-cross goods yard, and the last five to Clarence-yard. Nos. 498, 499, and 612 go to Blackwall.—Murano.

[31976.]—**Compound v. Ordinary Condensing Engines.**—On page 72 "Marine Engineer" says John S. Sunderland did a bad day's work when he abandoned his faith in the compound engine. I, however, think different. My reasons for doing so will be seen as we proceed. He then says that "the only fault I charge it with is the loss of heat in the transmission of steam from one cylinder to the other," concerning which he graciously informs me that it is a mere trifle. In reply, permit me to ask "Marine Engineer" if he does not think it advisable to save the "mere trifle" by disposing of the necessity for passing steam from one cylinder to the other by using it up in the first cylinder? He then criticises my statement that in the single cylinder engine all this heat is lost in the cylinder, and therefore performs duty. I think "Marine Engineer" must have read my letter in a rather loose manner, or he would have perceived that it was of the heat lost in the waste-room, &c., that I was then writing. And it is a fact that cannot be gainsaid, that if the loss from re-evaporation be the same in both engines, the heat which is wasted in the ports and other waste-room of the compound, will, in the single cylinder engine, be utilised in the propulsion of the piston, and the duty of the single-cylinder engine will exceed that of the compound in proportion as the loss of heat between the cylinders of the latter is great or small. "Marine Engineer" then makes a very vague attempt to prove that the compound engine absorbs more heat into the metal of the cylinder than the single-cylinder engine. He says "the top steam port of the high-pressure cylinder of the compound opens, steam enters at 75lb. absolute per square inch, and the piston passes down until a certain capacity is filled with steam. While this is going on the bottom end of the cylinder is open to the receiver, and filled with steam at, say, 25lb. absolute, or considerably above boiling point, and therefore retaining the latent heat of the steam. He then proceeds to say that when the point of cut-off is reached the measure of heat for that stroke is finished. I don't dispute that in the least; but when he says, "Now turn to single-cylinder engine; the top steam-port opens as before, and continues open until the same capacity has been filled as before," I feel that I must take exception to that statement. If "Marine Engineer" will think he will at once perceive that the steam must be cut-off much earlier to effect a given rate of expansion in one cylinder than it would have to produce the same rate of expansion in two cylinders, so that the measure of heat would be somewhat less in the case of the single-cylinder engine. As to the loss of heat being the only fault, the compound has many, besides that it is a much more costly engine, more complicated, and certainly not half as neat as a properly-designed single-cylinder engine of either class, marine or stationary. I need not say any more, as "Marine Engineer" will perceive by my letter, in the issue of April 5th, to F. H. Wenham, what means I should employ amongst others to render a single-cylinder engine more economical than any yet constructed.—John S. Sunderland, Armitage Bridge, near Huddersfield.

[31982.]—**Sending Caustic Soda by Rail (U.Q.).**—Caustic soda, when made, is ladled direct out of the pots into wrought-iron drums of about 3cwt. each, in which it becomes stiff. These drums are not only sent by rail, but are exported to all parts of the world. The orifice through which the liquor is poured is only about 4in. in diameter.—Corcyra.

[31994.]—**Pompeii.**—"The Buried Cities of Campagna," by Davenport Adams, is interesting and reliable, and contains the titles of all the best works on the subject.—Murano.

[32103.]—**Organic Chemistry.**—On page 610, Vol. XXVI., Mr. William John Grey gives some characteristics whereby normal, secondary, and tertiary alcohols may be distinguished from each other. These characteristics mainly depend on a progressive lowering of the boiling points which generally accompany a progressive increase of the percentage of carbon contained in the molecule. Thus the percentage composition and boiling points of the three alcohols named are as follows:—

	Normal.	Secondary.	Tertiary.
Carbon	60·00 ...	64·86 ...	68·18
Hydrogen ...	13·33 ...	13·51 ...	13·64
Oxygen	26·67 ...	21·63 ...	18·18
	100·00 ...	100·00 ...	100·00
Boiling Points	115° C. ...	95° C. ...	82° C.

The other conditions which determine their difference is their deportment, and the products they yield on being oxidised with chronic acid. My object, however, in writing just now is to draw Mr. Grey's attention to another very interesting research on the subject, by Victor Meyer and J. Locher, which appeared in the *Berichte der Deutschen Chemischen Gesellschaft zu Berlin*, No. 16, 1874, under the title of "Diagnosis of Primary, Secondary, and Tertiary Alcohols, and Alcoholradicals by Colour Reactions." The following is a brief abstract from that article:—"Should we require to determine whether an iodide of the $C_nH_{2n+1}I$ series contains a primary, secondary, or tertiary alcohol radical, we distil it with argentic nitrite, and treat the distillate with potash and nitrous acid. If a red colouration is produced (formation of nitralic acid) it is certain we have a primary alcohol radical. A blue colouration indicates a secondary, and the absence of colour shows a tertiary. As these alcohols are very easily converted into the corresponding iodides, and then again into the nitro-compounds, it suggested the idea that the colour appearance might advantageously be made use of as a means of distinguishing very small quantities of primary, secondary, and tertiary iodides, and consequently the alcohols. The authors say they have found that ·3—·5 gramme is sufficient to decide the question. With iodides poor in carbon, such as the methylic-propylic series, the reaction with the nitrogen compound is very easily effected, and it is found that ·3 gramme is sufficient for the production of the characteristic colour. In the secondary and tertiary series, which are rich in carbon, ·5 gramme will be required. And in compounds very rich in carbon 1 gramme is to be recommended. To carry out the experiments the following arrangement has been found suitable. Take a distilling flask of a few c.c. capacity, with a limb 4 or 5in. in length blown on the one side, introduce a small quantity of dry NOAgo (double the weight of the iodide) previously incorporated with its own volume of fine white sand; now add the iodide, and wait a few moments until the reaction begins, when it may be distilled over the open flame without the aid of a condenser receiving the distillate, which consists of several drops in a narrow test tube, which displays the characteristic reaction with great distinctness." The following are the results of a trial experiment on an alcohol of each series as given by the authors. Primary series: "0·3 gramme Iodmethyl wurden in der beschriebenen Weise mit 0·6 gramme NOAgo destillirt. Das aus etwa 4 Tropfen bestehende Destillat wurde mit ca. dem 3 fachen Volum einer Auflösung von Kalium-nitrite in concentrirter Kalilauge geschüttelt, die Flussigkeit mit etwas Wasser verdunnt und verdunnte Schwefelsäure zugesetzt. Die ersten Tropfen bewirkten eine intensir dunkelrothe Farbung; durch weiteren Zusatz verschwand dieselbe, und die farblose Flusigkeit gab nun, mit Kali versetzt, wieder die rothe Farbung, die sich durch abwechselnden Zusatz von Säure und Alkali beliebig oft aufheben und weiderherstellen liess. Das Iodur war also in der augenfälligsten Weise als ein primäres characteristirt." Secondary series: "·3 gramme secundäres Iodpropyl wurden in der beschriebenen Weise mit ·6 gramme NOAgo destillirt und das Destillat mit der Auflösung von Kaliumnitrit in Kalilauge geschüttelt, Auf Zusatz von verdunnter Schwefelsäure nahm die Flussigkeit sogleich eine tiefblaue Farbe an, die auf Zusatz von Kalilauge sich nicht veränderte. Durch Schütteln mit Chloroform wurde die wässrige Lösung entfärbt, und das Chloroform sank als tiefblaue Schicht zu Boden. Noch brillianter gestaltete sich der Versuch bei Anwendung von ·5 gramme Isopropyliodid. Hier konnte man die Abscheidung des blauen, halbfesten, beim Erkalten erstarrenden Propylpseudonitrals deutlich beobachten. Das Jodür hatte sich also in der unzweifelhaftesten Weise als ein secundäres zu erkennen gegeben." Tertiary series: "·5 gramme tertiäres Iodbutyl (dargestellt durch Einleiten von Isobutylen in rauchende Iadwasserstoffsäure und Reinigung des Produktes durch Rectification) gaben, mit 1 gramme NOAgo destillirt unter Entwickelung von Isobutylen, ein durch etwas Iod gefärbtes Destillat. Dasselbe wurde mit der Kali-Kaliumnitritlosung geschüttelt, Schewefelsäure zugefügt und die durch abgeschiedenes Iod sich dunkel färbende Lösung mit Kalilauge versetzt. Es wurde sofort eine farblose Lösung erhalten. Der Wersuch, mit 1 gramme Iodür wiederholt, ergab genau dasselbe Resultat. Es Zeigte also der Versuch in augenfälligster Weise, dass man es weder mit einem secundären noch primären Iodur zu thun hatte.".—R. Tervet, Clippens Oil Works.

[32106.]—**Chemical (U.Q.).**—Oxalic acid, non-deliquescent; ammonium bromide, non-deliquescent; A. chloride, non-deliquescent; A. oxalate, efflorescent; A. sulphate, non-deliquescent; barium nitrate, non deliquescent; bleaching powder, deliquescent; iron arseniate, non-deliquescent; I. phosphate, non-deliquescent; ferrous sulphate, slowly effloresces and oxidises in the air; ferric sulphate, deliquescent; magnesium sulphate, deliquescent; manganous sulphate, deliquescent; potassium bromide, non-deliquescent; P. carbonate, deliquescent; P. ferrocyanide, non-deliquescent; P. nitrate, non-deliquescent; sodium hyposulphite, efflorescent; S. oxalate, non-deliquescent; S. sulphate, efflorescent; stearine, non-deliquescent. I am not quite certain about iron arseniate and potassium bromide being non-deliquescent, but if I am wrong hope some one will correct me.—Eureka.

[32269.]—**Systematic Memory (U.Q.).**—There is a book, entitled "Mnemotechny, or Art of Memory, Theoretical and Practical, with a Mnemotechnic Dictionary, by Pliny Miles," published by E. Churton, 26, Holles-street, 1850. I suppose it is out of print now, but if it could be obtained second-hand would give what is required. The art lies in the association of ideas. For instance, if we wish to remember the date of an event we try and connect it with some fact, or we can make up a sentence, and it may be the greatest absurdity, being all the more easy to remember: "London founded by the Romans is now the largest city in Europe." In the word Europe we have the date when London was founded. You first strike out all the vowels—viz., e u o e—then, in the following order we have r signifying 4 and p 9, gives us A.D. 49. The following is the key: Each letter in the alphabet represents a figure, except A E I O U W H and Y:—

1	2	3	4	5	6	7	8	9	0
T D	N	M	R	L	Ch soft or like tch. G soft J Sh Zh	C hard G hard K Q	F V	P B	C soft S Z when it sounds like S.

You must commit this table to memory, and then it is easy to dissect the last word of the given sentence. The advantage of having the book is that it contains a copious dictionary, from which we can have a choice of words that will represent the number required to be remembered. It also gives numerous tables of historical events—ancient, middle age, and modern kings of England, ordinary events, latitudes and longitudes, specific gravities, &c., with the necessary words already associated, thereby saving much time. If the book cannot be obtained the student can make one for himself by writing down various nouns and ascertaining their value, then arranging them consecutively. A good and useful entertainment may be easily managed in the following manner:—Obtain a number of cards, and upon each write some historical event, with the date in figures. By the aid of above commit them to memory; it is surprising how quickly this can be done (when the associations are good) by any one of ordinary capacity, because in many instances the associations are so absurd that it is impossible to forget them. Take the following:—The quadrant invented by Godfrey is divided into *degrees* = 1740; vaccination first practised by Dr. Jenner, a London physician, who had a splendid *equipage* = 796 (we know that it did not happen at this time, but if we add a thousand to it we get the proper date); do the same with the following:—The microscope, invented by Jansen, enabled him to see millions of animalcula in *a wash tub* = 610; St. Paul's is surrounded by *gates* = 710. Now distribute these cards amongst your friends in a room. One of them reads the event only, and you immediately give the date it happened, and if the audience do not knew the secret you can astonish them by the rapidity with which this can be done. I was once acquainted with a gentleman who had from day to day committed to memory about a hundred or so various dates, and when before a public audience he always gained applause, the favourite trick being for some one to write down an addition sum, and in five minutes he would commit it all to memory, and tell you what was the fourth figure of the fifth line without any hesitation.—Theo. Izod.

[32331.]—**Engine-room Artificers.**—On p. 46 "C. E. K." gives full particulars of the circular under which all engine-room artificers have recently joined; but, for the benefit of fitters, boiler-makers, engine-smiths, and copperers, I wish to say it is simply a delusion. Some considerable number have joined. The circular being sent to them, they repair to the naval ports, present themselves, are tested as to their mechanical abilities, and pass a certain examination under inspector of machinery, surgeon, &c. Having passed, they may say good-bye to the circular, so far as it guarantees anything. They will find themselves subject to all sorts of annoyances and interference, and, in addition to the uniform laid down, will be ordered to wear a badge and conduct stripes, the same as worn by seamen. Appeals to the officer commanding, under whom some 100 are now serving, will be followed by the reply that the Admiralty can alter rules at any time as they think proper. If, sir, this can be done, what next are we to expect? Trusting you will give this insertion in your next, so that mechanics will not be misled.—One who was Misled by "Fair Promises."

[32343.]—**Cleopatra's Needle.**—Prof. Donaldson, in a lecture reported in the *Building News*, said that the base was 7ft. 10·3in. by 7ft. 8in., and the summit 5ft. 1·3in. by 4ft. 10·25in.—Murano.

[32319.]—**Zincography and Blocks for Printing.**—Mr. Ernest A. Nuth seems to have at length taken into consideration some of the difficulties of zincography—that, whereas the manipulative process is the same as in lithography, yet the lithographer must go through an apprenticeship before he can work with zinc. But it seems to have escaped the attention of Mr. Nuth that the zinc plate, when being printed from, requires to be kept moistened with gum-water, and this so affects the ink roller that it has to be scraped off for every 8 or 10 impressions worked off, and so greatly retards and annoys the printer. These and other disadvantages have proved too much for that much-maligned individual, the British workman, and so he gave it up. Hence the British workman is taunted with being conservative; but, until the changes he adopts are improvements, I hope he will still cling to the conservatism of common sense. No doubt zinc blocks may be produced (theoretically) by etching, but I think we have very little proof of this being yet successful. Mr. Nuth refers to the work Messieurs Gillot and Zimmerman do; but their work is not known to the public here. He also refers to the *Figaro*; and all I shall say with regard to that is. the sooner zinc plates are left aside the better. From the fact that *savants* like Dr. C. W. Siemens, after devoting time and attention to zincography more than 30 years ago, gave it up, I think it is too bad to be so hard on the British workman—the more especially when no specimens of the vaunted work are easily obtainable. Could not some galvanic process be used instead of the etching to produce the blocks suited for the typographical printing-press?—D'Evlyn.

[32362.]—**Underground Tubes.**—There are two processes of protecting iron from rust by creating a film of magnetic oxide on the surface; but whether either of them is commercially worked or is applicable to tubes I cannot say. I think if "Mechanic" heated his tubes until they became just too warm to be comfortable, then dressed them with boiled linseed oil, and subsequently coated with a coat of whiting mixed with size alone, he would find that corrosion might be disregarded for many years, especially if in laying the pipes he could bed them in flue dust, cinder dust, or some other dry powder, which would lie close and keep out the oxygen of the atmosphere. I have assumed that rusting is what is meant; for corroding is usually applied to internal rust, and for that I know of no remedy save purifying the liquid passing through the tube.—Essar.

[32362.]—**Protecting Iron Tubes.**—Make a rough wood box, without ends or top, the whole length of the pipe; stop up all holes in the joints of the wood with clay or putty, and then pour melted pitch over the pipe enough to cover it. The Imperial Gas Company (North London) serve all their pipes in this way now.—Murano.

[32363.]—**Dry Soap.**—If "C. S." means one of the washing powders he should say which, as dry soap may mean some preparation of potash and resin, with fat, formed into a powder, ground soap, bark, or something else unknown to me.—J. L. K.

[32365.]—**Phonautograph Curves.**—I do not think that any work contains phonautograph tracings representing the sounds of the various organ stops, not to speak of different musical instruments.—E. M. H.

[32370.]—**Marine Examinations.**—A candidate for a second-class engineer's certificate must (1) have served an apprenticeship to an engineer, or must prove that he has been engaged for three years in the making and repairing of engines; he must also have served one year at sea in the engine-room; or he must have been four years in the engine-room at sea; he must be well acquainted with the construction of engines and boilers, understand the use of the barometer, thermometer, hydrometer, and salinometer; the causes, effects, and usual remedies for incrustation and corrosion; must give evidence that he understands how to repair defects from accident or decay, and is competent to manage boilers and engines; he must write a legible hand, understand the first five rules of arithmethic and decimals, and show that he comprehends the nature and purposes of the various parts of different kinds of engines. I would recommend a perusal of the "Engineers' Manual," published by T. Ainsley, South Shields.—Condenser.

[32376.]—**Scale in Boilers.**—Soda is perhaps as useful as anything in removing scale; but the tannate of soda is highly recommended. As to introducing heavy petroleum, it can be done easily enough by the apparatus represented on p. 67.—H. L.

[32382.]—**Globes.**—Would "F. R. A. S.," Mr. Lancaster, or any kind reader reply to my query on page 24 on globes, as I am anxious to use them? The printer has made a mistake in the query, printing "*not* lettered from 'British Catalogue'" instead of "lettered from 'British Catalogue.'"—Cornishman.

[32384.]—**Telescopes.**—The back numbers of the English Mechanic contain numerous designs for mounting the diagonal plane of a Newtonian telescope. I am still using the form I described fully, with drawings, in Vol. XII., No. 307, Feb. 10, 1871. I have seen various forms before and since then, but up to the present time have seen none that appear to me to comply with the various conditions so completely as this.—A. Woolsey Blacklock, M.D.

[32387.]—**Lionite.**—The questions asked by "Americus" are, by their very nature, likely to remain unanswered. What is lionite—the "new material for picture frames"—like? It may be bois-durci, carton pierre, or some similar substance; but "Americus" gives no clue. I am afraid his conditions preclude the possibility of obtaining what he wants, which is evidently something unknown, and therefore suitable matter for personal experiment. A substance, elastic, waterproof, and strong, that could be laid on in solution, and withstand all ordinary temperatures, would be extremely valuable. —Scottus.

[32390.]—**Defective Hot-water Pipe.**—If 7 seconds represent the probable time that such a pipe would be emptying itself, it is probable there is a stoppage, as pipes 1in. diameter choke very quickly. It is impossible to say what is the cause without more details. Steel pipes close up just as quickly as iron. The remedy is to purify the water. —Renovo.

[32394.]—**Indiarubber Stamps.**—Steam heat and pressure must be used—not the heat of an oven.—Nemo.

[32398.]—**Circulation of Steam.**—I wish to remind Mr. R. Gatenby that his plan and the plans "Omega" and I described are each at least as antiquated as one another. If he will kindly look at query 32398 he will see that Mr. Carter had the pipes laid down in the way he advises on page 124; at least, the only difference was that he had the return pipe a little higher, which would not give any more heat. "W. G.," answering this query on page 76, says: As to the continuous circulation round the pipes, correctly speaking there is none, the pressure being the same at both inlet and outlet." This is true—still there is a certain amount of heat. The fact that Mr. Gatenby's plan was already in use and did not do its work caused Mr. Carter to say he wanted a continuous circulation round the pipes. This caused myself, and of course "Omega," to advise the plans whereby we knew he could get as great a circulation, or even greater, than he required. As to economy there is no cause of complaint. — Chelt.

[32403.]—**Lathe.**—It ought to be 20 gear into 15 teeth wheel. If a 4-thread leading screw use a 20 teeth wheel on mandrel. Leading screw 4 threads of what you want to cut. Supposing you want to cut 7 threads—

7 20 mandrel
5 = 4th of 20

35 = 35 screw.

Again, 9 20 mandrel
5

45 = 45 screw.

—Telescope Tele.

[32403.]—**Lathe.**—As regards the latter part of this question, P. Adelphi will find an answer in almost any back volume, as various methods of finding the wheels to cut different-pitched screws have been frequently given. There are also many tables published.—Renovo.

[32418.]—**Royal Engineers.**—A recruit in the Royal Engineers has to learn his drill for the first 3 months after enlistment, taking his turn for guards and sentries, cook's mate (in the performance of which duty he will have to look after his barrack-room, clean and tidy it, and bring the meals from the cook-house for his comrades in the same room), &c. When the recruit is efficient in his drill he passes through the field work course for about another year, during which time he learns his practical work as a Royal Engineer, and after this course is completed it is optional for him to go in for the special branches of telegraphy, torpedoing, &c. But all this time the sapper is liable to be called out to drill with his company (which is about twice a week), as he is still a soldier whatever his other duties may be, and smartness is required in him at all times. Every sapper, on enlistment, has two defaulter sheets (a company and a regimental one), which are kept in his company office, and in which all offences (whether company or regimental) are respectively entered into one or the other according to the degree of the offence. These offences are specified, and are known to every man; but it is quite easy for any steady man to keep both his defaulter sheets clean. After 6 months with a clean company (and, of course, regimental) defaulter-sheet, the recruit may become a lance-corporal, if a vacancy occurs, and every succeeding step of promotion to 2nd corporal, full corporal, sergeant, quartermaster-sergeant, and sergeant-major, takes, on the average, about two years to get, provided no regimental offence of any great consequence is recorded against him—if there is one he is thrown back for a certain time. Good conduct brings with it badges (up to 4 in number), each badge entitling the wearer to 1d. a day extra pay, but on punishment for any regimental offence these G.C. badges are taken away and have to be regained; G.C. badges also increase the pension of the soldier. The Queen's regulations lay down the degree of the offences and the corresponding punishments, and they are always available for every man's perusal. Ignorance of the law is no excuse, though for the first one or two offences, if not severe, the recruit is admonished only. Promotion is by seniority in the branch of the service in which the sapper is employed. For ordinary promotion a second-class school certificate is required, which embraces arithmetic as far as vulgar fractions and decimals, writing, and dictation. But a first-class certificate is required before a commission can be obtained. A man can have as many examinations as he likes in order to obtain his certificates. With a clear company defaulter-sheet for two years, and a recommendation from the commanding officer, military clerkships (of which there are three classes, one higher than the other) are open to the men, after three months' trial to see if they are fit for the post. Also posts as military foremen of works can be got by passing examinations to show qualification. As there are three classes of military foremen of works, three examinations will have to be passed, one for each class, in order to reach the highest class. Both these especial appointments bring the privilege of extra pay. In other cases the men serve with their companies or in detachments, at home or abroad, performing the different trades that they have learnt (at the School of Military Engineering at Chatham) on Government works. Examination for the men to get commissions is not possible; commissions as quartermaster and riding master (if in the mounted branch) are given to sergeant-majors by recommendation only, combined with length of service. Extra pay, according to proficiency, is given, besides regimental pay, for all non-regimental work, even to the recruit while learning his work, and kit, lodging, fuel, &c., or a substitute in money, are always given free to every soldier. The daily rates of pay are as follows:

	s.	d.	
Sergeant-Major ...	5	1½	
Q.M. Sergeant ...	4	3½	Additional pay of 2d. a day after two years' service in the rank.
Compy. Ser.-Major	3	5½	
Sergeant	2	11½	
Corporal	2	2½	Additional pay of 1d. a day after two years' service in the rank.
2nd Corporal ...	1	11	
Sapper	1	1½	

Sappers, 2nd corporals, and full corporals get an addition pay of 1d. per day for each good conduct badge, up to 4 in number. The above is for regimental pay alone, and besides this every sapper gets working pay at the following rates, according to his proficiency:—

A rate	...	3d. per hour.
B „	...	2½d. „
1st „	...	2d. „
2nd „	...	1⅓d. „
3rd „	...	1d. „
4th „	...	¾d. „
5th „	...	½d. „

which is clear pocket money to him, as he can easily live on his regimental pay.—Lt. R.E.

[32472.]—**Wire Tramway.**—I am much obliged to "T. G. S." for his description of a wire tramway at Aalsund, Norway, although it is not exactly what I require, being only applicable under special circumstances (as at the place he mentions) where the sending station is far above the level of the receiving one, and where the line is comparatively of short lengths, so that no other motive power is required beyond that furnished by the descending load which draws up the empty cage. The Wire Tramway Company some years ago professed to be able to work lines several miles in length through the roughest country, over hills, across valleys, and even round curves or return angles. Several lines 4 or 5 miles in length were constructed by this company (who had works, I believe, at Battersea), and sent to France, Spain, and other countries, but I have never heard whether they are still in use or not. The wire tramway, patented by Mr. Hodgson, consisted of an endless wire rope running on grooved wheels, supported on posts placed from 100 to 500 yards apart, according to the nature of the ground. This rope passed round sheaves on grooved wheels fixed at each extremity of the line, one of these being in communication, by suitable gearing, with a steam-engine, water-wheel, or other available motor, and in this way the rope was made to travel at a speed of 10 miles per hour, if I remember right. A number of small boxes or buckets containing the ore or other material to be carried were suspended from 50 to 100 yards apart on the rope, and the arrangements by which they were taken away from the sending station and placed on the travelling endless rope, which was never stopped, was extremely ingenious, as also the way in which they passed over the supporting pulleys, were received at the other end of the line, were emptied and again placed on the wire rope at the rate of about 200 per hour. Great credit was due to Mr. Hodgson and his assistant, Mr. W. H. T. Carrington, for the working out of the various details connected with his system, and I am surprised that such lines have not come into general use, especially in mining districts, where they would be invaluable. Can any of your readers inform me why so little has been heard of these lines, and if any of those constructed by the Wire Tramway Company are still at work, and if they give satisfactory results? I believe one line on this principle was sent out by the Wire Tramway Company about 4 or 5 years ago to Bilbao, Spain, for the carriage of iron ore; particulars would oblige—Etna.

[32472.]—**Wire Tramways.**—A wire tramway somewhat on the principle described by "T. G. S." was in use a few years ago by the Pestarena United Gold Mining Co., Limited (and, for all I know, may be working still), for bringing ore from their mines near Pestarena, at the foot of Monte Rosa, to the main road, whence it was carted to the reduction

The "permanent way" consisted of a wire htly stretched from one side of the valley to ', and so on, in a zigzag fashion, in several e entire distance required. The rolling nsisted of a small grooved wheel, from s suspended a sack containing about 1cwt. The sending station was, of course, at a vel than the receiving one, so as to give inclination to make the grooved wheels, ir respective loads, run freely down the t the extremity of each span a man was re- o receive the sacks of ore, and to transfer the next, and so on until the lower terminus hed. The empty sacks and little carriages carried back by boys, and it will be readily s in this manner a number of persons were to work a line, and must have seriously l the expenses. A wire tramway was also y Mr. Hodgson for his company, for the of ore from their mines at Val Toppa to ction works at Piedimuhera—a distance of, about two miles. The line consisted of an teel rope, driven by a water-wheel. The ore ed in little buckets, containing about ½cwt. pended on the rope, and delivered at the d at the rate of about 200 per hour, or, ons—the only expense being the wages of men required, and wear and tear to the machinery. The plan, notwithstanding the of the ground over which the line was -viz., from the mines across a valley in a an of 500 yards, and across a spur of the the bottom of another valley—appeared to mirably, but, for some reason or another, was abandoned; and it has been a matter of to me that wire tramways have not come e general use, especially in countries where means of transport is upon the backs of My object in writing is the hope that some numerous correspondents will kindly be able out the advantages and disadvantages of tramway, and to learn if any improve- ave been made lately, and if the system ed by the Wire Tramway Co. is at the time practically at work. Such lines as Pestarena and at Aalsund could only be under special conditions, and would not be e to the generality of cases where a line ired to be carried across country.—ETNA.

]—**Utilizing Flax Shores.**—I may be able "Flax" if he will advertise his name and —TORTORE.

]—**Utilisation of Flax Shores for Fire or Paper.**—Never having seen a sample of ores" I cannot speak as to its suitability for king purposes, but I would remind your ndent that the principal drawback to the such waste materials is the fact that a con- and sufficient supply cannot be insured. ste materials and raw fibres are suitable ng paper; but no manufacturer would erect ssary special plant for manipulating any of which the supply is uncertain. What the de at present requires is some new raw waste material of uniform quality, and in s and enormous quantities. As an instance cessity to be considered in introducing a erial, your readers should remember that .000 tons of esparto alone is consumed in a B.

]—**Eyesight.**—To MR. W. J. LANCASTER. following facts sufficient for the deter- of the fault in my eyesight. The observa- e made soon after rising in the morning:— listance I could read the letterpress of these quite distinctly. The "far point" for my as reached at 24in., the "near point" at the "far point" for my right eye was t 21½in., the "near point" at 19½in.; for together "far point" 24in., "near point" observed that my sight was clearer just ning them, and also when there appeared e moisture on the eye. When I placed the he sunlight the following were observed:— , "far point" 25in., "near point" 20¾in.; "far point" 24in., "near point" 22in.; , "far point" 25½in., near point 22½in. I observed that I can see more clearly when looking through the hole in a biscuit the naked eye. The effect of my sight se printed matter, and to blurr such things e blot on paper. I thank you for your ntion to my query, and await the answer BLIND BAT.

—**Blistered Hands.**—Get twopennyworth balsam, put a little in your hand, and rub e fire. Do this as often as you like.—

—**Sun-dial.**—A "CONSTANT READER." iest way to fix your dial is to go some when it is likely to be a sunny day, to the elegraph-office a few minutes before ten h time is given at ten), and adjust your the time given; then set it to solar time at where you purpose fixing the dial, and with and plummet place it horizontal; at the turn it horizontal till it agrees with the ated by the watch. Unless the watch goes all this should be done on the same day. that your dial is made for the latitude of e. Should it not—should you not under- I give, or should you wish to erect the dial ntly of your watch, I shall be glad to give both explanation and additional information.—H. H. H.

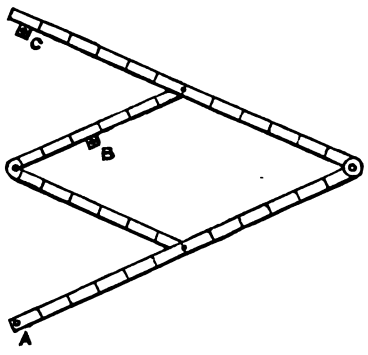
[32547.]—**Railway Rates.**—"Os," on p. 126, is very lame. There is no analogy between the cases. A railway company gets a monopoly and vested rights by its special Act of Parliament, whereas a manufacturer goes into an open market for competition with other manufacturers.—CORCYRA.

[32548.] — **The Westinghouse Automatic Brake.**—"J. F." (p. 101, No. 32548) asks "how the Westinghouse automatic brake contrives to close the ends of the tubes when any carriages break away?" If "J. F." will read my description of the automatic brake on p. 578 of last volume, he will see that when a train breaks loose it is not required that the ends of the broken brake tubes should be closed, as all that has to be done to cause the brake to instantly apply itself is to reduce the pressure of air in the brake pipe, which is, of course, at once done, when the air escapes into the atmosphere through the broken ends of the tubes.—C. E. S.

[32559.]—**Concrete Blocks.**—I would recommend "Cottager" to obtain a mould made entirely of wood, instead of from plates, and he would find it much better. If he intends to construct a house of concrete I shall be happy to give him directions.—IRISHMAN.

[32564.] — **Horns.** — "Canadian" does not say what kind of horns they are. A very large number of horns are used in the comb trade in the town from which I write, and I might be able to give him some information of value. Will "Canadian" advertise his address?—TORTORE.

[32565.]—**Pantagraph.**—I think I shall be able to tell you how to make a pantagraph easily: Purchase a two-foot rule with a joint in the centre, and also a one-foot rule, with a joint in the centre. Now put a screw through each end of the one-foot rule and let the screws go respectively into 6in. and 18in. of the two-foot rule, so that when the two halves of the two-foot and the two halves of the one-foot are at right-angles to each other, then the square shall be a true one. Now, at the lowest end of two-foot rule have a thumb-screw at *a*, so that it may be held firmly to the drawing or table, then at *b* and *c* are pencils fixed in movable slides, and I think it will be evident that when *a* is fixed and the pencil, *b* (let this be a glass one), is moved over the lines of a drawing, then the lead pencil, *c*, will reproduce the drawing. The size of the reproduction will depend upon the relations of *b* and *c*, and can be so altered as to produce either an enlargement or a reduction on the original.—W. J. LANCASTER.



[32585.]—**Friction Plate of Paper-Making Machine.**—Without sketch I should describe the friction pulley attached to reeling tackle of paper machine as follows:—A circular polished iron disc or plate is fixed to reeling shaft, and connected by a screw and wheel-handle (for tightening up friction plate) through the driving belt-pulley. There is a circular leather washer, full-size of friction plate, inserted between the polished surfaces of plate and driving pulley. The only lubrication necesssary is to grease the leather washer well before fixing.—JIB.

[32595.]—**Acacia Wood.**—A small daily dose of iodide of potassium is sufficient to preserve from the effects of poisoning workmen engaged in deleterious processes with lead and mercury, and may be of use here.—H. COLLIER.

[32601.]—**Telescope Mirror.**—The prices charged by the various makers of specula differ widely. I once bought a 6in. mirror of fair quality for 25s., while one well-known maker charges £8 10s. for a 6½in. "A." should get catalogues, and compare them, bearing in mind that the speculum is the most important part of the telescope, and that a little extra money is well spent in securing a first-class article. Specula may sometimes be bought cheaply second-hand: but I do not recommend this, unless a thorough trial can be arranged for, or an examination by a competent person. Unless, however, the speculum is mounted as a telescope complete, it requires special knowledge to test it. Eyepieces should be arranged in a series, with some definite proportion in the increase of power. I would suggest either an increase of 1½ to 1—thus: 40, 60, 90, 135, 200: or 2 to 1—thus: 40, 80, 160, 320. Then the addition of a Barlow lens would increase each of these about one-half, making them run thus: 40, 60, 80, 120. 160, 240, 320, 480.—A. WOOLSEY BLACKLOCK, M.D.

[32603.]—**Paper-Making.**—Linen rags make the strongest pulp and paper. A much simpler way to make pulp is by soaking down waste paper or shavings, but, of course, that from good raw materials is stronger and better. The best arrangement of mould I know is a strong circular hydraulic press box, with inside corrugations and perforated zinc lining to let off water. I shall be glad to furnish any further information in my power.—JIB.

[32611.]—**Glass Chandeliers.**—Use white of egg and whiting, or flour will do.—TELESCOPE TELE.

[32612.]—**Double Star.**—Webb gives the distance of the components of Castor as 4·7" (1830), and 5·7" (1865), and of γ Leonis as 2·6" (1831) and 3·2" (1865).—ARCANUM.

[32617.]—**Cast Monuments.**—"J. W." might try good hard red, blue, or glazed terra cotta or fire-clay. Oil or fine sand will keep any of these from sticking to his mould, or he might try cement or plaster of Paris. Terra cotta should not cost more than 2s. 6d. a cube foot.—CORCYRA.

[32618.]—**Revarnishing Violin.** — "Amateur" should glass-paper his violin nicely first, and then apply good spirit varnish as used by cabinet-makers. After each coat rub down with finest glass paper, give it four or five coats more, and then one with flat camel's-hair brush, taking care not to go over it in any part until each coat is perfectly dry.—IRISHMAN.

[32619.]—**Draughty Floors.**—The best way is to well scrape out all the dust, &c., and prime the joints with white lead, well mixed with linseed oil and turps, about the consistency of paint, and work it well in with a paint brush. When dry, stop with putty.—H. AUSTIN.

[32619.]—**Draughty Floors.**—Paint the cracks before applying the putty. It acts just in the same way with new window frames, unless painted first.—TELESCOPE TELE.

[32620.]—**Thermometer.**—Try it in a liquid of varying temperature with a standard glass, or send it to Loftus, 146, Oxford-street, for verification if an instrument of great finish; if a cheap one, throw it away—that is, if unreliable.—H. P.

[32621.]—**French Polish.**—I would advise J. E. Thomson to obtain some spirits of wine and white shellac, or orange shellac, if he wants a very bright buff. Put them in a bottle, let them rest for some time, and then shake occasionally. You can add shellac until you have the varnish the desired substance.—IRISHMAN.

[32626.] — **French Polishing.**— Let "Cabinet-maker" apply the French polish in the usual manner. Whilst filling in the grain of the wood you can occasionally rub down with fine glass paper as required. Be sure and dry each pad thoroughly, and free of oil, or nearly so. When you have sufficient body on, then thin your polish to half its usual thickness, and so on as before for a short time, and you will with practice bring it up nicely with care and the judicious use of linseed oil. Dry out the marks with spirits of wine only.—IRISHMAN.

[32626.]—**French Polishing.**—Your pad should not be too full of polish, and should only be touched with oil after you have given a few coats quickly. If it sticks take a clean part of your cover, and just touch it with oil as before. It will then leave a perfectly dry finish.—G. B.

[32630.]—**Phonograph.**—In my reply last week I intended to say that the phonograph could not be made to repeat songs satisfactorily without clock-work. "Songs" was printed "rings."—SPERAVI.

[32631.]—**Amateur Printing Press.**—A wooden press will do quite well, if you get one made on a good principle. I have one to print 11 × 14, and it does its work thoroughly. I supplied the drawings to a joiner, and it cost altogether 25s. The working parts are of mahogany, and there is a plate of thick zinc on the type bed and platten, which effectually prevents the type sinking into the wood. The pressure is given by an eccentric roller, and can be regulated at will. Should "Galvano" desire, I would furnish him with working drawings and full particulars of the press, if he chooses to advertise his address in "ours." I may say that it would not do for either copper-plate or litho. printing; and I doubt if any letter-press would do that sort of work. As to a self-inking press, I think that, unless a great number of impressions are required, they are of no use to an amateur. I have done 350 per hour on mine; but, of course, it depends entirely on what you are printing. Sometimes I have only managed 100 per hour, if large work. I inclose a few specimens, and shall be glad of our Editor's opinion of them.—CLYDE.

[Very good, indeed.—ED.]

[32631.] — **Amateur Printing Press.** — Some years ago I got a 10 × 8 wooden press from Fairham and Co., who advertised in this paper, for printing an amateur journal, and I have seen worse work in many a newspaper than what we did with it. At same time, I believe an iron press would be more satisfactory, and if we had the work to do again I should get an iron one, though I should hesitate about giving £5 for it. The wooden press was a very simple affair, and the materials for making it would not cost 5s. It was made of two slabs of deal, 2in. thick, hinged together with strong iron hinges at one end, the upper slab "type height" above the lower. To the other end of the lower slab was screwed a forked casting, carrying a lever of the second order, whereby pressure could be applied to the free end of the upper slab, which was covered on its lower side with thin flannel, and over that a piece of parchment, being thus "platen" and "tympan" in one. An oblong cast-iron frame ("chase") served for wedging the type in when set up. The paper was held on the tympan by a couple of bits of elastic stretched across it, answering the purpose of a "frisket." This press would not, I think, answer for litho work, but we did some wood engraving for our journal, which it printed very well.—J. Brown, Belfast.

[32631.]—**Amateur Printing Press.**—Nearly every question put by "Galvano" is answered in the "Eclectic Handbook of Printing," published by the Birmingham Machinists' Company, 19, Smallbrook-street, Birmingham (see advt. in same number as query). The best principle for any typographic printing press is that known in the trade as the bed and platten. Two absolutely flat surfaces should be brought together in perfect parallelism with each other, with a powerful and increasing pressure up to the culminating point, when it should stay and pause a moment, and then recede. The effect of parallelism is to obtain the same amount of impression on every part of the type alike, and the pause at the maximum fixes the ink upon the paper. No wood press is of practical value, though interesting as toys, and the better kinds actually do fair work for a time. The hinge variety is simply execrable. Copper-plate and litho is not done by bed and platten, but by cylinders, or a cylinder and flat surface combined. This last is the principle of Berri's press, which does all three classes of work as well as can be expected of such a tool. "Galvano" would find all the difference between the dirty and laborious operation of working a hand press, and the cleanly and expeditious work produced by self-inking machines, to say nothing of the better workmanship employed in the last class. Blankets are only used when the mechanical means of producing a level impression fails, or the type is old and uneven. New type and a well-constructed press need but the interposition of a few sheets of paper between the iron and type, to prevent the rapid wear of the latter if in actual contact with the harder metal. If requested I shall be happy to go into the question still further.—H. P. Trueman.

[32636.] — **Locomtive Gas Engines.** — Three years ago, or perhaps four, a patent was taken out for a tramway gas-engine; but, as the querist is evidently thinking of it rather in its application to velocipedes, I need not further particularise. I don't quite see what he means by velocipedes being superseded. Even if a gas motor be invented to drive some sort of tricycle (and nothing surely could be easier, for somewhat under £200), our young sinewy athletes would not thank you for the proffered relief, but would stick to their muscular exercise on their two-wheelers, which it would not be easy to supersede.—R. W. J.

[32637.]—**Pain in Back.**—As the pain of which you complain appears to be of a chronic and, probably, special nature, the better plan for your adoption would consist in consulting some skilful practitioner, instead of trusting to advice from those who, however well-meaning, could not, being unacquainted with the full circumstances of the case, pronounce an assured and proper opinion as to mode of treatment. Beware of nostrums—in themselves sad charlatans.—H. Woollen.

[32638.]—**Removing Paint from Steel.**—Benzoline will answer your purpose.—G. B.

[32638.]—**Removing Paint from Steel.**—Get a solution of strong soda and water, which will effectually take it off. After the soda and water wash well with some clean water, wipe, dry, and oil.—Telescope Tele.

[32639.]—**Pitch of Screws.**—"Nut" will find the following what he requires :—

TABLE OF PITCHES FOR SCREWS WITH ANGULAR THREADS.

No. of screw threads per inch.		Old sizes.		New standards of size. Decimals of an inch.
40	...	$\frac{1}{8}$	...	·125
32	...		...	·150
24	...		...	·175
24	...		...	·200
24	...		...	·225
20	...	$\frac{1}{4}$	..	·250
20	...		...	·275
18	...		...	·300
18	...		...	·325
18	...		...	·350
16	...	$\frac{3}{8}$	...	·375
16	...		...	·400
14	...		...	·425
14	...		...	·450
14	...		...	·475
12	...	$\frac{1}{2}$	...	·500
12	...		...	·525
12	...		...	·550
12	...		...	·575
12	...		...	·600
11	...	$\frac{5}{8}$	...	·625

—H. C. C.

[32639.]—**Pitch of Screws.**—In reply to "Nut" with regard to Whitworth's standard pitch of threads from $\frac{1}{8}$ to $\frac{5}{8}$, I can give the following :—

$\frac{1}{8}$ has 30 threads to the inch.
$\frac{3}{16}$ has 25 " "
$\frac{1}{4}$ has 20 " "
$\frac{5}{16}$ has 18 " "
$\frac{3}{8}$ has 16 " "
$\frac{7}{16}$ has 14 " "
$\frac{1}{2}$ has 12 " "
$\frac{5}{8}$ has 10 " "

—J. H. Turriff.

[32640.]—**Projection.**—"O. W. H." will find what he wants in *Engineering* for Jan. 19, 1877, p. 58.—E. H.

[32642.]—**The Telephone.**—It has been tried, but is not successful. Use thick wire, say 18 if you have it. Don't use the very thin unless you are obliged.—W. J. Lancaster.

[32643.]—**Oxide of Hydrogen.**—Hydrogen peroxide, oxide of hydrogen, or hydroxyl (HO_2 or H_2O_2) may easily be prepared on a small scale by passing carbon dioxide, or carbonic anhydride (CO_2), through water in which barium peroxide (BaO_2) is suspended. You need only get, say, a test tube, or a small beaker a few grains of barium peroxide, half fill it with water, and pass your CO_2 through it. You may test the substance by its action on PbS, it (the H_2O_2) acting on the insoluble black lead sulphide, and forming a soluble lead sulphate. The reactions are as follows :—

$$BaO_2 + CO_2 + H_2O = BaCO_3 + HO_2 \text{ or } H_2O_2$$

(Insoluble baric peroxide.) (Insoluble baric carbonate.) Hydroxyl.

or—

$$\begin{matrix}O\\O\end{matrix}\Big\{ Ba + CO_2 + OH_2 = COBao' + \Big\}\begin{matrix}OH\\OH\end{matrix}$$

$$PbS + 4\,H_2O_2 = PbSO_4 + 4\,H_2O,$$

or— $$PbS + 4\,Ho_2 = SO_2\,Pbo'' + 4\,OH_2.$$

This is the simplest way of making hydrogen peroxide on a small scale.—H. Hellewell.

[32643.] — **Oxide of Hydrogen.** — Wilson's "Chemistry" (Chambers) and Thorpe's, Vol. I. (Collins and Co.), give several methods of preparing this substance, but I have not tried them. If they are as "practical" as many of the directions in chemical books "Constant Reader" will have to buy a little additional knowledge by experience. Heat BaO to low redness in a combustion-tube while passing oxygen or air (free from moisture or CO_2) through it. A slight change of colour passes over the heated mass, and BaO_2 (baric peroxide) is formed. (If heated to full redness this BaO_2 gives off the additional oxygen, and you are "as you were.") BaO_2 is insoluble in water, but if suspended therein, and CO_2 passed through the liquid, $BaCO_3$ is formed, and H_2O_2 remains in solution. This may be concentrated by H_2SO_4 in an air-pump. Another method: — Form potassium peroxide by melting potassium in a porcelain crucible and directing a stream of air upon it. On adding this to a cold strong solution of tartaric acid, potassium tartrate is thrown down, and H_2O_2 remains in solution. — Daghbert.

[32645.]—**Paper Hanging.**—"Hopeful" would easily overcome his difficulty by using a little size in his paste; either weak glue or the ordinary patch size would do.—William Stanyer.

[32651.]—**Paste.**—Put into a basin ½-pint of flour, and add cold water gently—do not have any lumps—continue adding the water until the basin is nearly full. After put into a saucepan along with a teacupful of melted glue, and boil for twenty minutes. Stir gently the whole time. No doubt the quantities here given will be too much for what you require. You can easily divide the quantity.—Telescope Tele.

[32651.]—**Paste.**—Do not use paste. Have some good glue, not too thin; glue the case, not the lining; do a little at the time—say, for instance, back first, then front, &c.—H. Austin.

[32654.]—**The Antiquity of Man.**—It would occupy too much space to enumerate properly the calculations which have been made of the antiquity of man; and what calculations have been made are based on observations of the rate of changes in nature, and are, therefore, necessarily only approximate. M. Morlot calculates that the Bronze Age existed about 3,000 to 4,000 years ago, and the Stone Age about 5,000 to 7,000. A human skeleton found by Dr. B. Dowler in the delta of the Mississippi was estimated at 50,000 years old. But "Iscatel" will, I think, obtain all the most important information on this subject by reading Lyell's "Antiquity of Man," and also a Manchester penny science lecture, entitled "The Time that has Elapsed Since the Era of the Cavemen of Devonshire," by Wm. Pengelly; and coupled with this perhaps it will be better to read the one entitled "The Caves of Devonshire," by the same. These two last may be obtained from the publisher. John Heywood, 141, Deansgate, Manchester.—Novus Homo.

[32662.]—**Violin.**—I should recommend "Amateur" to try "Waud's Indispensable." It can be obtained at Messrs. Withers, Coventry-street, Haymarket.—H. Austin.

[32663.]—**Aquarium.**—"W. A. R." will come to grief with his aquarium if he proceeds in the way mentioned. Sticklebacks will nip off the fins and tail of every other fish in the tank; perch will swallow them afterwards, and I wouldn't place much confidence in the eels, which, by the way, are not nice fish for a small aquarium; while the trout and "miller's thumb" will not last long in confinement.
He can try them if he likes, but they will su
Instead of these I would get some carp.
member of this family, black, golden, or P
are as tenacious of life as a cat, and make
aquarium fish. The other fish he mentions
good in aquaria, and will live peaceably t
Get a dozen water snails as scavengers. V
does not grow wild in our island, but may b
in any large town at two pence a root f
naturalist's. The best plants to compen
water for loss of oxygen, however, are th
scopic ones, and the best way to manage th
have a piece of tophir for a rockwork in yo
The algæ will soon make their appearan
although nibbled off by the fish and snails
flourish in the crevices of this rough ston
water need not be changed more than once a
and then only for the purpose of cleaning
refuse. Be sure to give very little food.
to the gallon is the rule.—Nottingham Ba

[32663.]—**Fresh Water Aquarium.**—V
spiralis, the best of all aquatic plants for t
rium, can be obtained from any dealer in
It does not exist in your locality. Man
abound in the ponds and ditches, but strong
plants are useless. They will nearly all gr
or without roots, secured by a thread to
imbedded in the sand at the bottom of the t
is well to have your plants established be
fish are introduced. You will require also a
of freshwater winkles, whelks, planorbus, &c
as scavengers in keeping the plants clean,
will not thrive; without them the glass we
become opaque. All metal and putty or pai
be coated with varnish made of sealing-w
methylated spirit, or the affair will be a
About two inches of clean river sand, and a
inch of small pebbles, will make the best
Shells or calcareous substances should be c
excluded. The frame for a tank of eight c
must be very strong, and perfectly rigid. The
should be of slate, or, better still, of un
plate-glass, ⅜in. thick. The ends and sides
than 40oz. to the foot; the weight of eigh
feet of water being over 496lb., or nearly a
of a ton, and the pressure on all sides nea
that weight. I remind you of this to s
appointment. If your plants and scavenge
perfect order you may safely introduce fo
fishes for every gallon of pure river water
will never require changing. All débris ma
moved with a siphon. Perch and stickleback
be excluded. The perch would devour all
than himself, and the sticklebacks would
all they could not kill. Eels have no better
ter, though a couple of very small ones wi
teresting; but you must have a flange round
of your tank, in order to keep them imp
Dust should be excluded as much as possi
very strong light.—G. B.

[32665.]—**Siphon.**—No siphon can "st
operation" till the air contained is by som
abstracted, and the equilibrium of the fluid
therein destroyed by the descending leg of th
being longer than the ascending leg. T
practical siphon out—started by a small a
on the top of the bend—is made by Gale
Plymouth.—H. P.

[32666.]—**Heart.**—I don't think any medi
can answer a question of this nature throu
columns. How is it possible, unless he pe
examines you? There is such a thing as
paralysis of the heart's action; but it may ar
many causes—organic malformation or
such as hypertrophy, fatty degeneration, rh
deposits, and many others, to name whic
frighten you out of your wits. The sympt
diseased heart are—short breath, palpitatio
times excruciating pain about the region
heart, also a livid appearance of the coun
As to treatment, no one would advise
medical man. In your case it may arise fr
nervous affection, and be of quite a tempor
harmless nature.—Theo. Izod.

[32668.]—**S.W. Bogie Engines.**—The
between centres of cylinders of these e
6ft. 6in. The height from top of rails to
boiler is 7ft. The bogies are made acco
Adams's plan, which is well known. The a
lateral play is 2½in. at each side.—Th
Clock.

[32682.]—**Telephone.**—The terminal
fixed in *damp* earth. At so slight a depth
4in. this is seldom attainable. Let "Juveni
his plates at 3ft. or 4ft. deep, or deeper if t
seems dry there, and then report result.
plates would be better. The best plan of a
be to connect earth-wire to gas or water pip
conduct down a well or into a pond. Possi
telephone may be all right without your kn
(see last few sentences of "B. H.'s" letter,
—Glatton.

[32704.]—**The Cats and the Pigeons.**
wire guard round the support a little below
of pigeon-house, similar in construction to t
by the Zoological Society, Regent's-park, t
ingress of rats, &c. Conceive a wire cylin
away longitudinally and fixed by one of
edges to support, the other free and conca
wards.—C. O.

[32716.]—**Cuckoo.**—It is quite true
cuckoo has a small bird following it, as th
is very fond of sucking the eggs of the small

which habit causes it sometimes to be followed by several small birds. The cuckoo lays its eggs in the nests of smaller birds, and it is assisted by nature in a wonderful manner. If the cuckoo's egg was large in proportion to the size of the parent bird, it would be far too large for the little nest in which it was placed, and its unnatural size would, moreover, in all probability, frighten the lesser foster-mother, and induce her to desert her own nest; but a cuckoo's egg is remarkably small, and therefore can be laid without exciting suspicion in the midst of others of a naturally small size. In the next place, the young cuckoo always contrives to make room for its increasing size by throwing the other nestlings out of the nest, but were it of the usual form with other birds it would find great difficulty in accomplishing this. Nature, however, lends a helping hand, and has given it a remarkable depression or hollow between its shoulders, into which by an odd sort of jerk it contrives to lift the young birds, and then shuffling backwards to the edge of the nest, throws them over. This hollow, however, only remains for a certain time, and then fills up, and it is an extraordinary fact that if the young birds are designedly kept in the nest till the hollow is filled up, the young cuckoo, as if aware that it has no longer power to get rid of them, allows them to remain unmolested.—H. B.

[32724.]—**Canaries.**—I once heard a sharp discussion on the source from which the red parasites originate—a practical man maintaining that they were derived from the bird-seed, and that his cure for them, or rather prevention of them, was to support his perches by props standing in water, and so preventing these insects on their nightly rounds from getting to the birds. If possible, take cage to pieces, thoroughly cleanse, limewhite all joints, join up, and limewhite inside of cage, especially if a breeding cage.—C. O.

[32725.]—**Birds' Perches.**—By all means imitate nature as far as practicable in such matters. Have small tree branches for perches in all their pristine roughness, and if you do not join with the little creatures in their evident delight at such a luxury I shall be surprised. Would any man like to be obliged to hop about on a polished and slippery floor all day? The smooth-perch cruelty is but one of the many barbarous inflictions to which ignorance and carelessness condemn our pets. I hope our querist does not keep wild birds caged.—C. O.

[32729.]—**Chemistry.**—Bearing in mind that a molecule equals two volumes of a gas, the equation

$$\underset{4\text{ vols.}}{2CO} + \underset{2\text{ vols.}}{O_2} = \underset{4\text{ vols.}}{2CO_2}$$

shows that 4 volumes of carbonic oxide combine with 2 volumes of oxygen, producing 4 volumes of carbonic anhydride. Dividing the result by four 1 volume of carbonic oxide combines with ½ volume of oxygen, giving 1 volume of carbonic anhydride, and since 2 volumes of oxygen were given in the question, 1½ volume of oxygen remains in excess.—C. C. G.

UNANSWERED QUERIES.

The numbers and titles of queries which remain unanswered for five weeks are inserted in this list, and if still unanswered are repeated four weeks afterwards. We trust our readers will look over the list, and send what information they can for the benefit of their fellow-contributors.

Since our last "Telescope Tele" has answered 31758; "Corcyra," 31962; "Eureka," 32196; "Theo. Izod," 32269.

32067. Canoe Building, p. 564.
32073. Pantagraph, 564.
32078. Bicycle Construction, 564.
32086. Saponification of Linseed Oil, 564.
32091. Lightning Paper, 564.
32095. Screw Thread, 564.
32096. Cutter Bar and Double-edge Tools, 564.
32100. Legal Question, 564.
32106. Zoological, 565.
32117. Ornamental Turning, 565.
32122. Steatite Heads for Burners, 565.
32125. Fixing Diatoms in Groups, 565.
32125. Foucault's Experiment, 565.
32126. Ormolu Mounts, 565.
32138. Solids, 565.

32367. Flock or Wool-cutting Machine, p. 23.
32369. Paper Paste, 23.
32374. Non-Absorbent Material, 23.
32375. Rules for Choir, 24.
32382. Globes, 24.
32383. Cutting Steel Discs, 24.
32385. Yarmouth Sou'-Westers, 24.
32388. Centre-board Boat, 24.
32393. Legal, 24.
32401. Indigo Refining, 24.

QUERIES.

[32736.]—**Batteries.**—Would any subscriber be kind enough to tell me the best and cheapest battery to use for an electric bell, and whether one battery at one end would answer for both bells, the distance between both being about 20 yards?—Teleph.

[32737.]—**Welding Copper.**—Would any correspondent give me the recipe for welding copper, given on page 579, Vol. XXII., which number is out of print?—A Fitter's Labourer.

[32738.]—**Butterfly Catching.**—Will some reader give me information on the above? Some good places near London where I might meet with some "peacocks," "admirals," or "swallow-tails?" Also the best time in the day to look after them? And is there any herb or remedy to put in the cases to kill the parasites, with which I am told the insects are covered?—Young Entomologist.

[32739.]—**Microscopical Objects.**—If Mr. Randolph Richardson (letter 11205) would give further particulars respecting the formation of metallic copper, &c., he will greatly oblige me. I have tried his method and failed. Should the rings be pure tin, or will the ordinary tin do? What proportion of ingredients does he use, and should the solution be used warm or cold?—G. W. Brady.

[32740.]—**Purifying Naphtha.**—I have a quantity of coal-tar naphtha which has a very dark colour and bad smell, and to all appearance is largely charged with tar. Will any of "ours" say how I can purify the smell and colour? I had it direct from the manufacturers, to be used as a solvent for guttapercha.—Naphtha.

[32741.]—**L. C. and D. R. Engines.**—Will some correspondent kindly give dimensions of No. 162 class express bogie engines? Also how many tank engines of No. 62 class, four coupled, with small leading wheels, have the above company got?—A. J., Stratford.

[32742.]—**£5 Telescope.**—Would Mr. Proctor, Mr. Lancaster, "F. R. A. S.," or Mr. Dennett, kindly inform me what is the matter with my telescope? It is one that I bought secondhand. It is one of the noted £5 telescopes. When I look at a planet it does not appear but very little larger and brighter than when seen by the naked eye. The moon and sun look very well through it. It looks very cloudy on a clear day. I may say that the 2 diaphragms are loose in the body of telescope. Does this matter? What part of the telescope should I have to send to the maker to have a Barlow and astronomical eyepiece fitted, or would it be best to send the whole of the telescope? I have looked through English Mechanic for four or five volumes back, but have not come across anything particularly suiting my case. I think that I should have a very great difficulty in seeing the knitting needles and worsted playing, or seeing a man's face at 4½ miles off in its present condition. I can read the small print under the words "Letters to the Editor," in this paper, at 90ft., with the sun shining on it. In the terrestrial eyepiece it contains four lenses, in the astro eyepiece there is one lens—is this right? And also there is one lens along with the dark glass for the sun, and also the object-glass at the end, which measures 3in.; it is in zinc tube, covered with green cloth. I have a 4ft. tripod. An early answer will oblige—Telescope Tele.

[32743.]—**Handbook.**—Which is the best handbook of astronomy for a beginner to study, not too costly?—A Poor Cornishman.

[32744.]—**Photographic Lenses.**—I possess a foreign-made lens, the front and back combinations of which are not mounted rigidly as the English ones are, but each glass is loose, having a sort of edge-cap to screw on and secure them in their cells. What I wish to ascertain is this: When the glasses are secured as described, are they in strict centre with each other, as, when not screwed down, they have a side-shake of about the 20th of an inch? Does the act of screwing them down bring them to centre? Are they better when rigidly mounted?—Perplexed Photo.

[32745.]—**Lens.**—I have a portrait lens 2¼in. diameter, 6in. focus; one combination is double-convex, and separated by a brass ring, and the other is plano-convex cemented. Would either of these do for the object-glass of a telescope?—Filius Agricolæ.

[32746.]—**To Darken Basil Portmanteau.**—Can any correspondent tell me how to darken a new basil portmanteau, to make it look more like solid leather in colour?—Harry.

[32747.]—**Bell Hanging.**—Thanks to "S. M." for noticing my last query. Will he kindly inform me if he knows of a treatise on bell-hanging? I am a jobbing mechanic, and have been requested to undertake bell-hanging, as there is no practical hand in our neighbourhood.—J. Taylor.

[32748.]—**Transparent Paper.**—I wish to make ordinary printer's paper temporarily semi-transparent, and after to restore it uninjured to its original condition. If I treat it with white wax, what is the best material to use to dissolve it out again, without injuring either the paper or the printing thereon; or is there anything better than white wax?—Novus Homo.

[32749.]—**Nautical Astronomy.**—Answers to the following queries will be esteemed a favour:—1. In finding the latitude by double altitudes, when the bearings of the sun at both observations are given, what use can be made of the second bearing? 2. Show by a figure that a person elevated above the surface of the earth should see less of the earth, and more of the heavens than a hemisphere? 3. Show how to find the latitude by altitude of the sun near the meridian, without using the estimated latitude? 4. September 18, 1873, at about 9h. 50m. a.m. mean time, in latitude 47° 47′ N. longitude by account 71° W., the following observation was made:—

	Obs. alt. Sun's L.L.	Obs. alt. Moon's L.L.
	36 50′ 10″	61 17′ 0″
Index error	– 1′ 10″	– 3′ 50″

Obs. dist. N.L.
33° 41′ 20″
Index error + 1′ 30″

Height of the eye 15ft. Given the ship mean time 21h. 52m. 42s., find the longitude? What does N.L. stand for? A solution required.—J. J. P.

[32750.]—**Circular Saw.**—I have a small circular saw which I wish to fit to my lathe. Will some one kindly give me a few hints as to making a bench that I can fasten to the top of the iron lathe bed, one that can be taken off when not required? I propose fixing the saw on an iron rod, and driving direct from mandrel. Is that a good plan?—Circular Saw.

[32751.]—**Wheel-cutting Machine.**—Will any reader give me information as to making a wheel-cutting machine with a division-plate (not with change-wheels), to cut small bevels, skew and spur wheels?—J. C.

[32752.]—**Lepidoptera.**—Will any reader say which is the smallest butterfly or moth that requires stuffing, and how to do it? Also which is the best mode of setting insects?—Beginner.

[32753.]—**Bird's Eggs.**—Will some reader of "ours" say which is the best varnish for covering the holes in eggs after blowing?—D. M. A.

[32754.]—**Mercury.**—Will a kind subscriber give me a detailed information about distilling mercury (quantity contained in a barometer tube)? and oblige—A. Purgia.

[32755.]—**Acetic Acid.**—I shall be glad of information as to the best and most economical way of manufacturing the above for commerce?—D. M. S.

[32756.]—**British Wines.**—Would some of our kind lady friends who have a practical knowledge of making the above wines (the whole process) please say how parsnip and rhubarb wines are made?—Poor Wife.

[32757.]—**Mining.**—1. Mr. Smyth, in his work called "Coal and Coal Mining," at p. 154, says:—"In order to have the resistance equal in both directions, the empty tub being 3cwt., and the loaded one 12cwt., and the friction 1-80th of the weight, the inclination would have to be 1 in 133, and if the friction be 1-40th would be 1 in 100." Show how to obtain the "resistance equal in both directions?" 2. In reading Mr. Fairley's "Colliery Manager's Catechism," I find that he recommends the following works (with numerous others) to mining students:—Credner's "Elemente der Geologie;" "Ventilation des Mines," par A. Devilley; "Die Chemische Natur der Minengase," by Dr. Pollock; and "Leitfaden zur Bergbaukunde," by Dr. Albert Serlo. As I am particularly interested in coal mining, would Mr. Fairley, or some other able correspondent, say whether any of the above-mentioned books are translated into the English language?—Deputy.

[32758.]—**Map Printing.**—Would some reader kindly explain by what process the surfaces are prepared from which such coloured maps as those in Nelson's "Geography and Atlas Combined," or in Cornwell's Atlases, are produced, or for producing clear black outlines only? Could stereoplating be turned to account? If so, what details would have to be attended to in order to get my designs adapted thereto? Could such work be done on one of the small self-inking machines now advertised? Any hints on *modus operandi*, expense, &c., or hints as to dealing with educational publishers (should such work be deemed beyond the scope of a painstaking amateur), would be gladly welcomed by a—Schoolmaster.

[32759.]—**Sulphur Refining.**—Could any of your readers give me particulars as to the refining of sulphur, and a description of the most modern plant required for a small sulphur refining? Any information respecting working expenses, fuel, &c., would oblige—Brimstone.

[32760.]—**Glass Door for Hall.**—Will you kindly tell me what sort of glass door leading from hall into garden would be suitable to an old house (date 1650, gables, with large mullion plate-glass windows)?—W. W.

[32761.]—**Violin.**—I have a violin with the following inscription, "Cahusac, opposite S. Clement's Church, Strand, 1794," and should be glad if "Fiddler," or any other gentleman, would kindly answer these queries:—Is Cahusac considered a good maker? What is the best way of cleaning out a violin? The violin has red varnish and very large sound holes.—J. C. L.

[32762.]—**Cyclometer.**—Will some brother reader kindly explain the principle of and the instructions necessary to make a cyclometer? I have a mandrel and all other ordinary apparatus for small metal turning and pivoting. I want it for a 44in. bicycle.—Tuffs.

[32763.]—**Cut on Forehead.**—Can anything be done to remove mark from forehead, the result of a severe cut received some 18 months ago? The wound should have been sewed at the time, but, being far from any medical man, was neglected. The cut is over an inch in length by about an eighth of an inch in breadth, and rather disfigures the little girl, who is only ten years of age.—Lillie.

[32764.]—**Mode of Voting.**—Is it legal to elect directors of friendly or building societies by taking the two or three who have the highest number of votes, thus voting only once? Should not two and two be put up together, the one having the fewest number of votes being always thrown out?—Elector.

[32765.]—**Right to Fish in Rivers.**—To Legal Contributors.—Can proprietors whose land adjoins freshwater rivers prevent anglers from fishing there without their consent, although the angler may have fished the same for 40 years without let or hindrance? Also supposing he was wading in the water and not trespassing on their property?—Angler.

[32766.]—**Stopwork.**—A watch company just started have introduced to their going-barrel lever watches a contrivance which they state is equal in efficiency to the stopwork in an ordinary English lever with fusee. This contrivance they style "the patent sliding click." It differs from the ordinary ratchet work on a going-barrel watch in two important particulars—viz., the click, instead of having a round hole for the screw or pivot to work in, has an elongated one, or, termed in the trade, a "slot," and the click spring answers the purpose not only of forcing the click into ratchet wheel but also of giving it a forward movement. This, it will readily be observed, allows a certain amount of "give" or return in the ratchet work, and thus preventing the possibility of the springs being wound to its fullest tension and also of becoming blocked. Would "Seconds' Practical Watchmaker" kindly tell me if he thinks this would answer the purpose claimed for it?—A Lover of the Art.

[32767.]—**Safety-Valve Question.**—I have a safety-valve on my boiler, and I want to put a new weight on the lever, which has been altered. The lever is 24in. long from centre to fulcrum to where the weight is to be suspended, and 2in. long from fulcrum to centre of the valve. The diameter of the valve is 2in. I suspended a spring balance over the valve and tied the lever to it, to which I fastened the valve, and I find it takes 28lb. weight to balance the simple weight of the lever and the valve. I want to blow off at 60lb. pressure. Now if I put a weight on the end of the lever 32lb. weight, which, with the weight of the lever and valve, will make 60lb., equal to the pressure of the steam, will this be right? I am told by my engine man that it will not, but as I understand the principle of a safety-valve is one force balancing another, will some correspondent kindly say if I am right, and, if not, show me where I am wrong and how I am to set about righting it?—A Farmer.

[32768.]—**Purification of Manganese Chloride.**—What is the best way of doing this for laboratory purposes? One is—"Evaporate the $MnCl_2$ solution to dryness, heat to low redness, and treat the residue with water and filter." Is this method quite satisfactory? There appears to be considerable loss, perhaps through my using Hessian crucibles. At what temperature is the $MnCl_2$ volatilised or decomposed? Will Mr. Allen or some other practical chemist answer? Also how to prepare MnO_2 pure from $MnCl_2$?—Daghbert.

[32769.]—**Brewing.**—The kind manner in which our friend, Mr. Harris, replies to those seeking information about the brewing of beer makes me bold to ask one or two questions. I am far from being satisfied with the quality of beer we get in our neighbourhood here in N.E. Lancashire. A few large brewers own about 90 per cent of the retail houses for miles round this locality, where no other beer than that brewed by the owner of the public-house must be sold to the people. If ever our legislators alter the laws of the beer traffic, a clause ought to be inserted very much restricting the large brewers from owning so many retail houses, from whence they foist a very inferior beer upon the working population. The effect of some such law would be to make the brewers compete for quality of beer, and those who made most use of the rule of thumb would find themselves very soon at the wall, the inhabitants being great gainers thereby. John Bull will have his beer, do what we will. He ought to have it of good quality and at a cheap rate, which the scientific brewer alone can give. The compound that makes one dull and soddens the brain must give place—as Professor Graham says in his splendid lectures on brewing—to one of hilarity and cheerfulness. Having read these lectures, and also Muspratt's treatise on brewing, I have a great desire to brew my own beer, and perhaps other readers in the same business would like to do the same, and with myself would be grateful to Mr. Harris for the following information:—The best form of building for a brewery; the best arrangement of apparatus so as to save labour. A description of apparatus required, and probable cost, say, for brewing ten barrels at one time. The advantages of the "Archimedean attemperator." I should also like to be able to test a given sample of beer as to the original strength of wort, also the percentage of alcohol. Would the instrument called Casartelli's dilatometer be the best for these tests?—Victualler.

[32770.]—**Shot.**—I am having an apparatus made in which shot ⅜in. and ¾in. diameter are dropped singly down a tube from a vessel above; each movement of a valve, like a shot-pouch valve, allows one to drop. What should be the form of the vessel so as not to jamb the shot? I suppose it should be a funnel, but do not quite see how to insure the shots from jambing against each other.—Experimenter.

[32771.]—**Wood Lice.**—Will some reader inform me how I can get clear of wood lice that infest my cellar? What will destroy them, also keep them away? There is no rotten wood that I can see.—A. G.

[32772.]—**Decayed Finger Nails.**—About three months ago I had a very bad finger gathering; it got well, but the nails of my fingers and thumb are all coming off, and the appearance of the nails following them is not promising. Could any reader give me advice what to do? I have seen a doctor, but he states he never saw anything of the kind before. The fingers themselves are all right, the nails at the back part seem black and decayed.—A Constant Reader.

[32773.]—**Sir Isaac Newton's Magnet.**—I remember reading somewhere that Sir Isaac Newton wore in his ring a natural magnet which only weighed three grains, yet it was able to take up 746 grains, or nearly 250 times its own weight, whereas magnets weighing two pounds seldom lift more than five or six times their own weight. If a magnet weighing two pounds can lift ten or twelve pounds, what weight could it attract ten yards from it?—Self-taught.

[32774.]—**Electric Light.**—Many thanks to "Sigma" for answering my query (32599). Seeing that I could not succeed in conveying electricity from one shop to another to light it, I will be satisfied if I can illuminate the room in which the engine is. I am a mechanic, and I think I could make a machine to work one light, and that would be sufficient for my purpose. I have made the batteries and telegraph instruments and bells, &c., for our telegraph line. Electricity is my favourite study, and I understand the theory of the magneto-electric machine thoroughly, only I want advice about the gauge and quantity of wire to be used. I think it would answer if made on the principle mentioned on the lower half of page 265 of "Dr. Ferguson's Electricity." The engine is nearly three horse-power, and after dark might be used exclusively for the machine.—J. H. B.

[32775.]—**Fossil Fern.**—I have a fossil fern which I brought from India in 1877, and it has been shown to several eminent geologists, but they have failed to name or classify it; and from this I believe it to be entirely a new thing; therefore I wish to get it named and classified. If any of your numerous readers can give me any instruction as to the manner in which I ought to proceed I should be very happy to communicate with them. My address is—W. Miller, Wood-grove, Wincobank, Rotherham, Yorkshire.

[32776.]—**"Vienna Flute" Organ Stop.**—I am informed that lately there has been introduced to this country a new organ stop called the "Vienna flute." I understand it is a wooden one, the mouth circular, bevelled away in the inside; the wind is conveyed by a peculiar arrangement of the cap, and is thrown on to the edge of the circular mouth in a manner similar to that employed by an actual flute-player. May I ask some of our organ correspondents if they have seen such a stop, and if they can give me any particulars of how it is made and its scale? A diagram of it would be useful.—Musicus.

[32777.]—**Bar Frame Section.**—In looking over the articles on "Bee Management," by Mr. Travis, in the last volume, I notice that he speaks of the "bar frame section." I don't think that this has yet appeared; at any rate I have not seen it. Will Mr. Travis oblige?—W. W. M.

[32778.]—**Temper of Taps.**—Would you or any of your readers inform me of the best method of tempering taps for screwing with?—J. H. Turriff.

[32779.]—**Painting Light Carts.**—Would any reader tell me how to paint traps or light market carts so as to insure a good face and look smooth, and how to mix the colour? My work is always full of ribs and marks of the brush.—A Young Wheelwright.

[32780.]—**Snider Rifle.**—Can any of "ours" supply information on the following subjects?—1. The best method and materials to clean the Snider rifle. 2. How to reblack the "sights" by other means than smoke, if better. 3. Is there a work on "shooting" published that would be useful to a beginner?—Caw.

[32781.]—**The Gregorian Tones.**—Will some correspondent kindly enlighten my ignorance of these celebrated tones by giving me some account of their origin, nature, and use? 1. When were they written? 2. Why are they called "tones?" 3. For what words were they originally intended? 4. How is the intonation at the commencement of each tone managed? I understand that it is not usual to sing it to anything but the first verse of a psalm, &c. In that case is the recitation note before the mediation omitted, and the intonation used in its place; or are the first two syllables or words of the recitation sung to the two minims forming the intonation, and the rest of the recitation to the reciting note following the intonation? I should like to know something of the history of these tones.—George Bell, B.A.

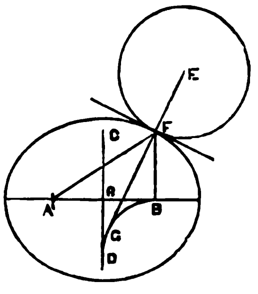
[32782.]—**Bone Manure.**—Will some of your numerous correspondents kindly give me some hints on the manufacture of bone manure on a small scale? What kind of mill is required for grinding the bone? Are any made to work by hand? And add, if they can, about the probable cost.—Bone Manure.

[32783.]—**The Moon.**—Why does the moon's dark limb appear more visible at some times than others?—Charles Robinson.

[32784.]—**Concertina.**—Will some fellow-reader who is conversant with the construction of English concertinas kindly enlighten me as to the following?—What is the best method of tuning the reeds (brass) when they are flat or sharp? Also can reeds be purchased in Birmingham in sets or otherwise, and would it be practicable to fit steel reeds instead of the brass ones, as I think I could manage it if it were not too difficult?—H. J. Blasdale.

[32785.]—**Speculum.**—My reflector not having been used for many years the metal speculum is covered with a deposit of dust. How can I best clean it without doing injury to the surface?—P. M.

[32786.]—**Mathematical.**—I am much obliged to "J. F. W." for his answers to my last questions (30920), but am sorry to say he has not helped me, my algebra not being strong enough to find the unknown in No. 1 from the formula he gives. Will he kindly give his opinion on the following construction (see diagram), and say whether some simple formula for the transverse axis cannot be got from it? Let E be the centre of the given circle and A B the given points, join A B, bisect A B in O perpendicularly by O D, with radius O B describe an arc touching O B, O D. From E draw a tangent to the arc B D, touching it in G, and cutting the circle in F. Then G F is a normal to the ellipse, and meets the curve at right angles; it is therefore at right angles to the tangent at F and bisects the angle, A F B. X Y Z's construction is a funny-looking affair, especially when angle, A B O, is much greater than a right angle. "Jerry" does not understand the question.—W. O., Australia.



[32787.]—**Foreign Packing Case Materials.**—Of what wood are tea-chests made, and of what wood are orange and lemon boxes and egg chests (French) made? The last-named are very even-grained and easy to work, and the orange-box wood is very hard and strong. I should like to know what they are, and if they are ever imported as timber.—Murano.

[32788.]—**Marks on Coins.**—What do the letters that are stamped on the obverse of silver coins in circulation mean? I have had a half-crown of George III., date 1817, stamped "J. P."; a half-crown, George III., 1817, "J. I."; ditto, 1818, "J. P."; ditto, 1819, "J. Y."; ditto, 1820, "J. P."; and also a ring stamped on his most gracious majesty's ear; also a half-crown of William IV., date 1834, stamped "M. B."; a shilling of Victoria, date 1868, "M. B."; a half-crown, Victoria, 1844, "M. B."; and a shilling, George III., 1817, stamped "T. T." I may add that the marks are always stamped on the head. I also had a halfpenny with a lion rampant on it (Victoria), and I have a farthing of George III., about 1780, with a "d" or "P" on the head.—Murano.

[32789.]—**L. B. and S. C. Engines.**—Can any one give me the dimensions of the "terriers," and have the company any other six wheels coupled, inside cylinder, tank engines, beside the said "terriers"? Which of the "terriers" was built first, and when? Did the L. B. S. C. send an engine to the Darlington Exhibition? What is the number of the six-coupled goods engine, fitted with wooden wheels, and are they found to answer?—Murano.

[32790.]—**Wood Lice in Violoncello.**—A friend of mine has a violoncello which the wood lice are doing great damage to. In hopes of saving the instrument he has rubbed it with both turpentine and paraffin oil, but so far his work has no effect. Will any correspondent kindly name a specific which will stop their career?—Rufus.

[32791.]—**Welding, &c.**—What is the best way to weld the prongs of steel-dung forks and what is best stuff for steeling horse-shoes?—Jenkin Watkins.

[32792.]—**Reflected Light.**—Will any reader kindly tell me the quantity of light that is regularly reflected from plane silvered mirrors at various angles of incidence, and if there is any book on the subjec
costly?—C. K.

[32793.]—**"The Dawn of H**
"F. R. A. S." kindly give me the name
lisher of "The Dawn of History," me
one of his late letters? and oblige—Flo

[32794.]—**Great Western and**
Engines.—Can any one give me the
class of four wheels coupled tank engi
running over the Metropolitan Railway
no number, and how much coal does
It looks very small compared with the
tenders. Have working drawings been
Queen 55 class? To what company do t
working the Metropolitan, Metropolita
Wood, and Metropolitan District Rai
said engines of exactly the same dimen
land 204 to 209 inclusive, and the L.
inclusive? Have not the S. W. R. s
pattern (No. 319, &c.)? Why do the
the letters H. K. R. M. and S. for lette
ments of their carriages?—Murano.

[32795.]—**Iodine, and How is it**
some of my fellow-readers please tell me
above and whether it can be got out o
weed, and how it is got out of it?—Iod

[32796.]—**Kaolin.**—Will "Pione
13026, Vol. XXV., p. 512) please inform
of the country the gravel pit to w
situated?—Tortore.

[32797.]—**Water Finding.**—Can
any reader, explain the knowledge of t
water under ground possessed by the
Melksham (see letter 13007, Vol. X
Tortore.

[32798.]—**Hamilton's String Or**
Rymea."—Can you favour me with a g
of this instrument, referred to by you
p. 510, Vol. XXV.?—Tortore.

A Really Indelible Ink.—The or
"indelible" inks are prepared from
and the writing done with them ca
soaking the linen with a solution
potassium (exceedingly poisonous, i
membered) or of hyposulphite of soda
ing with a solution of bichloride of c
washing with aqua ammonia. A
ink—that is, one that cannot be remo
agents, may be made from aniline d
the following recipe:—Dissolve 8½ g
of copper in 30 grs. of distilled w
10 grs. of common salt and 9½
ammonia. A separate solution is
of hydrochlorate of aniline in 20 g
water, which is then added to 20 gr
of gum-arabic, containing 2 parts o
of gum arabic, and, lastly, 10 gr
Four parts of the aniline solution t
mixed with part of the copper solut
thus prepared has a greenish colou
black in a few days after being use
or at once by the application of a
being otherwise heated. A steel p
for writing with it. If the clot
marked, is put into tepid soap-su
acquires a fine bluish tint. The
perfectly limpid, so as to penetrate
the solutions should be mixed only w
be used.

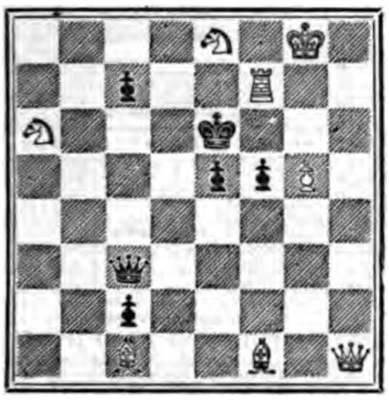
Improved Brick-kiln.—A new
recently tried at Normanton, the adv
for which are economy in fuel and la
is 108ft. long and 8ft. broad. The
set direct from the making mach
wagons, which carry them throu
length of the new kiln and bring t
exit end baked, which saves muc
handling. The fires are placed in th
kiln, at each side, and the draught o
towards a flue or chimney at the ent
this means the bricks are graduall
reaching the fires, and after passi
heat of the central section, they ha
before being drawn out at the recei
the burnt bricks can at once be throw
railway waggons or stacked. The ba
nine are in the kiln at one tim
together, and the action of drawing o
each of the succeeding eight a stag
same time pulling in a newly-loa
other end. Each wagon holds abou
making 45,000 in the kiln at once, o
of about 300 tons. The waggons
exactly to fit the breadth of the kiln
the usual spaces left for the equal pe
heat through the entire mass, the b
upon each waggon to a height of 7ft.
the whole space of the arch through
The iron of which the lower parts of
composed is preserved from injury t
not only by the fires being on a high
a superposed layer of fire-bricks, a
of cool fresh air being secured und
By means of present appliances a
finished bricks can be drawn out i
but a period of four or six hours
required before the bricks are suf
and then cooled enough to be taken
said that the cost of fuel for burni
by this new process is under 3d.

CHESS.

All Communications intended for this department must be addressed to J. Pierce, Copthill House, Bedford.

PROBLEM CCCCXX.—By W. T. Pierce and J. Pierce.

Black.



White.

White to play and mate in two moves.

Solution to 418.

White.	*Black.*
1. B to Q 3.	1. Aught.
2. Mates.	

Notices to Correspondents.

F. Darby.—The White Bishop in 417 should be a Knight, so this upsets your solution.

D.—Your solution (418) is correct. We quite agree with you in thinking it a remarkably fine problem.

G. F.—Thanks for problems just received.

H. Aubrey.—You are wrong. If 1. P to Q 7, Black plays, P takes Kt (this is what it should have been in previous notice), and how can White possibly mate?

USEFUL AND SCIENTIFIC NOTES.

Antique Bronzing.—The repeated applications copper or brass, of alternate washes of dilute acetic acid and exposure to the fumes of ammonia will give a very antique-looking green bronze; but a quick mode of producing a similar appearance is often desirable. To this end the articles may be immersed in a solution of one part of perchloride of iron in two parts of water. The tone assumed darkens with the length of immersion. Or the articles may be boiled in a strong solution of nitrate copper. Or, lastly, they may be immersed in a solution of two ounces nitrate of iron, and two ounces hyposulphite of soda in one pint of water. Washing, drying, and burnishing complete the process.

Wasted Land.—All land which, from any cause, remains uncultivated must be considered waste; but in a special sense that which forms part of a tract under tillage of some kind, and is unused, may be described as *wasted*. It is impossible not to perceive that in this snug little island of ours there is far too much ground not only able, but almost in a condition to produce food for the population, allowed to lie idle. A visit to some of our large military centres would suggest a way in which the odd pieces of arable land abutting on the highways, commons, and heaths in most parishes might, without any encroachment on public rights or infringement of private property, be turned to useful account and the general advantage. Soldiers in their leisure hours cultivate the small patches of ground scattered around their barracks, with results highly satisfactory. Paupers might be set to the same service in recompense for the relief afforded them out of the public rates. The "labour test" has not been applied to useful purposes. No grievance or wrong would be inflicted on the self-supporting classes by the utilisation of labour in this direction. The cultivation of "waste lands," meaning lands which had to be reclaimed from the sea, or raised to a condition fit for culture by laborious and lengthy processes, has been frequently proposed, but great monetary and engineering difficulties stand in the way, and there is the objection that works so expensive as these would necessarily be taken out of the hands of the self-supporters. None of these obstacles stand in the way of the measure we propose. Each local authority might arrange with the lord of the manor or highway board to undertake the use of available scraps of land in its district. The money value of crops judiciously grown on such ground would be not unimportant—in some districts it would be very considerable—while the sanitary effect of utilising the ditches and adjacent strips and patches of land would be to render the general atmosphere purer, and rid the country of some of its worst nuisances, which those who ride and drive much in rural districts have cause to dislike.

Permeability of Building Materials.—MM. Marcker and Berthold, of Paris, have lately made some suggestive announcements as to the permeability to gases and vapours, of various materials used for building purposes. They claim as the result of their experimental researches, that when dry bricks, sandstone, tufa, mortar, and cements permit vapours to pass through them, while granite, porphyry, slate, alabaster, and limestone are practically quite impermeable. It will be inferred from these statements, therefore, that the cementing of cellar floors, &c., or laying them with bricks and tiles, while it doubtless will considerably increase the wholesomeness of a dwelling exposed to dangerous gaseous exhalations from sewers and the like, does not afford a complete protection. Whitewash applied to a wall, though it exerts for a considerable time a purifying chemical influence, does not afford nearly so good a protection against the passage of gases and vapours as a couple of coats of oil paint, while thick glazed wall paper reduces the permeability of mortar nearly 40 per cent.

Curious Railway Accidents.—A curious accident happened, says a New Brunswick paper, to the Truro freight train which arrived at Moncton Station about 2 a.m. on Friday. Soon after entering the station yard, and at the first curve, the wheels of a coal-laden flat car near the locomotive left the rails and a halt became necessary. On examining the car which caused the trouble, the fact was revealed that the two pair of wheels at the "hind end" of the car had been travelling without any truck, further inquiry showing that portions of the truck were lying on the track near Dorchester Station. It would seem as if a wheel of one of the "followers" had broken badly east of Dorchester, and that the pair then ceased to revolve, as a portion of each of the pair is worn flat by dragging along the rail for thirty miles or more. Railway men cannot recall a similar accident. They say that after the destruction of the truck, the weight of the car, and for that matter, most of the train, was sustained by the draw bar, and they think that, looking to what was accomplished on the way from Dorchester, there was no reason why, on a straight line, the car might not have been dragged thirty miles further, but it was the rounding of a sharp curve that prevented further dragging and threw both wheels and car off the track. The accident is voted one of the most extraordinary in railway experience. Commenting on this, the *American Railroad Gazette* says:—"We have heard of a similar case on the Erie some fifteen years ago, when an engine ran into the Port Jervis yard with only one pair of wheels under the rear tender truck, and the wheels and axle were found on the side of a bank several miles back." To which we (*Engineer*) add that many years ago a passenger engine on the London and North-Western Railway lost a driving tire at night, and the loss was not discovered till the train reached London. The broken tire was found next day in a ditch thirty miles from London.

Making Wooden Pulleys.—A pulley over 24 inches in diameter should be built on a spider; all under that size can be made on a wood centre-piece about 2 inches thick, having a cast-iron flange, say 8 inches in diameter, for a 20-inch pulley, with a hub and boss about 3 inches long. Four bolt holes should be made through the flange for bolting to wood centre. The latter should be a nice fit on the shaft, with key seat the same as for an iron pulley. After preparing the centrepiece by planing smooth and straight, make a templet, the length being about one-sixth or one-eighth of the diameter and 2 inches wide. By this mark out the amount of stuff for the required width of face. The lumber should be about seven-eighths or 1in. thick, sawed out to the same circle as centrepiece. Plane straight and smooth, and make the butt joints a perfect fit; glue and nail on. If a flange is desired on each edge to keep the belt from running off, make the outside layer a little wider, and allow it to lap over the face. Put the pulley into a lathe and turn it up. Thus made, it will be durable and will not easily break.

A Warehouse Built of Iron.—A novel feature in building construction, due in great measure to the present exceptionally low price of iron, has been introduced in the erection of a large warehouse in Manchester, which is at present being built for Messrs. John Rylands and Reuben Spencer, from the designs and under the superintendence of Mr. John H. Synde, C.E. The building, when completed, will cover an area of about 600 yards, and consists of three fronts, six stories high, the whole of which are constructed of cast iron. The main structure consists of vertical iron standards 1ft. 9in. wide and 1ft. 9in. deep, the cornices and string 6in. wide, and are carried on stretcher beams running between the vertical standards, whilst the floors are carried by means of cast-iron columns, between which and the vertical standards are cast-iron girders, and the whole framework of the building is thus tied firmly together. The outside decorative features are in the Italian style, and the face of ornamented cast iron is hung on to the framework and bolted, but in such a manner that in the case of the bolts decaying, the ornamented castings will still remain in place.

ANSWERS TO CORRESPONDENTS.

*** *All communications should be addressed to the* Editor *of the* English Mechanic, 31, *Tavistock-street, Covent Garden, W.C.*

HINTS TO CORRESPONDENTS.

1. Write on one side of the paper only, and put drawings for illustrations on separate pieces of paper. 2. Put titles to queries, and when answering queries put the numbers as well as the titles of the queries to which the replies refer. 3. No charge is made for inserting letters, queries, or replies. 4. Commercial letters, or queries, or replies are not inserted. 5. No question asking for education or scientific information is answered through the post. 6. Letters sent to correspondents, under cover to the Editor, are not forwarded; and the names of correspondents are not given to inquirers.

The following are the initials, &c., of letters to hand up to Tuesday evening, April 23, and unacknowledged elsewhere:—

J. J. Peppiatt.—H. Tittley.—Hugh Jones.—C. E. Mendham.—G. Tolman.—A. B. M.—Hugh Clements.—W. J. Lancaster.—Mathematicus.—A Fellow Reader.—F. M.—Albert Smith.—T. Hull.—Nigger.—F. W. Muncey.—C. B.—D. Strathearn.—T. Brown.—Constant Reader.—A. A. Watkins.—John Anderson.—A Poor Leaseholder.—Permian.—H. Hellewell.—G. L. Southend.—G. B.—G. C. C.—W. H. K.—Jack of no Trade.—J. E. Gore.—Ad de Bõe.—Storace.—Eldnar.—W. S. A.—W. A. Morton.—J. A. P.—Adye Douglas.—A Mechanic.—Telescope Tele. — Photo Cymraeg. — Anxious Sperans. — H. Woollen.—Gamma.—Tonometer.—One in Distress.—Rathmena.—B. C.—H. G. Moberley.—C. M.—Plumb Bob.—J. J. A.—An Englishman.—N. Virch.—Arthur Alfred.—S. J. Clare.—Paolo Eo.—Coil.—C. J. Bonser.—Alfred Tozer.—J. L. Savage.—Stretton.—Naxos.—F. B.—Os.—Tamerlane.—The Yorkshire Yeoman.—Geo. Dashwood.—A Lover of Music.—Stromboli.—A Gallovidian.—F. W. B.—E. Rynes.—W. S. Travis.—A Subscriber.—Glatton.—Fiddler.—Concoil.

W. M. (You are apparently unconversant with the task of re-covering the hammers, and will in all probability spoil the instrument. If, however, you care to risk it, you will find plenty of information in back vols. We cannot repeat, nor can we give addresses of vendors of materials.)—R. W. J. (The speculations in your letter are ingenious, but we cannot spare space for any further discussion of the subject. Our opinion as to the nature of all spiritual manifestations is of a very decided nature, and our estimate of the character of those who profess to believe in, or bring them about, is not less so.) J. McDonough. (We have published many times directions for making machines for covering wire, and must refer you to indices of back vols. For ordinary work you will do well to buy the wire ready covered.)—Chas. Robinson. (For first query see "Astronomical Notes" in present number. 2. Translations were published by nearly all the newspapers at the time of the arrival of the obelisk. Look up back numbers of the *Graphic* or *Illustrated London News*. 3. Query inserted.)—S. A. Jones. (We *did* reply to you on p. 103.)—Working Bee. ("W. G. P." has anticipated your facts in letter 14229, so there is no need to insert your communication. We think, moreover, that enough has been said about the "British Workman" for the present, and that he has found—as we hope he always will find in the pages of the English Mechanic—friends quite able and willing to say all there is to be said on his side of the matter.)—Willows. (If the facts are as you state the solicitor is certainly liable, and we should advise application to another solicitor, with the view of taking compulsory steps.)—R. G. J. ("Roads and Road Material," published by Lockwood and Co.)—E. Sprague. (Write Longmans and Co.; they publish several good books on both subjects.)—J. L. (It is published by Cassell, Petter, and Galpin; but we forget the title.)—Thomas. (The question of piecework and daywork has been repeatedly discussed in back columns, and cannot be settled in the offhand manner you seem to think possible. In some cases where masters are fair and men honest, piecework is undoubtedly advantageous to both, and to the general public as well; but in other cases its adoption is impossible if all parties are to be dealt with fairly.)—E. Mann. (We were unable to find space for it.)—J. H. Schucht. (Too abstract a subject, and quite over the heads of the majority of our readers.)—P. W. (It is probable that the captain of the training ship thought he was getting the boy away from evil influences. If you feel aggrieved, however, you had better communicate with the Home Secretary, or get one of the members for your county to ask a question on the subject in the House of Commons when Parliament reassembles.)—Chelsea. (Several palliatives have been recommended in back vols., but there is probably no permanent cure.)—C. J. Bonser. (You had better apply to the locomotive superintendent of the line you desire to travel by, but unless you have some other motive than mere curiosity you will fail to obtain the desired permission.)—A. Horton. (We do not see how we can interfere; both are common signatures and likely to be adopted by other correspondents; we should, however, be glad if readers would pay more attention to the matter.)—W. Greenwood. (Neither your letter nor that of the bank manager throws any light on the question asked. We will insert your other reply next week. The slide was unfortunately broken in transit.)—Zetetes. (Octahedric is correct.)

Leo, Boeb, Peasant, T. Foster, T. Stephen, Leo.—See indices to back vols.

Telescope Tele, Irishman, and others have replied to queries already similarly answered.

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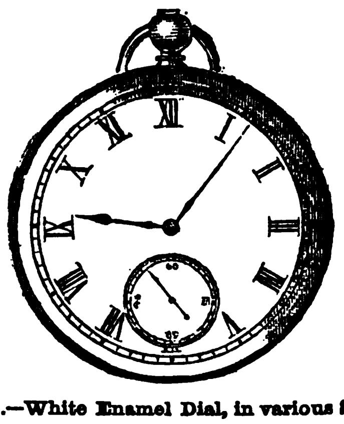

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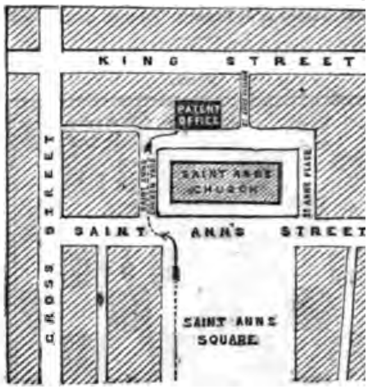

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FRIDAY, MAY 3, 1878.

ARTICLES.

LATHE FLYWHEEL AND TREADLE.—II.

JMING that the object in view is to ecure the very maximum of power ible with general convenience, the n to be solved is not only compound haracter, but the several conditions re or less antagonistic to each other. the flywheel might no doubt run to atest perfection if the weight of the were exactly balanced by the coune. But then the wheel would come in one place as readily as in another; is would interfere with one of the onveniences of weighting, which is the crank about three parts up whene wheel stops, so that all may be or starting again by the foot alone; secure this the wheel must be slightly *anced.* Then, again, it is a great to obtain proper leverage on the But leverage can only be increased ing the pivot of the pitman further nd if this be at all exaggerated it es the rise and fall of the foot to an enient degree. The action of the , too, will be influenced both by cenl force and the direct attraction of ; while the power of the latter will ary with the momentary position of ight as it revolves with the wheel— il when the weight is at the (vertical) bottom, and greatest when at either ital extreme of its revolution. Morehe speed pulley on the mandrel with the band may happen to be connected ercise considerable influence on the of the weight when the wheel is g down. The best general arrangenust, therefore, be a matter of come; and, with such a contrary set of to deal with, the best plan would o be to start by settling those which st necessary to the personal comfort operator in treading. The length ble for the treadle is generally limited, us the first step must be to place the of the pitman so as to get all the ge possible without giving the foot and fall of more than 8in. or at the very most. Taking an ordinary 5in. or 6in. centre lathe, it is not often that the treadle can be made more than 30in. wide, and about 25in. is the more probable width. Under such conditions the pivot for the pitman will probably have to be placed about two-fifths from the foot-end and three-fifths from the centres of rocking-shaft. This assumes a crank having a throw of 2½in., and it must be remembered that this point again introduces another variable condition. For an increase of only ½in. in the throw of the crank would make a considerable increase in the rise and fall of the foot, if the above proportions were taken without corresponding modification. From the "compromise" point of view, I do not think anything is gained for the ordinary foot-lathe by making the throw of crank more than 2½in.

FIG. 1

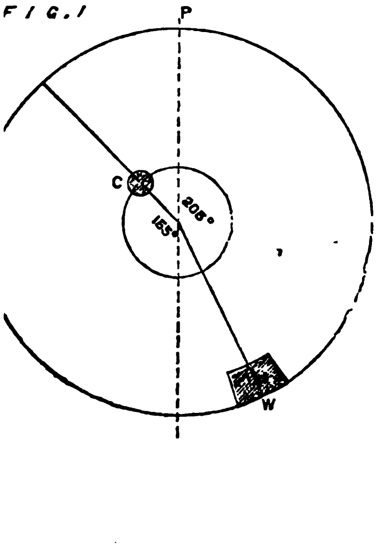
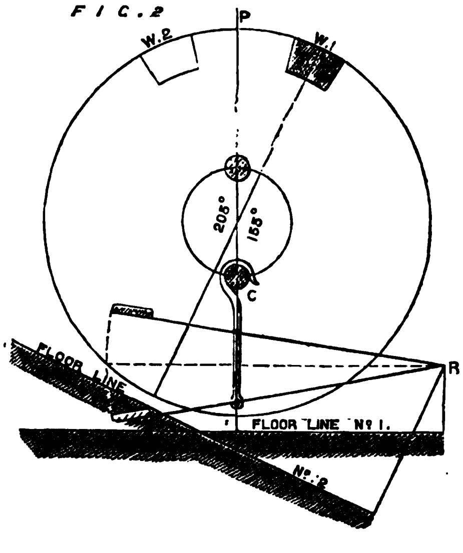


FIG. 2



Having settled the proportions of the treadle, the next most constant conditions are—the amount of weight required to balance the treadle, and the position which this should occupy on the wheel. Although rather more weight may be required, I think it is better to place it some 4in. within the full diameter of the wheel than on the extreme of the diameter, as, of course, the nearer the weight is to the centre of rotation, the less will be its velocity under any given speed, and the less is it likely that centrifugal force can produce any injurious results. But, if carried too near the centre, the weight must be so much increased, and will lose so much of the desirable impetus of centrifugal force, that the wheel loses in liveliness. Taking all things into consideration, there can hardly be a better place for the weight than that suggested by the convenience of attaching it to a plate, as has been already illustrated; and in this position it need not interfere with the use of that most invaluable addition to the foot-lathe—a flywheel brake.

The next point will be the angular relation of the weight to the crank, in order to bring up the latter ready for starting. If the wheel were not connected with the mandrel, the position to which the crank would be brought might be looked upon as absolutely constant, for it would depend on gravity alone. But the different connections for different speeds are apt to influence the effect of the counterpoise very considerably, unless this be increased to an amount that would be very objectionable in running. Indeed, it must be remembered that it is an object to use the least amount of counterpoise that will suffice; and, to arrange this, it is perhaps best to weight for some intermediate speed, such as the slowest of the fast speeds. It is true that this may not invariably bring the crank to the same position when running the fastest speed, where, of course, the mandrel exercises the most power over the flywheel. But I have found that, on this principle of hanging, the wheel may be started from almost any point, so that it is not actually on a dead point; and that if, when running down from the highest speed, it ever does stop in this way, it is always on the lower point, when the weight will be exactly on the top of the wheel, so that a mere stroke of the mandrel pulley with the hand will start it again either way. But the occurrence is very rare (unless done purposely for convenience), and is only mentioned as a fact connected with this plan of hanging. Very careful experiments to determine the best position for the weight with reference to the crank, seem to prove that the two should make an angle of between 150° and 160° with each other. Taking the mean of these, the circle will be divided into two parts of 155° and 205° respectively, and the crank and weight will come to rest in the positions shown by C and W in Fig. 1, so that C makes an angle of 135° with the perpendicular line, F, on one side, and W makes an angle of 20° with the same line on the other side. W must, therefore, ascend through 160° before it can reach the highest point. Now, as W is travelling against gravity while making its ascent, it must contribute to the power which can be developed from the wheel that W should benefit by the pressure of the foot until it has reached the highest point at F (Fig. 1); and even then it will have to travel some little distance (as to W_2 in Fig. 2) by impetus alone, before the attraction of gravity can have much power. But when the treadle is hung in the ordinary way (say, some 5 inches from the floor, as at R, floor-line No. 1, Fig. 2) the line (dotted in the illustration), which bisects the oscillation of the treadle, being at right angles to the perpendicular line, F, and the pivots of the pitman oscillating on this perpendicular line as the chord of the arc,—then the two dead points of the crank will also occur on this line, F, and the direct force of the tread will end when the crank reaches its lower dead centre, C; or when the weight (which makes an angle of 155° with the crank) is still 25° from its highest point where the counteracting influence of gravity ceases. It will therefore be a gain of 25° in the circle, for the application of direct force in lifting the weight, if the pitman can be arranged so that its draught shall be 25° *backwards* from the perpendicular line, F. Under the ordinary hanging, however, it would be practically impossible to arrange this. But the advantage of dealing with a circle is, that everything must relate to its centre, and that such distinctions as "top," "bottom," "side," or "floor-line," are mere accidents of the case which need not affect any principle of action. So the height at which the treadle is hung from the floor need not in any way affect its action on the crank. Reference to Floor-line No. 2, in Fig. 2, will illustrate this. As gravity acts in the vertical direction, and the object is to place the weight, W_1, on the vertical line by the direct pressure of the foot, which can act no further than C, draw a line from W_1 through the centre of the wheel, and then draw an imaginary floor-line, No. 2, at right angles to the perpendicular from W_1. It will be seen at once that the object thus obtained on paper, by shifting the imaginary floor-line from No. 1 to No. 2, may be obtained in practice by raising the centre of the rocking-shaft, R, to the required height, and that while the weight has been accommodated to the unalterable conditions of gravity, no alteration whatever has taken place in the action of the treadle on the crank. The only practical difference which occurs is, that the operator will be placed at a slightly different tangent to the arc of the treadle's oscillation, owing to the shift of its centre, and that the form of the treadle may require to be accommodated to its new floor-line. But so long as there is plenty of room between the centre of the rocking-shaft, R, and the pivot of the pitman, the direction of the treadle-arm, from this pivot to the foot, is simply a matter of choice and convenience, which affects nothing but the rise and fall of the foot, and the direction which this may take with regard to the position of the operator.

The centre of the rocking-shaft having been adjusted so that when the pivot of the pitman is at its lowest point the weight shall be balanced on the (vertical) top of the wheel; the amount of the weight should be just enough to commence bringing the treadle up when the counterpoise begins to leave this vertical balance by one or two inches. I have found it better to concentrate the weight as much as possible on one point, so that the effect of the whole may tell directly the (vertical) balance is passed. In my own case the treadle weighs 15lb. in the middle of its upward lift from the pivot-point by the crank, and a counterpoise of 6lb. lifts it smoothly and effectually, beginning to act when one or two inches past the vertical point. But a heavier counterpoise would be required if it were spread over a longer surface on the wheel.

D. H. G.

(*To be continued.*)

PORTLAND CEMENT.*

In a work on Hydraulic Mortars, by Dr. Michaelis, published at Leipsic, in 1869, the learned author alludes to the labours of Smeaton, in connection with mortars and cements, and he pays that distinguished engineer the high compliment of being the real discoverer of the principle which underlies their action. The Eddystone Lighthouse, he says, is the foundation upon which our knowledge of hydraulic mortars has been erected, and it is the chief pillar of modern architecture. Smeaton freed us from the fetters of tradition by showing us that the purest and hardest limestone is not the best, at least for hydraulic purposes, and the cause of hydraulicity must be sought for in the argillaceous admixture. Pasley, writing in 1838, says: Of all the authors who have investigated the properties of calcareous mortars and cements, Smeaton appears to have the greatest merit; for, although he found out no new cement himself, he was the first to discover that the real cause of the water-setting properties of limes and cements consisted in a combination of clay with the carbonate of lime. In the year 1756 Smeaton, having been commissioned to build a lighthouse on the Eddystone, commenced the work by studying the plans of the two previous structures erected by Winstanley and Rudyerd. The work of the latter, which was destroyed by fire, was immeasurably superior to that of the ill-fated Winstanley; but Smeaton saw at once that its great defect was want of weight, and he speedily determined that his lighthouse should be of stone. The popular impression, even amongst the Brethren of the Trinity House, was that nothing but wood could possibly stand on the Eddystone; but Smeaton persevered in working out his idea, and before he had had an opportunity of visiting the site, had decided on the method of building by dovetailing every stone to its neighbour, and the whole to the solid rock. The Eddystone, it will be remembered, is the highest part of a crest of rocks, and on its S.W. aspect slopes down to the sea. The latter is urged in this direction with the greatest fury during storms, and the water rushing up the slope threatens to sweep everything before it. Having determined upon the shape of the lighthouse, and the mode of bedding and bonding the stones, Smeaton turned his attention to the mortar, which of necessity must be proof against the effects of frequent water-washing. The practical masons of the time had a dogma that the harder the stone of which lime was made the harder would the mortar set, and another article of their creed was the belief that mortar made with sea-water would never harden equal to that made with fresh water. Smeaton himself was convinced, from personal observation, that where plastering had been done with the aid of sea-water, or where sea-sand had been used in the mortar, neither the plaster nor the mortar ever became thoroughly dry, while they were injuriously affected by atmospheric changes. But there was no fresh water on the Eddystone-rock, and, from the shape of the blocks of stone with which he intended to build his lighthouse, it was necessary to drop them into place perpendicularly, so that a very thin mortar or grout would be required to fill the interstices at the sides of the stone, the thicker mortar being available for use only in the horizontal joints. He commenced his experiments by ordering a variety of limes from different parts, as they were brought to his notice in response to his inquiries. His method of testing was to mix the ingredients gradually until he had obtained sufficient to form a ball about 2in. in diameter. This ball was allowed to lie on a plate until it was set, and would not yield to the pressure of the fingers, when it was immersed in water, and the result carefully studied. At the first experiment Smeaton proved the fallacy of the hardest rock making the best lime, and ascertained, at the same time, that salt or fresh water produced no appreciable difference in the setting of the mortar. At an early stage of his experiments Smeaton discovered that if he could not obtain a sufficiently fast-setting mortar he could (eventually he did) point the external joints with plaster of Paris, which, though it could not resist the action of the sea-water for any length of time, would protect the true mortar joints until they were thoroughly set. The best results he obtained from his experiments were with Aberthaw lime, but the differences in the qualities exhibited by various mortars aroused his curiosity, and having learned how to analyse roughly the various limestones, he speedily discovered that those which yielded the best results had in their composition a clay which, when burnt, equalled a brick in hardness. It happened that a Plymouth merchant had previously imported a large quantity of Terra Puzzolana as a speculation, which he was glad to sell to Smeaton, and the latter soon found that with Aberthaw lime and the puzzolana he could make a cement which would harden gradually, and become equal to the best "merchantable Portland stone." Hence the name of Portland cement, and the discovery of the art of making hydraulic mortars. Smeaton continued his experiments with a large number of limes, and finally attacked the most difficult question of all—the preparation of a grout sufficiently thin to run in between the stones. His success was perfect, and he had, as he says, "no longer any doubt of being able to unite the whole of the materials of my building into one solid mass of stone." Since the time of Smeaton many investigators, both in this country and on the Continent, have turned their attention to the production of hydraulic cements; but possibly Pasley, who was employed by the Government, helped considerably to found the present flourishing manufacture of Portland cement. Like the steam-engine, many inventors helped to bring it to the degree of perfection in which we have it, but to none in particular can be ascribed its invention. Aspdin, who was one of the first to take out a patent (Dobbs, in 1810, appears to have been the first), for making cements by mixtures of clay and lime, burnt and ground, deserves especial mention for his perseverance in enforcing the necessity of a high temperature in the kiln, and also because he was the founder of the present trade.

Portland cement is a chemical product obtained by a mechanical combination of carbonate of lime with silica and alumina, subsequently converted by heat into what may be termed a double silicate of lime and alumina. There is, as Mr. Reid says, a good deal of mystery imported into its manufacture; some of the makers seeking to enshroud the process with an air of ignorant exclusiveness. Since 1826, when Frost was the first to erect a manufactory near London, the Kentish bank of the Thames and Medway has become the locale of many Portland cement works, and a large part of their product is exported to the Continent, India, and the colonies. Near Boulogne, in France, there are very large works, and at Stettin, in Germany, the manufacture of Portland cement is carried out on an immense scale; indeed, at the latter place, a cement is made from Witherite (carbonate of baryta), which, for work above water, is far stronger than the Portland, but is also very expensive. In his "geological and mineralogical observations," forming the longest chapter in the book, Mr. Reid gives a large number of analyses of natural deposits suitable for the manufacture of cement, and in the following chapter we have a few pages on the artificial sources of cement-making materials. The field of selection for what may be regarded as the natural supply is, however, so wide that, unless some special advantages are to be obtained, many of the valuable supplies of artificial character are likely to be neglected. But the essentials of Portland cement being lime, silica, and alumina—small quantities of iron, magnesia, manganese, and other substances, frequently found in the materials used, exercising little if any influence on the product—it will be obvious that many of the slags produced at ironworks, combined with the waste lime heaps of the lime-burner, the soap-maker, and the gas works, would be chemically well adapted for the manufacture of cement. The supply is practically unlimited, but the conversion into cement must be carried out at the spot, as any expense for carriage is prohibited by the abundant supply of the natural materials in the neighbourhood of the present works Attempts have been made to utilise the immense heaps of alkali-waste as an ingredient in the manufacture of Portland cement; but, owing to the quantity of sulphur remaining in those noxious deposits, no appreciable success has been obtained. The sulphate of lime produced prevented the fabrication of a perfectly hydraulic cement, although it is not impossible that a cement suitable for the manufacture of concrete and mortar might have been obtained. De-sulphuring processes have since been tried with the view of not only recovering the sulphur, but of rendering the remaining waste available for other purposes—a double advantage which would be readily appreciated, for the accumulations are becoming so extensive that considerable expense is incurred in carting the refuse from the works, and in finding localities for its deposition. Alum-waste can, as a rule, be converted into cement, and soap-lime waste has been profitably treated in that manner by the author; but the sulphur in the gas-lime effectively prevents its utilisation for the purpose. Mr. Reid furnishes chapters on the choice of a site for a cement works, the selection of the raw materials, their analy-

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* The Science and Art of the Manufacture of Portland Cement. By Henry Reid, C.E. London: E. and F. N. Spon.

reatment, either by the wet, the
, or the dry method. The wet
consists in mixing the chalk and
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any useful progress will surely
the direction of the dry method,
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as much as from 50 to 60 per cent.
here is some difficulty in obtaining
machinery to reduce those sub-
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and unless some little skill is dis-
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admixture of the particles of chalk
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which he declares is not only
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and calcined at a high temperature.
ment obtained by grinding these
is equal to the best "London"
In all weathers, and on the same
, from the time of quarrying to filling the sack or cask, one week is sufficient for the process of manufacture where lias deposits are worked; and when the products become better known there will be more enterprise displayed in the manufacture of cement from the blue lias. A good Portland cement, made from white chalk and Medway mud, was found to contain silica 22·74, alumina 7·74, oxide of iron 3·70, and lime 56·68, with small quantities of sulphate of lime, magnesia, carbonic acid, water, and alkalies. If from any other raw materials a cement having a similar composition could be made, we should expect to find that it gave similar results in the testing machine, and be as much entitled to the name of "Portland" as that made from chalk and clay in the neighbourhood of London, especially when we remember that Aspdin applied the name to his cement, which was made in Yorkshire. We must leave to a future opportunity a notice of the applications of Portland cement; but, meantime, those who are desirous of having the science and art of its manufacture before them will find it in this able work from the pen of Mr. Reid.

THE ORGAN: A COMPREHENSIVE TREATISE ON ITS MANUFACTURE, PROCURAL, AND LODGMENT.*

By JOHN WATSON WARMAN,

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PART I.—GENERAL TREATMENT IN MANUFACTURE.

z. NO. 4 is the best arrangement for a properly designed Instrument, with commensurate Pedale. It is here that the Part Sub.-oct. to Ped. or Part Sup.-oct. to Ped. comes in so valuably; the Swell to Ped., being a Part Coupler, will make up Ped. fully without recourse to Great. (By Chorus is here meant the Mixture, and perhaps 15th if Pedale be large; if no Mixture, simply 15th.) No. 5 suits a rather smaller Pedale, as the non-division of the Swell will throw the supplementing of the Pedale more on to the Great, for which purpose the Great to Ped. will here be *Clear* or independent of the Swell to Great. No. 6 will be very effective when Ped. is really incommensurate, and Swell will also bear strengthening. No. 7 will be excellent for a Concert Organ. No. 8 will be suitable when Ped. only is incommensurate. No. 9 is suitable when the Swell is larger than the regular proportion (*see* SPECIFICATIONS). No. 11 *a* avoids the expense of two Pallets throughout, and favours the evenness of the Reeds, but of course latter as a *whole* will be less effective.

[11.] *Three Mans.—Great Swell and Choir.* 12, Heav. to whole of Swell, and Reed-and-Chorus portion of Ped. 13, Heav. to Reed-and-Chorus of Swell (*see* also Nos. 4 and 11 *a.*) and Reed-and-Chorus portion of Pedale. 14, Heav. to Reed-and-Chorus portion of Pedale, and all Manual Reeds except those of Choir. 15, Heav. to Pneumatic and Reeds of Great. 16, Heav. to Pneumatic only. 17, Heav. to Pneumatic, and all Reeds except those of Choir. 18, Heav. to Pneumatic, and whole of Swell. 19, Heav. to Trebles of all Manual Reeds except perhaps those of Choir. 20, Heav. to Manual Reeds generally (except perhaps of Choir), and to Flue Trebles of Great. *See* also at end of these INSTANCES (11, z.), also BORROWINGS (26, e., to end).

b. No. 12 is now the best arrangement for a properly-designed Instrument. The whole of the Swell is here put on the heavier wind; 1st, because it now has (or it is desirable that it should have) the Choir coupled to Great to contend against; and, 2nd, because the Choir will here furnish an admirable supplementary Pedale. By Reed-and-Chorus portion is meant such Registers as it is desirable to exclude from the action of the Sub-oct. to Pedale; for full definition, *see* SPECIFICATIONS. (It has, of course, the same signification in Two Man. preceding, only that Ped. is in such case rarely large enough to render any more precise definition there necessary. No. 13 (*see* also Nos. 4 and 11 *a*) will be excellent when Swell is well able to hold its own, either by its great size or from the absence of Choir to Great; though even here, bear in mind, the presence of the Choir does away with the reason for parting the Swell, as Choir is always convenient for soft Bass. No. 14 will, of course, bring the Reeds more into prominence; it may be confidently adopted for Concert Instruments which have not—although Three Man. Concert Instruments ought to have—a regular Solo organ. No. 15 is a good arrangement when it is wished to get as much as possible out of the Instrument, as octave and other Man. couplers can be freely used, and the Great Reeds become powerful; the heavy Pneumatic will, of course, insure promptitude and efficiency: an example occurs in the case of St. John the Evangelist, Penge, by Willis. No. 16 is a good useful arrangement under ordinary circumstances; it is particularly suitable for Instrument receiving a Pneumatic as an *addition*, as it interferes with nothing: St. Stephen's, Lewisham, by Walker, furnishes an example. No. 17 makes a good deal of the Organ, and is also suitable for Concert Instrument; but there is some danger of rendering the Swell and Pedal *blaring*: an example is furnished at St. Columba's, Haggerstone, by Allen, of Bristol. No. 18 is good with an *incommensurate* Swell.

c. It will be noticed that there is no example given of one pressure to whole of Mans. and other to whole of Ped.; such is, in Author's opinion, a very unwise arrangement, unless the Pedale be incommensurate, or heaviness of touch apprehended. Examples—but in each case it is believed with reason—are furnished by St. Alban's Abbey (Hill) and St. Alphonsus, New York (Hook and Hastings, Boston), &c.

d. *Three Mans.—Great Swell and Solo.* 21, Heav. to whole of Solo, and Pneumatic, and Swell Reeds and Mixture (*see* also Nos. 4 and 11 *a*). 22, Heav. to whole of Solo, and Pneumatic, and Ped. Reeds (or Ped. Reed-and-Chorus portion) and Swell Reeds and Mixture (*see* also Nos. 4 and 11 *a*). 23, Heav. to Solo Reeds, Ped. Reeds (or Ped. Reed-and-Chorus portion) and Swell Reeds-and-Mixture (*see* also Nos. 4 and 11 *a*), and Pneumatic. 24, Heav. to whole of Reeds (including, if choose, Ped Reed-and-Chorus portion), and Swell Mixture (*see* also Nos. 4 and 11 *a*). *See* also at end of these INSTANCES (11, z.), also BORROWINGS (26, e., to end). 25, Heav. to whole of Man. Reed Trebles. 26, Heav. to whole of Reeds, and Flue-Trebles.

e. No. 21 (*see* also Nos. 4 and 11 *a*) may be looked at as the best method with a properly-designed Instrument; the *Part* Oct.-Coupler can of course be applied to the Pedale with equal facility, one Ped. Front-board will here do; space often valuable in an Orchestra. No. 22 (*see* also 4 and 11 *a*) may be freely used if the Solo be large, and space for the second Ped. Front-board can be insured; of course Ped. will become louder, and care must be taken that the Pneumatic do not demand so heavy a wind that Ped. Chorus becomes outrageous. No. 23 (*see* also Nos. 4 and 11 *a*) of course gives less Solo power, but eases Pneumatic, so favours moderate treatment of Ped. Chorus, which is, obviously, here even more necessary. No. 24 (*see* also Nos. 4 and 11 *a*) is only to be recommended when Organ is *under*-Reeded or much Reed-power desired.

f. The division of the Swell has here been almost insisted on for obvious reasons—the Solo is naturally of little use to furnish soft Supplementary Ped., and the Great, even if united to Ped. by a Clearing coupler, is here of comparatively little benefit for such purpose, as some strong imitative Stop—perhaps a Trumpet—is always liable to be on. Particular care must be taken with the Ped., either to *insure* admission to both Front-boards or *abandon* the two pressures to that Section (unless some method be adopted to get at Valves from top, as Puppet or Disc, and this makes any ciphering in Ped. valves a terrible affair, as Pipes must come out to get at, *see* SOUNDBOARDS, &c.); space on the Orchestra is almost invariably of the very greatest value. It will also be well to repeat the caution about the Pedale Reed and Chorus; if the Pneumatic be of such nature or size that the Heavier is very much stronger than the Lighter, there will be danger of this portion

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—viz., the Ped. Reed-and-Chorus—becoming, as already said, ferocious.

g. *Four Mans.*—27. Heav. to Pneumatic, and whole of Solo, and Ped. R, Ped. Reed-and-Chorus portion, and Swell Reeds (*see* also Nos. 4 and 11 *a*). 28. Heav. to Pneu., and whole of Solo, and Ped. Reed-and-Chorus portion. 29. Heav. to Pneumatic, and whole of Solo, and Reeds of Swell (*see* also Nos. 4 and 11 *a*). Nos. 30 and 31, *see* Nos. 19 and 20. *See* also at end of these INSTANCES (11, z.), also BORROWINGS (26, e., to end).

h. No. 27 may perhaps on the whole be here considered the best arrangement, although it must not be forgotten that even this is a makeshift, for more than three Manuals *really* demand more than two pressures. Of course two Ped. Front-boards are required, and both Sub. and Sup. Oct. Part-couplers should by all means be employed here, for the four Mans. require a large Pedale, and yet the space for it is often begrudged in Instruments built at a low cost; which kind is of course that now under consideration, for *first* quality Four Man. Instruments will certainly have at least three pressures (and are therefore treated further on, i., next). In Orchestral Instruments, where it is sometimes objectionable to throw the player up more than can be avoided, the Ped. action can easily pass under the Orchestra: in other Organs the throwing up of the player is highly beneficial: in other cases it is imperative. No. 28 sacrifices power of Swell Reeds, but is less expensive, and Choir, of course, will furnish soft Ped. Bass: this may be employed when Swell is really large and commensurate—not recommended otherwise. Both in it and preceding take care that Pneumatic can work with a wind not very much heavier than the lighter one, and that the necessary space for Two Ped. Front-boards can be spared, or one made to suffice). No. 29 (*see* also Nos. 4 and 11 *a*) use freely when space for Pedale is really circumscribed; take care that the lighter wind be adequate for the Pedale, as the Heavier pressure has now nothing to render it a matter to be feared: remember that pressures may be not too *diverse*, and both tolerably strong. This will be found in fact a very convenient arrangement, but remember to employ both Sub. and Super-oct. Part-coupler to Pedale.

The need of securing both a loud and soft 16ft. Reed (which need always exists where there is heavy Manual Reed-work to be matched), has not been gone into so far because it is obvious that the Solo Reeds cannot here be powerful enough to make their proper Pedal backing a serious consideration. The point is fully treated with three pressures, next, but it should be remembered that the Reed 16ft. must be of an useful medium strength, or it will be certainly less loved than feared; an instance of a fine but ferocious Register of this nature is furnished in the Pedale of All Saints, Margaret-street, London; by Hill.

i. THREE PRESSURES. *Two Manuals.* Not necessary to give Examples here as it is decidedly unnecessary to have more than two pressures with fewer Manuals than three. *See* fully in DETERMINATION (12, h).

j. *Three Manuals. Great, Swell,* and *Choir.* It will be seen that when the third Man. is a Choir, as many as three pressures are only recommended when there is a Pneumatic, and that owing to absence of Solo the Pneumatic engrosses the heaviest pressure, so leaving the Sounding-portion to the two remaining ones.

k. 32. Heaviest to Pneumatic: Middle pressure to Swell Reeds (*See* also No. 4 and 11 *a*) and Great Reeds, and Pedal Reed-and-Chorus portion. 33, Heaviest to Pneumatic; Middle to Swell Reeds, and Swell Mixture (*see* also No. 4 and 11 *a*), and Ped. Reed-and-Chorus portion. 34, Heaviest to Pneumatic; Middle to whole of Swell, and Ped. Reed-and-Chorus portion. Nos. 35, 36, and 37, like three preceding except that whole of Ped. is on one wind; either the lightest or middle wind may be selected according to circumstances, without reference to keeping separate from Manual wind. (*See* 10, e.) For Nos. 38 and 39 *see* No. 19 and 20 (11, a.). *See* also at end of these INSTANCES (11 z.) Also BORROWINGS (26 e. to end).

l. No 32 (*see* also Nos. 4 and 11 *a*) may be considered, on the whole, the best arrangement here. It does not assist Swell to supplement Ped., but that is effectually done by Choir. Swell Reeds become fine, and Great Reeds also; these make up want of Solo to some extent. No. 33 (*see* also Nos. 4 and 11 *a*) does make such provision for Pedale, and will be very useful when Ped. or Choir, or both, are incommensurate. No. 34 strengthens whole of Swell, and will be the best when that Section is incommensurate. Nos. 35, 36, and 37 are all inferior arrangements, to be selected under conditions same as preceding three, *except* that space is too circumscribed to permit of the two Front-boards to Pedal, and cost will not admit of modification of Soundboard (*see* that *Dep.*): with regard to whether lighter or middle wind be selected for Ped. in these last three cases, much will depend on size of Pedale and scales of Pipes employed; *see* in GENERAL CONSIDERATIONS (9, *y*). It must not be forgotten that the system of Sub. and Sup. Oct. Part-couplers is here just as practicable as with two winds, only in the latter case, to use a vulgarism, "two birds are killed with one stone."

m. *Three Mans., Great Swell,* and *Solo.*—No. 40, Heaviest to Tubas; Middle to Pneumatic, remainder of Solo, Swell Reeds, Swell Mixtures (*see* also Nos. 4 and 11 *a*), and Ped. Reed-and-Chorus portion. No. 41, Heaviest to Tubas; Middle to Pneumatic, remainder of Solo, Swell Reeds, Swell Mixtures (*see* also Nos. 4 and 11 *a*), and whole of Pedale. No. 42, Heaviest to Tubas; Middle to Pneumatic, remainder of Solo, whole of Swell, and Ped. Reed-and-Chorus portion. Nos. 43 and 44, *see* Nos. 25 and 26. See also at end of these INSTANCES (11 z). Also BORROWINGS (26 e.).

n. No. 40 (*see* also Nos. 4 and 11 *a*) may be considered the best method here; both it and the next are, as will be seen, designed to adapt Swell to supplementing the Pedale, as was done with but two Pressures—here obviously rendered necessary by absence of Choir. There now appears a difficulty in consequence of the Tubas being now of full power, and it is this, if the Pedal 16 reed be *strong* enough to cope with the Tubas, it will necessarily be too strong for general purposes; if it be of useful *medium* power the Full organ will, to a certain extent, lack bottom: if the Pedale can contain two 16ft. Reeds, it is manifest the difficulty is got over at once, but this is not advisable except with a good-sized instrument. The three Apportionments now given are designed as far as possible to meet this difficulty. No. 40 is, as has been said, the best Apportionment; the two 16 reed powers are obtained by it thus: the Swell 16ft. Reed may now, in order to better assert itself against the Tubas, be of tolerably strong tone, and with the heavier pressure in addition make a good serviceable Pedal Register; it is true it is not designed to be included in the Swell to Ped. (there being no Choir Organ), but Swell to Gr. will always so obtain it in conjunction with Gr. to Ped., and as these two couplers may easily be well out when such a Register is required, no practical inconvenience will result from the Swell Reeds not being on the Swell to Ped. The Ped. 16 Reed proper will always be of strength to match the Tubas, and consequently rarely used. No. 41 (*see* also Nos. 4 and 11 *a*) will be the best when space for two Pedale Front-boards cannot be spared: the middle wind will now be best for Pedale because of the existence of the Solo. No. 42 is designed to be used with a 16ft. Reed on Great, and no such Register on Swell, but Sub-octave Swell instead; the said Reed being now outside Box, will be a good useful power without extra pressure. This arrangement, however, is not to be considered on the whole so good as the preceding, because the division of the Swell is not favoured by it; use, however, freely when Swell is incommensurate.

o. It will be seen that only one arrangement is given that allows of but one Pedale Front-board; the simple reason being that with a Solo Organ present, division of pressure in the Pedale may be regarded as essential, and proper space for it ought to be *insisted* on.

(To be continued.)

A NEW PROCESS FOR THE PRESERVATION OF IRON.

A NEW process for protecting iron surfaces from oxidation has been patented by Mr. George Bower, of St. Neot's. This process depends like that of Professor Barff, on the formation of an unalterable magnetic oxide of iron (Fe_3O_4); but the means by which this desirable end is accomplished are in every way very different. Previous to laying before our readers the details of the process, it will be well to remind them of the objections to the various methods at present in vogue for preventing rust. The most general plan, and, indeed, the only plan until now at all applicable to the protection of what we may term "structural" iron, is to give it a coating of some kind of paint or composition that will, as it were, form an envelope over the iron, and so protect it more or less, according to the impermeability of the envelope. Now, such a coating has a purely mechanical adhesion to the surface to which it may be applied, and, consequently, is readily abraded by very slight friction, and is also liable to scale off on exposure to atmospheric influences, thus involving frequent renewal and consequent expense. This fact, however, does not constitute the only objection to the use of paints, &c., there being a far more serious one arising from the tendency of iron to "granular" rusting, which may be considered to be a kind of progressive action which takes place with iron, should oxidation be started at any one place, tending, of course, seriously to weaken any structure composed of that metal. The reason why paints are objectionable will, in view of this fact, be tolerably evident, for if rusting has once commenced at some small point of the ruptured surface, it spreads laterally under the paint, which then simply serves to hide a serious defect, which should at once be remedied.

Iron articles for many purposes are [illegible]quently coated with some less oxidisable metal—such, for instance, as tin or zinc. If the former metal is used, the product is known [illegible] tinned iron or "tinplate," and if the latter [illegible] employed, the iron is said to be "galvanised." This method of protection, for small articles especially, is valuable and efficient so long as the continuity of the zinc or tin film is complete, but should it be destroyed, the galvanic action set up between the iron and the metal coating destroys the former with increased rapidity.

For many years past it has been well known to chemists that, if it were only possible to give metals a coherent and permanent coating [illegible] their own oxides, in many cases, at any [illegible] further destruction by oxidation would [illegible] stayed. As it is, many of the metals largely used for articles likely to be exposed to [illegible]nary oxidising influences depend on their adaptability for such purposes to the film of [illegible] which forms on their surfaces, and so protect them from further action. We see this [illegible] well exemplified in the case of lead and [illegible] Iron, however, presents the difficulty already referred to of being susceptible of progressive rusting if any of the red oxide or rust be formed on its surface. If, however, we come to examine the matter a little more closely, we find [illegible] there is an oxide of iron known to chemists [illegible] the magnetic or ferroso-ferric oxide, which [illegible] unalterable, and requires an elevated temperature to produce it. This oxide, then, seems [illegible] solve at once our difficulty, and as a matter [illegible] fact the Russians, as pointed out by Dr. P[illegible] in his interesting paper read before the I[illegible] and Steel Institute, have been using this [illegible]stance for many years as a protector of [illegible] from further oxidation. The coating formed, however, on Russian iron is very superficial, and the method of procedure defective and inapplicable to most articles.

It is well known to every tyro in chemistry that if we pass steam over red-hot iron the steam is decomposed, hydrogen being set free, whilst the oxygen goes to the iron to form the stable magnetic oxide (Fe_3O_4). On this reaction depends the process of Professor Barff, who places the articles in a heated chamber, and then passes in superheated steam, for a time dependent, of course, on the thickness of the film required.

Mr. Bower has, however, discovered a process that will most efficiently coat the iron, and [illegible] me time simplifies the whole of the g details. The agent he employs is the of the atmosphere. The articles are in a chamber, constructed of fire-brick or ad fitted with inlet and outlet pipes; air d in, and the chamber closed as com- as possible. The temperature is then to the requisite degree, which varies with ture of the articles, and which ranges dull to a bright red heat. At the end of hour the inlet and outlet pipes are , and the air renewed, the pipes being losed. This process continues until the d thickness of oxide is formed, which course, depend on the purpose for which icles are designed. The cost of thus ing iron depends simply on the amount used, with the labour and wear and tear ratus involved; so that the process has, imed, the advantage of being the cheap- well as the most effective yet brought the public.

coating has been most severely tested, to hardness, homogeneity, and capabi- withstanding all the ordinary oxidising ces likely to be brought to bear on it, s not been found wanting. It is found he process, as at present carried out, s best with cast iron; but, with a cheap sily applied modification, the details of are not yet made public, it is found to equally well for all other descriptions of tal. A successful method of protecting its commercial forms deserves especial gement when we recollect how enor- it must enhance the value of iron as a ctive material, and also facilitate its tion under circumstances which at pre- rbid its use.

THE LATHE.—II.

By Fred. Hoffmann, Engineer.

RE are three common forms of cramping own screws for the triangular top plate, , 2, and 3, the second being perhaps the The first can be readily made from a f square steel; the third is screwed down arrier screw, and has the advantage that ot be screwed down hard enough to burr ends, Fig. 4. If the tool is held down cramps the thread of the studs in the ce must be fine. Whitworth has dished and nuts to suit, which afford a secure the nut, and allow a greater depth of be used. A square thread is quite un- ry for the clamping-down bolts, as it is ly more trouble to make one bolt with threads than have to repair or make a of ones with V-threads. Care must be o oil these bolts occasionally; it is not ry to screw down the tool so very hard. ool does not appear to be steady it is le that it is packed unequally, or that l itself rides on the top rest, from being round at the under side, or from being out too far from the rest (Fig. 5). The screws may be either of a square or d. A square thread is preferable from llowing reason:—In a V-thread the nd nut, acting against each other, do not gainst each other at right-angles, but ly, as shown in Fig. 6, the screw tending t the nut outwards, while the square has a good flat surface, and it is gene- und that where much work has to be e square thread is preferable, the V- being of course most useful for joining f machinery together (Fig. 6). The lead- w is an exception to this, because it would ach longer to lock the slide-rest of a utting lathe on to a square than a V- d leading screw. The thread of a screw must not be too fine, as although feed may be put on, the screw is always o be stiff from the difficulty experienced ning the clotted oil and dirt off, unless e is in constant use. The pitch of the may be made as quick as is wanted, by a double thread. Nuts for these threads cast or wrought iron, or brass, or white Brass is perhaps the best, as it is easy nd fit, and works smoothly.

nut need not necessarily be screwed on under-side of the rest, but may be just to a hole drilled in the rest, and the hole may be bored and cut on an angle iron, as shown in Fig. 7. The rest should be fitted together, and the nut marked off the slide-rest by a scriber of the form shown in Fig. 8. Now we come to the method of fixing the feeding-screw. Some engineers prefer to have the end loose, considering the nut as a sufficient guide for it. This method must have a couple of lock-nuts at the handle-end, either inside or outside the rest. In many lathes a hole has to be made in the second piece of the slide-rest, to let in the nut for the top piece. This hole also serves to allow all the water, rusted iron turnings, and dirt from accumulating, and if this hole is not cast to let through the nut, it is advisable to drill one through. Often the feeding-screw is fastened in (see Fig. 9) by a cap which takes up the backlash through a couple of small screws, through the steel cap into the slide-rest; but this method always gives trouble in a lathe from the inability and inconvenience of oiling. The lock-nuts are shown outside the slide-rest in Fig. 9, with a washer between them and the casting. The thread for these should be very fine, as is the case with most locking nuts. A word now about the square end of the spindle. Engineers generally after drilling the hole through the boss of the handle, drive one or two steel drifts through, until the square hole fits the end of the spindle. An allowance of $\frac{1}{16}$in. should be made in fitting this, as a man cannot be wasting his time trying to fit the handle on; in fact, some makers purposely hollow out the handle, as in Fig. 10. Sometimes, when the square hole does not come right through the handle, it is necessary for it to be turned, as shown in Fig. 11, which leaves clearance for the hole to be slotted out, as filing would, of course, be out of the question.

FIG. 1

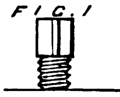


FIG. 2

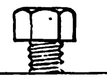


FIG. 3

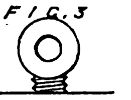


FIG. 4

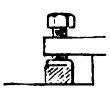


FIG. 5

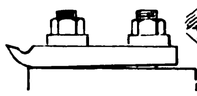
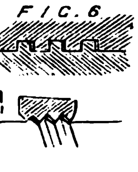


FIG. 6



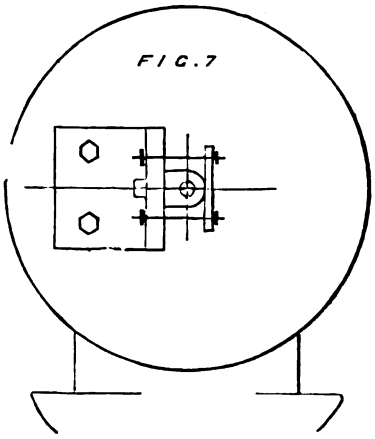


FIG. 8

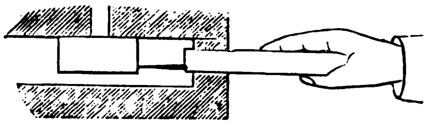


FIG. 9

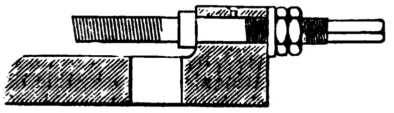


FIG. 10

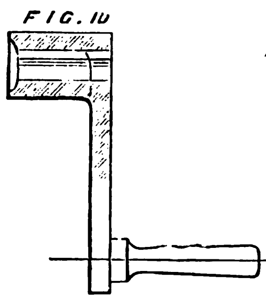
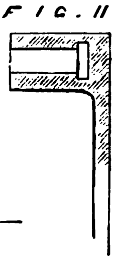


FIG. 11



(*To be continued.*)

CHIEF PHENOMENA OF THE THREE PRIMARY STATES OF MATTER.

By J. Douglas Scoffern.

Part I.—Introductory.

I HAVE long had the impression — strengthened and confirmed by some degree of experience as a teacher of natural science—that no slight amount of blame attaches to the authors and compilers of a great number of the so-called elementary "text-books," constantly being put forth with the implied object of rounding off the sharp corners, and smoothing down the seared wrinkles of technical study.

Curious, indeed, would be the result of a return framed in accordance with a conscientious admission of failure, of the numbers that have turned aside disgusted with themselves from the threshold of science, utterly unable to correctly apprehend and apply the beautiful principles which she at all times exhibits.

Not a little mischief has, I am convinced, been brought about by the undue importance, which has within the past few years been given to a collateral department of mathematical investigation, to which the name of "modern geometry" has been applied. Viewed in its right light this is really intended to supply a fitting superstructure to theoretical reasoning which the student has already gained; but it appears to me a matter of common occurrence for the pupil to have unfairly thrust upon him an exercise of this character—forming, in fact, a species of geometrical charade—at a time when he can barely grasp even the most elementary demonstrations which are to be found in "Euclid's Elements."

Far be it from my purpose to seek in any manner to inculcate a want of appreciation of the manifest importance connected with a correct knowledge of the theory of "Loci," and the origin and attributes of "Symmetry;" I am fully aware of the value to be derived from an acquaintance with these properties, but I contend that such knowledge should, for the most part form a subsequent acquisition, and a thorough grounding in legitimate geometry—a primary desideratum.

Observation has shown me that many persons possessed of what is commonly termed an "inquiring turn of mind," have in reality dormant faculties and habits of observation susceptible of being attuned to the successful prosecution of numerous branches of recondite research; nor need we marvel that so many brains, albeit highly speculative *per se*, remain oftimes hopelessly barren of results, if we consider for a moment the uninviting way in which physical science is for the most part dished up.

Suppose, for instance, we take up almost any one of the "elementary" manuals (and their name is legion) professing to guide the student in his obligatory course of preparation tending to say, the Matriculation Examination of the University of London. We shall discover in nearly each book a degree of sameness and dearth of originality such as to render the task of perusal one almost of oppression.

Many works, it is true, deal with the leading facts in sufficiently clear language, and supply not a few illustrative examples fully and consistently worked out, as a guide to the learner in his subsequent progress; and I use the word "consistently" with an object which I will explain.

I do not include in the category of such text-books the names of writers who, having put themselves to infinite pains in order to enunciate certain fixed and immutable laws, forthwith rush off at a tangent, *in medias res*, abruptly from known generals to generally unknown particulars. With such writers it appears to be the correct thing to address their would-be followers somewhat after this fashion:—"The primary laws governing this branch of study are fully elucidated in the foregoing pages, and they can easily be shown to rule all the known cases that can possibly present themselves for consideration. The student must bear in mind that nearly all he can attain in the way of proof must ever be derived from purely geometrical and trigonometrical functions—that is to say, from the judicious application of the teachings of Euclid and of Algebra, neither of which the writer feels called upon to in the least degree explain for his benefit. Indeed, in a work of such an elementary character as this professes to be, such a dissertation would but entail wholly unnecessary labour on the author's part, and he leaves it to the pupil, therefore, to obtain this absolutely essential knowledge of working principles, this accurate acquaintance with the nature and uses of the slide-rule of science as best he may. It will suffice to state that the few special cases of 'composition and resolution of forces' capable of being solved without the aid of trigonometry admit of easy demonstration by means of propositions to be found in the first and second books of 'Euclid's Elements;' that many of the phenomena attendant upon that species of energy which we term heat are ordinarily associated with an examination of the mathematical properties pertaining to adiabatic lines and isothermal curves, derived from the rectangular hyperbola; and, further, that in calculations connected with gases our object is to find numerical expressions for the respective areas included between different portions of these lines and corresponding projections situated upon the asymptotes to a series of such curves. Finally, that if the searcher after truth will but persevere in his studies he can easily calculate the continued gravitation of the moon towards our earth—that is, the orbital motion which this celestial body exhibits—by means of an extremely simple application of a proposition occurring in the third book of Euclid. But for further information relative to this and other subjects of a similar nature, the reader is referred to the more suitable manuals, of which so many exist in the English language."

Now, in the above supposititious instance there is by no means so great a degree of exaggeration as might at first sight seem to be the case. An episode bearing upon our present subject recurs to my mind at this moment, and as it is not uninstructive, I venture to reproduce the same.

Some few years since, an intending candidate for matriculation placed himself under my guidance in regard to the science portion of the curriculum; and in *physics* he elected to use a small work from the pen of a quondam master at a London middle-class school—himself, I believe, a self-educated man, and one therefore well competent, as we may presume, to judge of the arduous nature of all primary advancement in technical study. Upon my assurance that all would be well, could he but master the method of proof which the above author adduced, my pupil set resolutely to work, and for a time achieved very fair success. At last, however, he not only stuck fast, but got "stuck" in a way which was truly pitiable to witness; and I will explain the cause of failure in this case, as it was but typical of all too many similar failures. Most of my readers are, doubtless, familiar with the theoretical nature of the screw—are able, that is to say, to view this mechanical power according to its true construction—that of an inclined plane wound around a cylinder, and forming by the intervals between successive turns of its upper edge what is termed the "pitch" of such screw.

The writer of the work in question had, of course, no alternative but to define the ratio of the power to the weight as that of the circumference of the circle described by the moving force to the distance between any two threads—*i.e.*, to the "pitch." Had he given but the least degree of attention to the requirements of his readers, he would have entered upon some slight explanation concerning the relations subsisting between the diameter, radius, and circumference of the circle, and thus have at once rendered the whole matter clear and susceptible of practical application. It certainly appeared not a little unfair, to my way of thinking, to curtly sum up the desired information in these terms:—"In this machine, therefore, it is obvious that $P : W ::$ pitch of screw $: 2\pi r$ or πd." (!) As a very natural result of all this, I had, at a time, too, when my pupil could ill afford to take up even the most elementary principles of trigonometry, to make him acquainted with the real significance of these latter values. When we bear in mind that the matriculation examination demands a knowledge of but the first four books of Euclid (together with the most familiar "riders" constructed upon them), of algebra only up to quadratics, and of trigonometry none at all, I am fain to think that the author who handles a subject in the above manner does but make known the indifference which he feels in regard to the expeditious advancement of his readers in the study of which he treats.

Again, in the usual treatment by writers on mechanics of the "Centre of Pressures in Solids," and of the "Triangle of Forces," I venture to note errors which might easily be amended.

Relative to these two subjects the student is almost invariably admonished to approach them only when he has succeeded in proving that "the angle contained by perpendiculars or parallels to two straight lines is equal to the angle contained by the lines themselves." No proof could well be more simple in character, following directly from Euclid I., xxx., but it is first necessary, as I have already hinted, that the student should have rendered himself so completely conversant with the application of what we may not inaptly term the geometrical slide-rule, as in reality to have fulfilled an apprenticeship to a course of abstract mathematical reasoning which, in this age of "cramming," but few have time to undergo.

Speaking personally, I have observed whilst engaged in imparting instruction in elementary chemistry to a class of ladies, that they needed only a simple interpretation of the more crucial features of the subject, in order to grasp with characteristic correctness of apprehension, phenomena which to casual observers would be deemed wholly beyond the general capacities of an average sample of "sweet seventeen." I cannot but think that were any one, sufficiently well versed in the various details connected with elementary mathematical, physical, and chemical science, to set himself resolutely to work with the avowed object of ultimately putting forth a manual calculated really to serve the purposes of a "text-book," and one, moreover, in which every difficulty or impediment, were it never so visionary, should be relegated to its fitting place for logical inquiry and scientific discussion, he would at least have the gratification to find the circle of his disciples gradually enlarge, instead of rapidly diminishing and ultimately falling away one by one in quest of "fresh fields and pastures new." Frequently, indeed, has the thought framed itself in my mind that I might perchance possess sufficient time in which to execute, and ability wherewith to fulfil, so great a desideratum; but I incline to the belief that the required object might be more satisfactorily attained were I to meet with another who might be willing to join issue with myself in this projected mental venture. Of this, therefore, perhaps more anon. As regards the subjects which I propose shortly to consider, I will merely remind my scientific readers that few facts connected with physical research are of greater interest, perhaps, than those relating to temperature and pressure as applied to liquids and gases; while the theoretical aspect of a body deprived of every trace of heat-ohms*—that is to say, at 0° of absolute temperature—affords scope for a considerable degree of philosophical inquiry; and that an acquaintance on the part of the generality of mankind—"the hewers of wood and drawers of water"—with such practical hints as are of essential service in the calculations for the determination of the specific gravities and relative weights of vapours, or of varying bulks of steam under increased or diminished temperatures and pressures, cannot but be productive of some good. I deem it well to bring these prefatory remarks to a close, and propose in my next article to offer some observations couched in plain language, touching the simplest of the known conditions of matter—that is, the gaseous state. And, finally, seeing that the questions which I shall pass in somewhat brief review present certain intrinsic difficulties, I must beg that my readers will bear with me in my endeavours to satisfactorily accomplish the object I have in hand; that they will, in fact, be mindful of the old monkish epigram, "Invidiosus Ego; non invidus esse, Laboro!"

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* I prefer this expression; but can we justify it in re Heat, as it is a term relating to Electric resistance?

GEOLOGY OF THE POLAR REGIONS.

At a recent meeting of the Geological Society a paper was communicated by Captain H. W. Feilden, R.A., F.G.S., and Mr. De Rancé, her Majesty's Geological Survey, on the geological results of the Polar Expedition under Admiral Sir G. Nares, F.R.S. The authors describe the Laurentian gneiss that occupies so large a tract in Canada as extending into the Polar area, and alike underlying the older Palæozoic rocks of the Parry Archipelago, the cretaceous and Tertiary plant-bearing beds of Disco Island, and the oolites and lias of East Greenland and Spitzbergen. Newer than the Laurentian, but older than the fossiliferous rocks of Upper Silurian age, are the Cape Rawson beds, forming the coast line between Scoresby Bay and Cape Crosswell, in lat. 82° 40′; these strata are unfossiliferous slates, and grit dipping at very high angles. From the fact that Sir John Richardson found these ancient rocks in the Hudson Bay territory to be directly overlaid by limestones, containing corals of the Upper Silurian Niagara and Onondaga group, Sir Roderick Murchison inferred that the Polar area was dry land during the whole of the interval of time occupied by the deposition of strata elsewhere between the Laurentian and the Upper Silurian; and the examinations by Mr. Slater, Dr. Haughton, and others of the specimens brought from the Parry Islands have hitherto been considered to support this view. The specimens of rocks and fossils, more than 2,000 in number, brought by the late expedition from Grinnel and Hall Lands, have made known to us, with an absolute degree of certainty, the occurrence of Lower Silurian species in rocks underlying the Upper Silurian, and as several of these Lower Silurian forms have been noted from the Arctic Archipelago, there can be little doubt that the Lower Silurians are there present also. The extensive areas of dolomite of a creamy colour discovered by M'Clintock around the magnetic pole, on the western side of Boothia, in King William's Island, and in Prince of Wales Land, abounding in fossils, described by Dr. Haughton, probably represent the whole of the Silurian era and possibly a portion of the Devonian.

The bases of the Silurians are seen in North Somerset, and consist of finely-stratified red sandstone and slate, resting directly on the Laurentian gneiss, resembling that found at Cape Bunny and the cliffs between Whale and Wolstenholme Sounds. Above these sandstones occur ferruginous limestones with quartz grains, and still higher in the series the cream-coloured limestones come in. The Silurians occupy Prince Albert Land, the central and western portion of North Devon, and the whole of Cornwallis Island. The carboniferous limestone was discovered rising to a height of 2,000ft., on the extreme north coast of Grinnel Land, in Fielden and Parry Peninsulas, and contains many species of fossils in common with the rocks of the same age in Spitzbergen and the Parry Archipelago, being probably continuously connected with the limestone of that area, by way of the United States range of mountains. The coal-bearing beds that underlie the carboniferous limestones of Melville Island are absent in Grinnel Land, but they are represented b true marine Devonians, established in the Pola area for the first time, through the determination o the fossils by Mr. Etheridge. In America a vast are is covered by cretaceous rocks. The lowest divisio the Dakota group, contains lignite seams an numerous plant remains indicating a temperat flora; overlying the cretaceous series are vario Tertiary beds, each characterised by a special flor the oldest containing sub-tropical and tropical form as various palms of Eocene type. In the overlyi Miocene beds the character of the plants indicat a more temperate climate, and many of the speci occur in the Miocene beds of Disco Island, in We Greenland, and a few of them in beds associat with the 30ft. coal seam discovered at Lady Frankl Sound by the late expedition. The warmer Eoce flora is entirely absent in the Arctic area, but t Dakota beds are represented by the "Atane strata of West Greenland, in which the leaves of dicotyl donous plants first appear. Beneath it, in Gree land, is an older series of cretaceous plant-bearin beds, indicating a somewhat warmer climat resembling that experienced in Egypt and the Canar

Islands at the present time. In the later Miocene beds of Greenland, Spitzbergen, and the newly discovered beds of Lady Franklin Sound, the plants belong to climatal conditions 30° warmer than at present, the most northern localities marking the coldest conditions. The common fir (Pinus abies) was discovered in the Grinnel Land Miocene, as well as the birch, poplar, and other trees, which doubtless extended across the polar area to Spitzbergen, where they also occur.

At the present time the coasts of Grinnel Land and Greenland are steadily rising from the sea, beds of glacio-marine, with shells of the same species as are now living in Kennedy Channel, extending up the hillsides and valley slopes to a height of 1,000ft.. and reaching a thickness of 200ft. to 300ft. These deposits, which have much in common with the "boulder clays" of English geologists, are formed by the deposition of mud and sand carried down by summer torrents, and discharged into fiords and arms of the sea, covered with stone and gravel-laden floes, which, melted by the heated and turbid waters, precipitate their freight on the mud below. As the land steadily rises these mud beds are elevated above the sea. The coast is fringed with the ice-foot, forming a flat terrace 50 to 100 yards in breadth, stretching from the base of the cliffs to the sea margin. This wall of ice is not made up of frozen sea water, but of the accumulated autumn snowfall, which, drifting to the beach, is converted into ice where it meets the sea water, which splashes over it.

A NEW GALVANIC CELL.

QUITE a new form of galvanic cell was described at a meeting of the Royal Society lately, in the reading of a paper "On Contact Theory of Voltaic Action," by Profs. Ayrton and Perry, of the Engineering College, Tokio, Japan—namely, a description of a cell composed entirely of metal. Its importance may be judged of from the following particulars communicated by the authors:—"It may be known," they state, "that when rods of zinc and copper are placed in mercury and connected with an electrometer no charge is observed. If known, this may have been regarded as a crucial test of the truth of the common theory of compound metallic circuits. Whether the zinc and copper are in contact outside the mercury or not, the amalgamation of the zinc appears to proceed at the same rate. Now, it seemed to us that in this case the impurities and great conductivity of the zinc, with the great liquidity of the amalgam, and the close proximity of foreign particles to pure metal, caused the amalgamation to be produced by local action alone, so that the supply of available chemical energy for the production of a current from the zinc to the copper was exceedingly small; and we have no doubt that at low enough temperatures, when the amalgam loses its liquidity, such an arrangement becomes a simple voltaic cell. It was necessary for us to use instead of zinc a metal of which the amalgam is nearly solid at ordinary temperatures. On inquiry we found that magnesium was such a metal, and on the first trial we obtained a result corroborative of the above theory. Strips of platinum and magnesium, metallically attached to the electrodes of the electrometer, were dipped into mercury, which was, perhaps, slightly impure from the presence of other metals, but which had previously been washed with distilled water, and then well dried. There was a sudden large deflection, the amount of which fluctuated very much afterwards, but which was always considerable, and on the same side of the zero. On successive reversals of the electrometer key, the deflections to right and left of zero were found to be nearly equal to one another. In a short time there seemed to be an increased steadiness in the amount of deflection. When the platinum and magnesium were short-circuited for some minutes, the deflection had decidedly increased in amount on being again insulated, and this occurred after every short circuiting. To determine the electro-motive force of the arrangement, strips of platinum and magnesium, scraped very clean, were dipped into pure mercury which had previously been washed with distilled water and well dried. The maximum electromotive force obtained was 1·56 volts,—that is, about one and a half times the electromotive force of a Daniell's cell, the platinum corresponding with the copper plate in the Daniell's cell. It may be possible, by mechanical or other means, or by using another metal than magnesium, to give constancy to this arrangement, and, as its internal resistance is extremely small, the cell may be of great practical use for the production of powerful currents. It may be remarked that, as an amalgam may be easily separated into its compartments by distillation, such a cell, by suitable arrangements, can be kept in action for an indefinite time. We have examined a circuit composed of the metals platinum, tin, and lead, and the coil of a galvanometer. On raising the temperature of the tin gradually we found that there was a current, and that it gradually increased. Rapid changes in the current were observable at the melting point of the tin, and there seemed to be a small electromotive force independent of thermo-electric effects. When the platinum and lead strips were connected with the electrometer the deflections were found to be too small for decided conclusions to be drawn. We shall proceed, when time allows us, with the investigation of metallic voltaic cells."

NEGATIVES ON PAPER.

IN the bulletin of the Belgian Photographic Association there is a communication by M. Laoureux on the employment of paper instead of glass in the dry plate processes. Paper or cardboard is waxed in the ordinary manner, and is next rubbed over with talc, when it is ready for collodionising. To do this, alcohol is floated over a sheet of glass rather larger than the paper, and the paper is placed on the glass, and after covering it with blotting paper a soft roller is passed over the surface to expel the excess of alcohol. (We may remark that an ordinary wooden roller covered with felt will answer the purpose. Or if a sheet of paper, also waxed, be placed over the blotting paper, the ordinary squeegee may be employed.) The collodion is applied, and the remaining operations are proceeded with as usual. After the preservative has been used, the paper is suspended by one corner to dry. Too thick cardboard should not be used, as it is apt to warp in drying. This paper is placed in the dark slide behind a glass plate and then exposed. The development is conducted in the usual way, by replacing the paper on a glass plate, or by using a developing dish.

The writer remarks that this negative, if printed, would show the grain of the paper; so in order to avoid this, the film is detached after being gelatinized. The gelatine solution is prepared as follows:—Gelatine, 20 parts; water, 100 parts; glycerine, 2 to 4 parts, according to its concentration. The gelatine is first allowed to swell in part of the water, and the remainder added boiling, or by heating over a water bath. The glycerine is added last, and the solution is then filtered. This solution is poured on the film at a temperature of from 85 to 95° Fahrenheit, and is allowed to dry. The film is then readily detached, and the author says that he never meets with a failure. This process answers well, no doubt, but we should feel inclined, after getting the negative, to adopt Woodbury's plan of utilising the film for printing—viz., to coat a plate with gelatine, to which a little chrome alum has been applied, and then to bring the film in contact with it. In this operation the gelatine is allowed to dry, and is then immersed in hot water, and when still tacky the film is brought in contact with it by means of the squeegee, a film of water being between it and the plate. This gives a very compact way of carrying a sensitive surface in the field, and is capable of being utilised by any one. We recommend a washed emulsion as being the most suitable sensitive compound to use.—*Photographic Journal.*

THE MECHANISM OF RUMINATION.

THE force by which in ruminants food is brought back from the first stomach into the mouth has hitherto been attributed either to the stomach or to the gullet, but exact data have not been furnished with reference to the share of these organs in the process. In a dissertation recently published in Lyons M. Toussaint describes an experimental investigation of this question. By means of the graphic method he has demonstrated that the cause of the food rising along the gullet is rarefaction of the air in the chest cavity, and so is to be sought in that portion of the gullet which lies in the chest cavity. This rarefaction is produced by a sudden contraction of the diaphragm coinciding with closure of the larynx; thus the food floating in the liquid of the first stomach is sucked into the gullet. A reflex contraction of the right strand of the diaphragm, in consequence of the pressure of the food on the mucous membrane of the gullet, closes the lower end of the gullet, and so limits the quantity of the substance which can pass into this canal; then the food comes quickly into the mouth, and chewing commences.

These various phenomena take place in a very short time, and without the aid of the graphic method it would be impossible to accurately determine their duration, and the mode of co-operation of the different organs in the process of rumination. Besides the pressure of the air in the respiratory passages M. Toussaint has graphically determined quite a series of other accompanying phenomena, and from the coincidence in time of a group of the phenomena he has been able to prove the rôle of diaphragm in the act of rumination—a rôle hitherto hardly suspected, but very important.

If the diaphragm be paralysed by section of its motor nerves, rumination can yet take place through sudden elevation of the ribs, which, instead of the sinking of the diaphragm, operates to cause a diminution of pressure in the chest cavity.

M. Toussaint could also produce rumination artificially. He stimulated the motor nerves of the diaphragm while an assistant stopped the nostrils; in each case a morsel rose along the gullet, the animal chewed it for a few seconds, then swallowed it again.

We will now state the conclusions which M. Toussaint draws from his numerous experiments. They are:—

1. That the rarefaction of the air in the chest cavity is the cause of passage of the food from the paunch into the gullet, and that therefore no proper previous formation of the morsel occurs; the supposition, therefore, of an organ for forming the morsel is erroneous.
2. That it is necessary, in order that rumination may take place, that the food be very much diluted in that part of the paunch which is next the gullet.
3. That the rarefaction of the air in the lung is produced by a contraction of the diaphragm coinciding with closure of the larynx.
4. That this diminution of pressure within the lung is indispensable for the entrance of substances into the gullet, for if an opening be made into the windpipe, thus neutralising the action of closure of the larynx, the ribs come to the aid of the diaphragm and rise suddenly and simultaneously with it, so as at once to produce this diminution of pressure.
5. That in rumination rarefaction of the air is the only force which has to be postulated, and that the stomach is inactive.
6. That the depressing action of contraction of the diaphragm exerts its influence even on the cavities of the heart, and so much the more on the large vessels of the chest cavity.
7. That rumination can be produced artificially by causing a strong contraction of the diaphragm, through stimulation of the proper nerves (nervi phrenici).

M. Toussaint's further experiments on the phenomena of vomiting, retching, and swallowing do not appear to have led to results which are not open to objection.—*Der Naturforscher.*

THE ANALOGY BETWEEN LIGHT AND SOUND.—III.

BY PROF. W. F. BARRETT.

WE might, if there was time, point out that this analogy extends even to the *details* of absorption and radiation. One reference will suffice. I presume many of you are familiar with the magnificent generalisation of Kirchhoff, who has shown us the composition of the sun from the absorption of certain luminous rays emitted by its incandescent nucleus. If a glowing gas emits a certain character of light, it will absorb precisely that character of light when cold. If, for example, a heated gas emits a certain red light it will when cold absorb a similar red light. If a body emits certain green rays when it is cold, the vapour of that substance will absorb similar green rays. Now this reciprocity, as we may call it, of radiation and absorption is beautifully illustrated in the case of sound. In fact, we obtain the clearest notion of the optical law from the parallel experiment in the phenomenon of sound. I have here a whole series of different tuning forks, two only being of the same pitch. Against one of those (A, Fig. 6), which is now silent, I place a little suspended bead; now I will sound any one of these other forks which is not in tune with it, and it will have no effect upon the silent fork, but if I sound the fork, B, which is exactly in tune with the one now silent, the vibrations emitted by the sounding fork will be taken up by the silent fork, A, and I expect you will find the bead will be pushed away by the vibrations of the fork—the movement of the bead indicating the vibrations as we saw at the beginning of the lecture. You see by the shadow on the screen the bead is agitated directly, and if I quench the sound of the fork, B, those near will hear a faint whisper of the note persisting. That is due to the vibration of A; which has taken up, and is now giving forth, the vibrating energy it has absorbed from B. I will now stop this, and fix the least piece of wax to one of the prongs of A, so as to make it a little flat. The period of the two forks now slightly differs, and you notice that there is no response on the part of A when I strike B; quickly removing the wax from A, matters are restored to their original condition, and the dancing of the huge shadow of the bead shows that A once more responds.

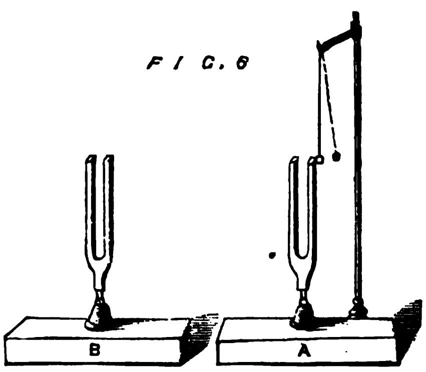
This interesting experiment is, then, the exact analogue of the phenomena of selective radiation and absorption referred to previously. A sodium flame, for example, emitting light of a bright yellow colour, corresponds to our sounding fork; cool sodium vapour, because it is capable of vibrating in the same period as its glowing vapour, absorbs light of that particular yellow character, and hence corresponds to our reciprocating fork A. Considerations such as these have led to the belief that sodium vapour exists in the atmosphere round the sun, because, from among exactly those rays which sodium itself would give us, if it were burning on the surface of the earth, a portion of the light of the sun has been robbed. You will notice here how helpful is the analogy in the case of sound; how it enables us to form clearer and more definite mental pictures of those subtle luminous phenomena!

Not only, however, can a wave of light or sound be accepted by bodies in unison, but one wave can be made to extinguish or to strengthen another by its coalescence with it. Of this we may gain an excellent conception from Wheatstone's beautiful wave apparatus which I have here. You may imagine this wave-like row of beads to be either a wave of sound, or a wave of light, or a wave of the sea, and by moving this slide to and fro I can cause the wave to travel backwards and forwards. Then I have here the means of producing a second system of waves, and when the hollows of one set of waves coincide with the hollows of the other set, they will produce a hollow twice the depth, and when the crests of one set coincide with the crests of the other they produce a crest twice the height, but when a crest coincides with a hollow than we shall find that instead of getting a wave twice as great we shall get no wave at all, because the tendency of one wave will be to move upwards whilst the other moves downwards, and thus a level line, or calm is produced. Waves in this condition are said to be in opposite *phases*.

Now I want to show you the actual effect of this in the case of sound and light—that is to say, the destruction of one sound-bearing wave by another, and the destruction of one light-bearing wave by another. This is termed the *interference* of waves, and we will try to exhibit it in the case of sound first. When I strike a tuning fork, the two prongs of the fork are sending off two sets of waves; and if I place the fork over a jar, so that the two prongs shall send waves into the jar in the same phase, we get a sound of greater intensity than would be produced by one prong; but I can place the fork in such a position that the wave produced from one prong is in a phase exactly opposed to that of the wave produced by the other prong; then the two sounding pulses will neutralise one another, and we shall have perfect silence resulting from the coincidence of two sounds in opposite phases. This I can obtain by merely placing the fork obliquely to the jar, and if I turn it backwards and forwards the sound comes and goes alternately. A similar behaviour is exhibited very well by taking two tuning forks very nearly in unison. If they are only slightly out of tune, the vibrations of one will neutralise for a moment the vibrations of the other, and we shall have intervals of sound and of silence regularly succeeding each other. These are the so-called "beats" in music, and the rhythmic swelling forth and then subsidence of the resultant sound from these two very slightly dissonant forks can be heard by every one present. By means of two pendulums of the same length, this fact of interference can be made evident to the eye. If the pendulums are both started at the same phase, they will strengthen one another; but if they are started at opposite phases, their motions tend to neutralise one another. If one is made a little shorter than the other, then they alternately strengthen and neutralise one another.

This phenomenon can be made evident by other means. Here is an apparatus designed by Kœnig, of Paris, and here is one I designed the other day. It is a tubular ring of brass, and if a whistle be introduced at the top, it being placed in a certain position, you will hear the sound of the whistle readily, but if you place it in such a position that the path of one wave has to travel through a longer branch than the other, a certain position will be arrived at in which the two waves will be in opposite phases, and however loudly you blow the whistle no sound will come out of the tube.* It seems very remarkable that two sounds can produce silence, but we must remember that sound is motion and not matter. Further, there is only half a step between strength and destruction. Half a wave-length behind another, we have perfect silence; but with two half-lengths' difference the waves coincide and they are strengthened.

FIG. 6



We must now briefly notice the optical correspondence to this phenomenon; an analogy first pointed out by Dr. Thomas Young, who from the interference of sound inferred that in the case of light a similar action must take place. I will not read to you the description he gives, which I have here in his early memoir on the subject, but it will be sufficient for you to bear in mind that from this phenomenon of the interference of sound pulses—these beats which you have just now heard—Dr. Young inferred the existence of corresponding beats, as it were, in the case of light; that two waves of light in opposite phases ought to extinguish one another and produce darkness, and it was according to this theory that he gave the explanation of what are known as Newton's rings, or those beautiful colours that you observe in a soap bubble, the colours of thin films. Here I have on the screen an image of these Newton rings; a glass lens is laid on a level plate of glass, and the slight interval between them gives rise to these lovely bands of colour. Using red light instead of white, you see intervals of light and darkness; and these intervals of darkness are produced by two series of waves of light coinciding in opposite phases and thus neutralising each other. We have here the analogue of our beats in music; in one case the extinctions are distributed in space, in the other in time; a characteristic difference which is even more strikingly manifest in the case of music and colour. Subsequently to Young's time, Fresnel succeeded in making two rays of light passing through slightly different paths to interfere, so as to entirely destroy one another.*

I am anxious now to point out what so
consider a fanciful aspect of this analogy,
analogy between colour and music. You
what can be the resemblance between a pai
Rubens and a sonata by Beethoven; but I t
will agree with me that this relationship wil
conceivable if we consider this matter fo
moments.

All the composite sounds of language,
complex notes of an orchestra, are the res
few simple tones variously combined. So
colours of an autumn landscape, or on the
canvas of a Turner, are the product of a fe
colours variously blended and juxtaposed.
I need not remind you that every pigmen
own natural selection derives its colour f
colourless rays of the sun. Now the pris
tegrates white light, and sorts its constitue
a graduated series of wave-lengths, giving
exquisite band of colour you see upon the
called the spectrum. In like manner
analyse a musical composition and arrange
stituents into the sequence of notes ca
musical scale. The succession of colours
spectrum follows an invariable and har
order—namely, going up the scale—red,
yellow, green, blue, indigo, and violet. An
any other arrangement of these colours is le
able, so also is any attempt to ascend or des
gamut than by following the sequence of
D, E, F, G, A, B. Here, however, let us b
guard, for no doubt much of the pleasure g
the spectrum is due to its delicate grada
colour, to imitate which in music we ought
even more notes than are to be found wi
octave of Mr. Bosanquet's beautiful enh
organ, that is to be seen in the loan collectio
sustained sound of the common chord—as
all its purity by these excellent tuning fork
by Kœnig of Paris—produces on the ear a
delicious impression of conscious repose
which the spectrum produces on the eye
harmony of these forks we have, æsthet
rainbow of sound. But even here the an
more poetical than physical. For the
analogy to the spectrum should be found in
rather than in harmony; in the sequence,
blending of tones.

Sir Isaac Newton, however, lent the auth
his great name to the consideration of the

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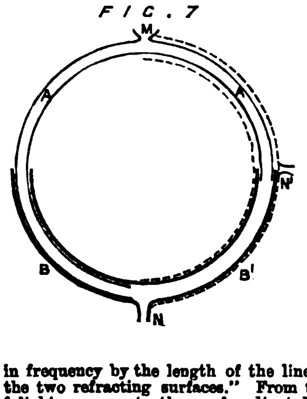
* The apparatus mentioned in the lecture for showing the interference of sound-bearing waves consists of a circular arrangement of tubes, one sliding within the other. One tube A (Fig. 7) to which the mouthpiece M is fixed, is three fourths of a circle; the other tube B, to which the nozzle N is attached, is half a circle, and of such a diameter that it slides freely over the tube A. When the nozzle is diametrically opposite the mouthpiece, the path of the sound-waves is of equal length, and hence the sound from any convenient source placed near to or within the mouthpiece is distinctly heard. By turning the nozzle towards N', in the direction shown by the dotted lines, one limb of the tube is lengthened, whilst the other is correspondingly shortened; the path of the waves being now unequal, a point is soon reached where the sound is nearly obliterated. Employing a suitable source of sound, and a sensitive flame or a resonant jar as a phonoscope, an audience can perceive at once the gradual destruction of the sonorous pulses; and, moreover, the relative lengths of the two branches of the tube clearly indicate the principle of interference thus illustrated. One instrument I made was of brass tubing, 1 foot in diameter, the one limb being ½-inch, the other ⅝-inch tube. About 18 inches in diameter would probably be the best and most convenient size. With an ordinary pitch-pipe inserted at M, the experiment is very striking. A continuous blast of air should be driven through the pipe from an acoustic bellows; and the loud note heard at first is *utterly extinguished* by altering the relative lengths of the tubes. By pushing the tube still further round, the note again comes out; thus the sound of the pitch-pipe can be turned on and off at pleasure. In this case it is probably the interference of two resonant columns of air, rather than the coalescence of two progressive waves in opposite phases.

* The principle of interference first advanced by Dr. Young, from the sound analogy, did more than anything else to establish the undulatory theory of light: a principle which, Sir John Herschel remarks, "has proved the key of all the more puzzling and abstruse properties of light, and the establishment of which would alone have sufficed to place Young in the highest rank of scientific immortality." The principle explains not only the colours of thin plates, such as Newton's rings and the colours of a soap-bubble or iridescent scum, but also the more refined and complicated phenomena known as *diffraction*, where coloured fringes are seen to accompany shadows, or brilliant spectra to be produced by means of fine lines or scratches ruled closely together. It is curious, however, to note that Young was led to a false analogy in the case of the colours of thin plates; he compares them to the sounds of a series of organ pipes. Remarking that in Newton's rings the same colour recurs whenever the thickness answers to the terms of an arithmetical progression, he notes, "this is precisely similar to the production of the same sound from organ pipes which are different multiples of the same length. Supposing white light to be a continued impulse or stream of luminous ether, it may be conceived to act on the plates as a blast of air does on the organ pipes, and to produce vibrations

FIG. 7



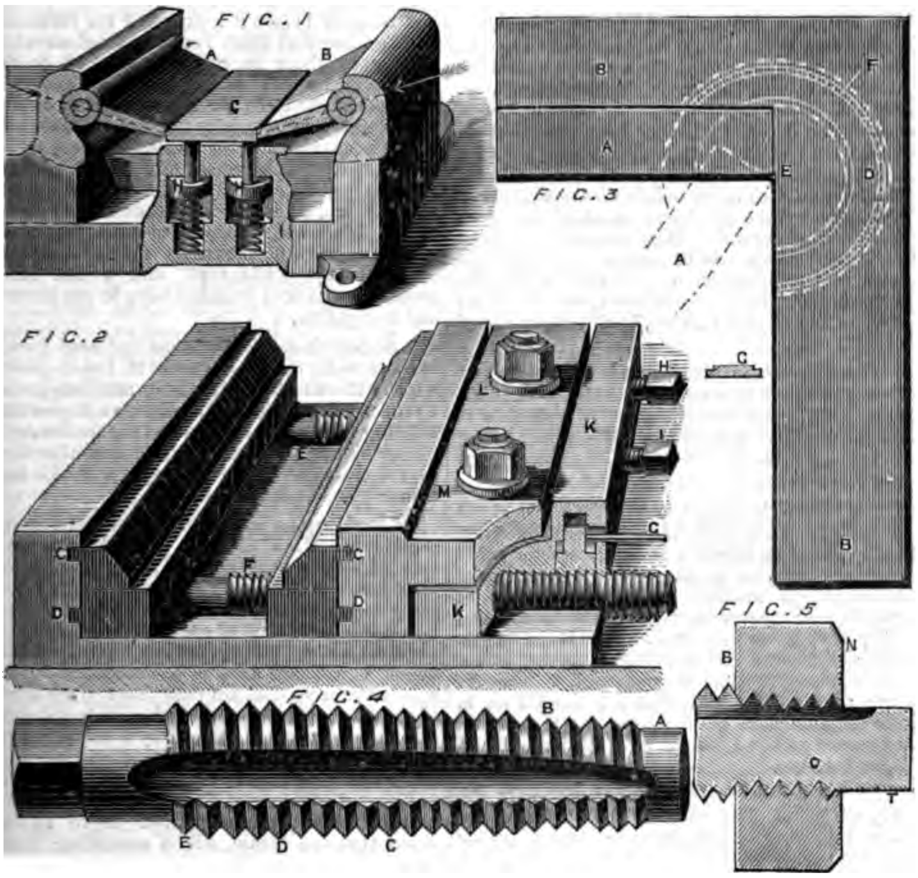
regulated in frequency by the length of the lines terminated by the two refracting surfaces." From the phenomena of light we pass to those of *radiant heat*, the identity of which with light is now conclusively established. Since the period of Young the phenomena of
interference, double refraction, polarisation, &c.
rays have been proved, and also the fact that tr
bodies exercise a special selective absorption of
just as coloured bodies do of luminous rays; so t
substance transmitting radiant heat has its ow
tint" as it were. In the Proceedings of the R
stitution, for April, 1852, there is a report of
rable lecture by Prof. Baden Powell on the "
of Light and Heat." In connection with this su
following striking passage from Dr. Thos. You
tures on Natural Philosophy (Lecture 52), will
with interest, when the date, 1806, on which it wa
is borne in mind:—"If heat, when attached to
stance, be supposed to consist in minute vibrat
when propagated from one body to another, to d
the undulations of a medium highly elastic, it
must strongly resemble those of sound, since eve
ing body is in a state of vibration, and the ai
other medium, which transmits sound, conveys
lation to distant parts by means of its elasticity,
shall find that the principal phenomena of
actually be illustrated by a comparison with
sound. The excitation of heat and sound are
similar, but often identical; as in the operatio
tion and percussion: they are both communica
times by contact and sometimes by radiation; f
the common radiation of sound through the air,
are communicated by contact, when the end of
fork is placed on a table, or on the sounding bo
instrument, which receives from the fork an i
that is afterwards propagated as a distinct sou
the effect of radiant heat, in raising the tempera
body on which it falls, resembles the sympat
tation of a string, when the sound of anoth
which is in unison with it is transmitted to it th
air. The water, which is dashed about by the
extremities of a tuning fork dipped into it, may
the manner in which the particles at the sur
liquid are thrown out of the reach of the force of
and converted into vapour; and the extrication
in consequence of condensation, may be comp
the increase of sound produced by lightly touch
cord which is slowly vibrating, or revolving
manner as to emit little or no audible sound;
diminution of heat, by expansion, and the incre
capacity of a substance for heat, may be attribu
greater space afforded to each particle, allowin
equally agitated with a less perceptible effect on
bouring particles. In some cases, indeed, heat
not only resemble each other in their operations,
duce precisely the same effects; thus an artificia
the force of which is quickly destroyed by heat,
more slowly in a similar manner, when made to
considerable time; and an electrical jar ma
charged, either by heating it, or by causing it
by the friction of the finger." To this we ma
fact, that the conductivity of bodies for sound
runs in closely parallel lines. In the case of wo
is conducted with different facility in three
according to the grain of the wood. This is al
the relative conductivity of heat. And here
another relationship appearing. The conduct
of bodies for *electricity* is well known to be very
their order of heat-conducting power. In
analogy between the conductivity of sound,
electricity, is nowhere more strikingly seen tha
rate of propagation relatively to the differen
wood and in certain crystals

between colour and music; he sought and found some resemblance between the relative widths of the various colours of the spectrum and the relative extent of the intervals in the notes of the gamut. But this, with all respect to Newton, is acknowledged to be an unjust and fanciful analogy, inasmuch as the colour spaces vary with the material of the prism, and are quite different in their relative width when seen in a "diffraction" instead of a "refraction" spectrum. Moreover, the coincidence between the *seven* colours in the spectrum and the seven notes in the gamut is also entirely accidental; for, though we still adhere to Newton's classification, there is really an infinite variety of tints in the spectrum.

SOME NEW WORKSHOP APPLIANCES.*

MOST mechanics have experienced difficulty in setting work in a planer vice because of the liability of the work to lift when the vice screw is tightened. To obviate this, Mr. Babbitt, of the Harris-Corliss Engine Works, has designed for those works the chuck vice shown in Fig. 1.

In this chuck, instead of gripping the work with the vice jaws direct, two pivoted plates are interposed, which incline from the pivots towards the work. A and B represent these plates, and C represents the work, so that the strain of the plates upon the work is in the direction denoted by the respective arrows, so that the work is forced downwards upon the tops of the pins. The plates are made to bear, at the back of the hinge, upon the hollow curve in the chuck jaws, as shown, which relieves the pivot of the strain due to screwing the chuck tightly.



The pins are made adjustable for height to suit the work, being screwed into the discs, H, which are attached to spiral springs, which depress until the discs, H, meet the shoulder at I, resting solidly upon them.

A chuck recently constructed by Mr. Thomas, at the Freeland Tool Works of this city, has an excellent provision for holding thin work, either parallel or taper, true and level between the jaws. In each jaw of the chuck there is cut a small square recess, shown in Fig. 2 at C D. A is a strip containing a projecting piece fitting into either of these recesses, according to the height required for A, the piece, B, serving for packing pieces. The work rests upon the narrow upper surface of B, which projects beyond A, while A grips the work. Now it will be noted that the jaws of the chuck act upon A to tighten the work, and the contacting surface between A and the jaws is mainly above the horizontal level of the part of A that grips the work; hence the force holding the work is in a direction to bind the latter close down upon the pieces, D, which, being parallel and true, adjust the work true of themselves, whether it be taper or parallel. It will be noted, however, that the work may rest upon the upper surface of A A, and be gripped by the vice jaws themselves.

The holding of thin work has long been a matter very difficult to accomplish without springing, and any application of the hammer not only penes the upper surface, but the rebound of the metal causes the work to lift in the chuck. By the construction shown in Fig. 2, the work will be set true whether the jaws of the chuck are worn untrue or otherwise. The movable jaw is operated by the screws, E F, the thread having one V and one square side. The nut lifts and falls by operating the lever, G, enabling the throwing out of gear of the nut so as to move the movable jaw quickly. The movable jaw, it will be noted, receives the pressure of the screws, H I, above the horizontal level of either A or B; hence the tendency is to close its jaw surface down upon the chuck face; but since this jaw slides upon the piece, K, and K slides upon the surface of the chuck, the bolts, L and M, bolt K and the movable jaw firmly to the chuck. The whole of the parts comprising the movable jaw will swing to suit taper work.

In Fig. 3 is shown a new protractor, designed by Mr. Swasey, at the Pratt and Whitney Co.'s Works. The set screws, by which the movable blades of ordinary protractors are secured, are often in the way, preventing the face of the instrument from lying flat upon the face of the drawing board or upon that of the work. In Mr. Swasey's protractor the blade, A, is attached to the circular piece, D, the latter being recessed into the square, B B, and marked with the necessary degrees of angle, as shown, while the mark, F, upon the square, B, serves as an index point. The faces of A, B B, and D are all quite level, so that the edges will meet the lines upon the work and obviate any liability to error. The piece, D, is of the shape shown in section at G, which secures it in B B, the fit being sufficient to permit of its ready adjustment and retain it by friction in any required position. The dotted lines indicate the blade as it would appear when set to an angle, the point, E, being the centre of D, and hence that from which the blade, A, operates.

In Fig. 4 is a form of tap that is finding much favour for use in large tools. The thread is cut in parallel steps, increasing in size towards the shank, the last step (from D to E in the Fig.) being the full size. The end of the tap at A being the proper size for the tapping hole, and the flutes not being carried through A, insures that the tap shall not be used in holes too small for the size of the tap, and thus is prevented a great deal of tap breakage. The bottom of the thread of the first parallel step (from A to B) is below the diameter of A, so as to relieve the sides of the thread of friction and cause the tap to enter easily. The first tooth of each step does all the cutting, thus acting as a turning tool, while the step within the work holds the tooth to its cut, as shown in Fig. 5, in which N represents a nut and T the tap, both in section. The step, C, holds the tap to its work, and it is obvious that, as the tooth, B, enters, it will cut the thread to its own diameter, the rest of the teeth on that step merely following frictionless until the front tooth on the next step takes hold. Thus, to sharpen the tap equal to new, all that is required is to grind away the front tooth on each step, and it becomes practicable to reverse the tap a dozen times without softening it at all. As a sample of duty, it may be mentioned that, at the Harris-Corliss Works, a tap of this class, 2¼in. diameter, with a 4 pitch, and 10in. long, will tap a hole 5in. deep, passing the tap continuously through without any backing motion, two men performing the duty with a wrench 4ft. long over all, the work being of cast iron.

SCIENTIFIC SOCIETIES.

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THE METEOROLOGICAL SOCIETY.

THE usual monthly meeting of this society was held on Wednesday, the 17th ult., at the Institution of Civil Engineers, 25, Great George-street; Mr. C. Greaves, President, in the chair. Mons. Marie Davy, Captain N. Hoffmeyer, Prof. D. Ragoni, and Dr. A. Wojeiroff, were elected honorary members. The discussion "On Waterspouts and Globular Lightning," which was adjourned from the last meeting was resumed and concluded. The following papers were then read:—"On the Application of Harmonic Analysis to the Reduction of Meteorological Observations, and the General Methods of Meteorology," by the Hon. R. Abercromby, F.M.S. The meaning of harmonic analysis is first shown, in reference to average barometric pressure, by tracing the growth and physical significance of every step from the barogram till the tabulated results are combined in a harmonic series. It is then shown that, whether we regard this series simply as an algebraic embodiment of a fact, or as a series of harmonic components, as suggested by Sir W. Thomson, it is simply a method of averages, and our estimate of its value must depend upon an estimate of the use of averages at all in meteorology. It is then pointed out where averages are useful, and their failure to make meteorology an exact science is traced to three causes. (1.) That the process of averaging eliminates the variable effects of cyclones and anticyclones, on which al weather from day to day depends; and on this are based some general remarks on the use of synoptic charts, not only in explaining and forecasting weather, but in attacking such problems as the influence of changes of the distribution of land and water on climate, and the cyclic recurrence of rain or cold. (2.) That deductions from averages only give the facts, and not the causes of any periodic phenomena. The position of diurnal and other periodic variations in the general scheme of meteorology is then pointed out, and it is shown that their causes can only be discovered by careful study of meteorograms from day to day. (3.) That in taking averages phenomena are often classed as identical, which have really only one common property. For instance, rain in this country is associated with at least three different conditions of atmospheric disturbance, and it is necessary to discriminate between these kinds before meteorology can be an exact science. "On some Peculiarities in the Migration of Birds in the Autumn and Winter of 1877-78," by J. Cordeaux, Mr. Symms gave a verbal description of the recent heavy fall of rain on April 10th and 11th, the greatest amount known to have been registered being 4·6in. at Haverstock-hill.

Brake Experiments.—Mr. Stroudley is now constructing, at the Brighton works of the London, Brighton, and South Coast Railway, a van for Mr. Westinghouse, which will be fitted up with the special apparatus designed by the latter gentleman for registering simultaneously all the forces brought to bear during the operation of a brake. It is a very beautifully designed piece of work, about which we shall have more to say. As an example of the ease with which the automatic brake may be fitted, we give the following facts:—On the arrival at Brighton, on 20th ult., of the 2 p.m. express train from London, it was taken into the shops, and the whole of the eighteen six-wheeled vehicles, including the two vans, of which it was composed, were fitted complete, and the train put out of the shops on Sunday morning. On Sunday afternoon it ran an experimental trip to Worthing, working without a hitch. Mr. Stroudley has introduced some modifications on the proportions of parts adopted by Mr. Westinghouse.—*Engineer.*

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* From the *Scientific American.*

SCIENTIFIC NEWS.

HITHERTO Anglo-Saxon enterprise has been devoted rather to the keeping open of Nature's waterways than to the blocking up of any avenue for the passage of ships; but, if the money is forthcoming, an effort will be made to block up one of the inlets of the Gulf of St. Lawrence. Newfoundland is separated from Labrador by the Straits of Belleisle, so named from an island at the northern entrance. Through these straits and into the Gulf of St. Lawrence a vast body of Arctic water makes its way, bringing with it immense quantities of ice, the chilling effects of which are not only visible in the St. Lawrence, but are felt far inland. It is proposed to block up the straits, and prevent the constant flow of the Arctic water, which effectually negatives the benefit that might be received from the influences of the Gulf Stream, and freezes up the St. Lawrence in a manner that is rather too effective to suit the tastes of an industrious people. It is thought that by blocking up the straits the cold Arctic water will be kept out of the gulf, because, creeping down the coast of Labrador, it will be canted off by Newfoundland, and sent out to the ocean, leaving that portion of the Gulf Stream which finds its way into the St. Lawrence to exercise its genial effects without hindrance. The objectors urge that the expense would be enormous, and the result uncertain; the colony, and for that matter this country, is, however, so much interested in any proposal tending to improve (ameliorate) the climate of Canada, that the idea is being seriously considered. The average width of the straits is about 12 miles, but they are of little use to shipping, being considered dangerous at nearly all seasons.

A canal is to be made from Amsterdam to the Upper Waal (the southern branch of the Rhine)—an undertaking which will doubtless prove of considerable importance to the towns on the Rhine.

At a recent meeting of the Royal Scottish Society of Arts, Dr. Stevenson Macadam stated that in the experiments, conducted at the request of the Commissioners of Northern Lights, to test the relative illuminating value of paraffin and colza oils, a modified form of the Doty lamp was used, which gave for the paraffin a superiority of from one-fourth to four-fifths in the different orders of lamps. That is, taking the regulation lighthouse lamps, in the first order the paraffin gave one-fourth more light than the colza oil, while in the fourth order it yielded four-fifths more. Further, taking equal weights of paraffin and colza, the former was found to yield double the light in lamps of the fourth order. The light of the paraffin Doty is also brighter, and can be seen at a greater distance than the colza lamp. The paraffin oil used had a specific gravity of 815, and a firing point of 150° Fahr. Its temperature in the tanks, and at the overflow points of the lamps rarely exceeds 80°, so that there is a tolerably large margin of safety.

At a meeting of the Hunterian Society, held at the London Institution, Dr. Richardson read a paper on the "Physiological Action of Alcohol," which led to a debate on the use of alcohol in health and disease. There was a general consensus of opinion among the medical gentlemen present, that alcohol is quite unnecessary in health, but there was a difference of opinion as regards its use in disease, some speakers contending that it was occasionally absolutely necessary. Dr. T. B. Crosby, the chairman, referred to the general use of alcoholic drinks, and to the number of habitual but moderate users who lived to a good old age, as proof that they could not be very harmful. Dr. Richardson said, that in the few exceptional cases in which he thought it necessary to exhibit alcohol, he did so as a drug, and never prescribed it to be taken by the patient as a drink.

Dr. Thomson, F.R.S., for several years superintendent of the Botanic Gardens, Calcutta, died on April 18. He was joint author with Dr. Hooker, of the "Flora Indica," and has contributed to the "Flora of British India," by Sir J. D. Hooker, shortly to be published.

Dr. P. Carpenter's splendid collection of shells is to be sold: it contains about 4,000 species and varieties, and is at present deposited at M'Gill College, Montreal.

Prof. H. Girard, of Halle, until recently director of the Mineralogical Museum of the University, died on the 12th ult.

It is reported that Dr. Muirhead has succeeded in "duplexing," the Direct Atlantic Cable, which is thus the longest line so worked. The fact is encouraging, as anything which tends to improve the carrying power of a line will help to reduce the price of telegrams.

The Royal Cornwall Polytechnic Society will hold the Annual Exhibition at Falmouth, on August the 27th and following days.

The eighth number of the *Mineralogical Magazine* contains a satisfactory balance-sheet of the Mineralogical Society, showing that the society is now firmly established; and amongst the numerous papers and notes is the commencement of an important "work," on the "County Geognosy and Mineralogy of Scotland," by Prof. Heddle. The same writer in a letter points out that Sonstadt's specific gravity solution is a "rapid and powerful vesicant, and is frightfully poisonous."

The new twin steamer Express made a second trial of her engines recently, when she attained the high rate of 15¼ knots, steering admirably. Such a result contradicts the prophecies of those who doubted whether twin vessels could be made to travel fast, and is a good promise for the future. The new steamers built for the London, Brighton, and South Coast Railway Company will be the finest vessels ever put on the Channel service. They are of steel, draw little more than 7ft. of water, and are fitted with new paddles, from the design of Mr. W. Stroudley. The Victoria was tried the other day on the Clyde, and realised a mean speed of 17 knots.

The Yorkshire Steel and Ironworks at Penistone have forwarded to Paris a rail, 142ft. 3¼in. long, bent into the form of a double S, for convenience in carriage. When just rolled it was over 145ft. Of course, if required, the works could produce much longer rails.

The Royal Horticultural Society are about to carry out a series of experiments at Chiswick, with various manures. The *Gardeners' Chronicle* suggests that they should secure the services of a competent analyst, by whom samples of patent and other manures could be tested and their real value indicated. The Royal Agricultural Society found it necessary to protect its members in that manner, and we may be sure that similar practices are carried on in the manufacture of manures for the use of amateurs as have before now been played off upon farmers.

An electro-magnetic sounder, recently described by M. Semonola, in *L'Elettricista*, has the following arrangement:—In a hollow metallic cylinder, closed at the top, open below, is suspended by a strong spiral spring, a plunger, with weight attached below. When the apparatus has been let down into the water below by a line, the weight strikes on the bottom, the plunger rises in the cylinder, and thereby closes a circuit formed by wires in the line, a battery and an alarm apparatus. At the same time a hook is caused to liberate a float, which rises to the surface, and indicates the distance travelled by the ship during the experiment.

It is known that M. Daubrée has lately been occupied with an interesting series of researches on experimental geology, in which he successfully illustrates many of the phenomena of the earth's crust. In his last paper on the subject, he describes what occurs when a balloon of caoutchouc filled with air, and coated with a non-elastic coloured layer, has a little of its gas discharged. The coloured layer being unable to follow the caoutchouc in its contraction, wrinkles and cracks in a manner quite similar to what may be observed in many geological formations.

It has generally been supposed that the metals of the alkaline earths are essentially distinguished by non-volatility from those of the alkalies. It has recently been shown, however, by M. Mallet (Liebig's *Ann.*), from experiments, in which the oxides of these metals have been reduced, that they sustain a loss of substance through volatilisation. Calcium is the most volatile; barium the least.

A good dialyser, of simple construction, has recently been described by M. Huizinga, of Gröningen. It is made of rectangular bags of parchment-paper, fastened with adhesive material, consisting of chromatised gelatine. As an example of the action of such dialysers, some egg albumen, cut small with scissors, and neutralised with muriatic acid, was put in the apparatus, and in twenty-four hours had lost its soluble mineral salts; after twelve hours more it showed all the properties of Schmidt's dialysed albumen. It was no longer coagulable by heat, and showed no reaction from heavy metallic salts.

In a remarkable double rainbow, observed on the 8th of April at Toulouse, the two bows were arranged nearly like the branches of an italic *x*. The colours were in contrary directions in these two bows—the place of tangence showing super-position of the two reds, which thus gave increased brightness at that part.

The Meteorological Commission of Vaucluse had recently before it a proposal for formation on the summit of Mont Ventoux, an observatory similar to those recently established on the Puy-de-Dôme and the Pic-du-Midi (between which it is situated) for meteorological science in general, and specially for determination of the atmospheric laws in the south-west region of France. This mountain offers peculiar advantages from its height (nearly 2,000 metres) and its isolated position in the centre of the plains which terminate the valley of the Rhone. The observations made would be transmitted by telegraph, and would afford useful prevision of weather both to agriculture and navigation.

A Société de Minéralogie has just been formed in Paris under the presidence of M. Descloizeaux, who is incontestably the first mineralogist in France. The society will take up all questions relating to mineral species and the increasingly numerous applications of physics and chemistry to mineralogy. The meetings will be held monthly at the Sorbonne.

To explain the so-called spheroidal state of liquids M. Favé assumes a repulsive force exerted by the heat rays of the ether on the ponderable material. These rays emitted from the glowing metal act on the drop in a direction opposite to that of gravity. The drop thus acquires an oscillatory motion and a rotation about a variable axis, as the resultant of the repulsive forces does not pass through its centre of gravity. In support of this view he cites, among others of M. Boutigny's experiments, those of distilled water being supported on a heated metallic capsule, the bottom of which is perforated with small holes, or on a metallic network, or a platinum spiral. Here he considers that the steam, which according to the old view keeps the liquid from contact with the metal, can escape without hindrance.

In a recent communication to the French Academy, M. Anatole Dufour describes a new balloon of his invention, to which he gives the name of Anatolie. Propulsion is obtained by means of a reaction motor. A steam-engine compresses air into a reservoir, from which it is allowed to escape suddenly through an opening, and drives the balloon in the opposite direction.

The envelope of the grand captive balloon now being constructed by M. Giffard, for the Paris Exhibition, is formed of the following layers proceeding from within outwards:—(1) muslin, (2) natural caoutchouc, (3) strong linen cloth, (4) natural caoutchouc, (5) linen cloth, like the former, (6) vulcanised caoutchouc, (7) muslin. This last muslin is covered with a varnish formed of linseed oil, and containing a certain quantity of caoutchouc dissolved in oil of turpentine. The whole is covered with a layer of zinc white paint.

In heating metallic alloys some peculiar irregular expansions have been observed, rendering it probable that there was a transition from one modification of the alloy to another.

The behaviour of alloy in cooling has lately been studied by M. Wiedemann (*Ann. der Physik*) in the case of the Rose and Lipowitz metals, and his experiments confirm the supposition just mentioned. Rose's metal, cooled from 100°, at first sent the index slowly back; between 95° and 90° a strong contraction occurred, and the liquid metal solidified; this phenomenon was complete after about three or four hours. On cooling further, the metal shrank more, in one case to 50°, when a rapid expansion took place; in other cases only to 70°, at which temperature there was slow steady expansion, completed, in separate cases, only in 24 to 36 hours. After complete expansion, the metal, with further cooling, contracted again regularly. Lipowitz's metal behaved similarly, only the change of volume and the times were less.

It is said that an American company has een negotiating with the Russian Government r construction of a maritime canal in the agoons, which extend from Cronstadt to St. 'etersburg. The work is to be commenced in ctober, and completed before 1883. The resence of ice each year reduces the time for ork by about 6 months. The width of the anal will be about 85m., and its depth 6m. he length will be about 10 miles, and the uantity of sand, and especially mud, that has be extracted is estimated at nearly 7,000,000 ubic metres. The object of the enterprise is form in the immediate neighbourhood of t. Petersburg a port of trade accessible to hips of any tonnage. When, moreover, the ateral canal to the Neva, and the railway proected for connecting all the lines of Southern ussia with the capital will have been executed, ommerce will find great facilities for penerating into all parts of this immense country. he vessels on the Volga will then be able to ransfer their merchandise directly to ships ngaged in ocean navigation. The dredges nd other machines required for this great cheme are now being constructed in America.

Sweden possesses at present two vessels, a unboat or launch and a yawl, designed for ransport of wounded. They are not meant to e attached to a naval expedition, but for succour of the wounded on land or sea, in defenive operations. It is desired to utilise for ransport of such the numerous navigable ways y which the country is traversed, seeing the ailway system is rather scanty. The Swedish ociety for Succour of the Wounded resolved to onstitute an ambulance brigade (of which the aunch and yawl are a portion), including a teamer of 20 or 30 horse power, for accommoation of surgeons with their materials, four aunches, containing each 12 or 13 beds, a yawl ith very small draught of water, for wounded hat have to be taken away at once and isolated, e taken to land and embarked on the launches, nd a steam launch as auxiliary, and for coneyance of orders, &c. The vessels are suplied by the State and managed at the expense f the society above named. The general rrangemeht of the ambulance launch is escribed in the *Annales du Genie Civil* for March.

USEFUL AND SCIENTIFIC NOTES.

Eclipse.—The eclipse of the sun on the 2nd of ebruary was carefully watched at the Observatory t Melbourne. Owing to the interference of clouds the earlier phase there was little success in the ectroscopic observations at first contact, at which was desired to witness the obliteration of the ectrum of the chromosphere, and to ascertain hat, if any, change occurred in the lines of the lar spectrum itself in close proximity to the oon's advancing edge; a decided thickening of ay of the lines close to the moon's edge was, wever, distinctly observed.

Cement for Kerosene Lamps.—The cement mmonly used is nothing but plaster of Paris. But is is porous and quickly penetrated by the kerosene. nother cement is highly recommended which has t this defect; it is made with three parts of resin, e of caustic soda, and five of water. This compotion is mixed with half its weight of plaster of aris. It sets firmly in about three-quarters of an our. It is said to be of great adhesive power, not ermeable to kerosene, a low conductor of heat, and ut superficially attacked by hot water. Zinc white, white lead, or precipitated chalk may be substituted for the plaster, but they harden more slowly.

LETTERS TO [illegible]

[We do not hold ourselves [illegible] our correspondents. The Editor [illegible] communications should be drawn [illegible]

All communications should be addressed [illegible] ENGLISH MECHANIC, 31, T[illegible] W.C.

All Cheques and Post-office Orders [illegible] J. PASMORE EDWARDS.

*** *In order to facilitate reference, [illegible] speaking of any Letter previously [illegible] mentioning the number of the Letter, [illegible] which it appears.*

"I would have everyone write what he [illegible] much as he knows, but no more; and [illegible] only, but in all other subjects: For such a person [illegible] have some particular knowledge and experience [illegible] nature of such a person or such a fountain, [illegible] other things, knows no more than what everyone [illegible] and yet, to keep a clutter with this little [illegible] will undertake to write the whole body of physics [illegible] from whence great inconveniences derive their [illegible] —*Montaigne's Essays.*

◆◆◆

SUGGESTED OBSERVATIONS FOR THE TRANSIT OF MERCURY.

[14267.]—SOME of the observers of the t[illegible] Venus thought that they saw the body of the pl[illegible] projected on the bright background of the cor[illegible] before it came up to the sun's limb. M. Ja[illegible] says that by making use of a screen of blue gla[illegible] saw Venus projected on the corona some time before it was visible without the screen. Thus proving, as he thought, that the light of the corona was rich in rays at the blue end of the spectrum.

But Stone, observing the total eclipse of 1874 with a spectroscope, considered that the spectrum of the inner or lower corona was rich in red light. As far as I am aware the only other observations bearing on the richness of various parts of the continuous spectrum of the corona are the observations of Mr. Hammond and Padre Denza in 1870. Mr. Hammond's observation cannot be considered as deserving of very much weight, as he failed to observe the well-known green coronal line. He states that in the spectrum of the corona, observed with an integrating direct vision spectroscope, the red and green were present, while the blue and violet were absent. Denza, after speaking of the yellow region of the spectrum, says—"Nel* rimanente campo dello spettroscopio, e massimi del lato dei colori meno refrangibili, me sembro intravedere la continuazione dello spettro continuo, ma debolissimo." The question of the richness of the continuous spectrum of the corona in red or in violet rays is one of much interest. If a great part of the light of the corona is dispersed by particles small compared with the wave-length of light, we should expect to find its light rich in short wave-lengths, like the light dispersed by the small particles in our own atmosphere. But even the outer parts of the corona are not usually described by observers as blue, and more than one class of observation tends to show that the light of the lower parts of the corona is not chiefly due to light derived from the photosphere, and dispersed by small particles. The spectroscope shows that no considerable quantity of the light from the lower regions of the corona is due to incandescent gas. And there are polariscopic observations which indicate that the area of maximum radial polarisation is some minutes above the sun's limb, as if the light of the lower corona contained a larger admixture of unpolarised light than can be accounted for by the admixture of the light which constitutes the bright line spectrum.

Such an admixture may be accounted for in several ways—for example, by assuming that the particles floating in the lower regions of the corona are many of them large compared with the wave length of light; or that the particles are incandescent. This latter assumption would seem to be favoured by Stone's observation in 1874, that the continuous spectrum of the lower corona is rich in red light.

I should be glad if some of the observers of the transit of Mercury, who propose to make spectroscopic observations of external contact, would turn their attention to the part of the spectrum below the C. line, and observe whether they can detect any difference in the brightness of the part of the field which corresponds to the disc of the planet. They might also, for the purpose of testing M. Janssen's observation, sweep to the violet end of the spectrum, though I would remark that it seems extremely improbable, from photometric considerations, that such a difference of brightness at the violet end could be detected.

The remarks made by observers with regard to the visibility of the moon's limb outside the sun's disc during partial eclipses (though very conflicting), would lead one to conclude that the brightness of the corona is not sufficient, when compared with the brightness of our own atmosphere, as illuminated by full, or nearly full, sunlight, to form a background on which objects can be seen projected. Dunkin, Good, Dawes, Humphrey, Olufsen, Goujon,

[illegible] in t[illegible] say [illegible] begin[illegible] me a [illegible] Foucault [illegible] try it was [illegible] observation [illegible] published. [illegible] observed, my [illegible] pointed to other [illegible] the Pole, and did [illegible] supposed ghosts. [illegible] to my observatory, [illegible] declared he saw one [illegible] he made a voyage to Rome [illegible] Secchi, who, on his [illegible] on this subject on the [illegible] avons examiné la Polaire, [illegible] soir là; nous vîmes, [illegible] points autour; mais ayant [illegible] disparaissaient." I had [illegible] reflector, and tried with that instrument [illegible] tion of my observation, but [illegible] abandoned the search.

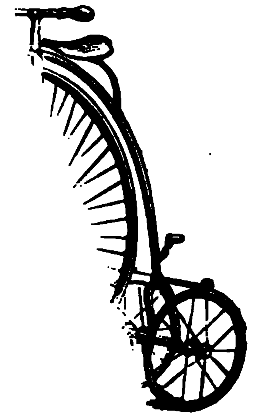
In 1874 I transformed my observatory, [illegible] was sold to the Observatory of [illegible] director, before accepting the instrument [illegible] Messrs. Henri, of the Observatory of [illegible] their opinion on the optical part of the [illegible] and on this subject M. Secretan wrote [illegible] messieurs ont bien voulu me donner [illegible] cet objectif. Ils trouvent que c'est [illegible] d'œuvre, et affirment obtenir des résultats [illegible] à ceux qu'ils obtiennent journellement av[illegible] centimetres." Remembering then my [illegible] on Polaris with that same instrument, I saw [illegible] declaration a great presumption that its [illegible] might have shown me a reality, which my [illegible] reflector could not do. Soon after I received a [illegible] equatorial refractor, and this was the time when Baron Van Ertborn installed his observatory [illegible] miles south of Antwerp. What concerns his [illegible] is known, and need not be repeated. We undertook then, also with Dr. V. Monckhoven, in Ghent, continued observations, the result of which have been published.

As to what regards my further observations, which have been long interrupted on account of a severe illness, I find in my register that I saw one of the two comites (330°—12m.) on September 20th, 23rd of October, 1876, and 21st of February, 1877. Many other evenings gave no result.

A remark which is not without importance is, that your correspondent (letter 11250) published his discovery (28th of July, 1876) earlier than my letter to Le Verrier (23rd of August, 1876), and that thus he was not in search of comites whose existence had been announced.

Antwerp, 21st April. **Ad. de Boo.**

[illegible] even road (all three wheels being always upon the [illegible] the swaying motion of the machine is at [illegible] unpleasant, and sometimes dangerous. [illegible] medying this defect is to place the [illegible] as near together as is possible, [illegible] hat the machine must be capable [illegible] and of being mounted and dis[illegible] rest; and I found by experiment



[illegible] ry stability; [illegible] ug so near [illegible] will cause [illegible] as readily [illegible] be turned [illegible] uneven [illegible], as the [illegible] on the [illegible] dge.

TED [illegible]

[illegible] liest [illegible] ing [illegible] ng [illegible] nd [illegible] g [illegible] t

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"THE ORGAN."

[14269.]—"TONOMETER" and Mr. Webb are both thanked for their remarks; any really authentic corrections of that nature are always welcome in a work of such magnitude as "The Organ." The authority for the Exeter Hall statement is Hopkins, p. 468. The assertion with reference to Ulm was made in an American musical journal, started [illegible] a leading organist of that country a few year[illegible] The former was doubtless correct at the [illegible] penned. **J. W. W[illegible]**

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* Rapporti della Commissione Italiana, p. 61.

MIDLAND ENGINES.

[14270.]—One of your correspondents upon page 127 wishes me to give a side elevation of two classes of Midland engines, and the dimensions:—

In Vol. XXIII., pages 361, 388, and 434, I gave the dimensions of No. 134.

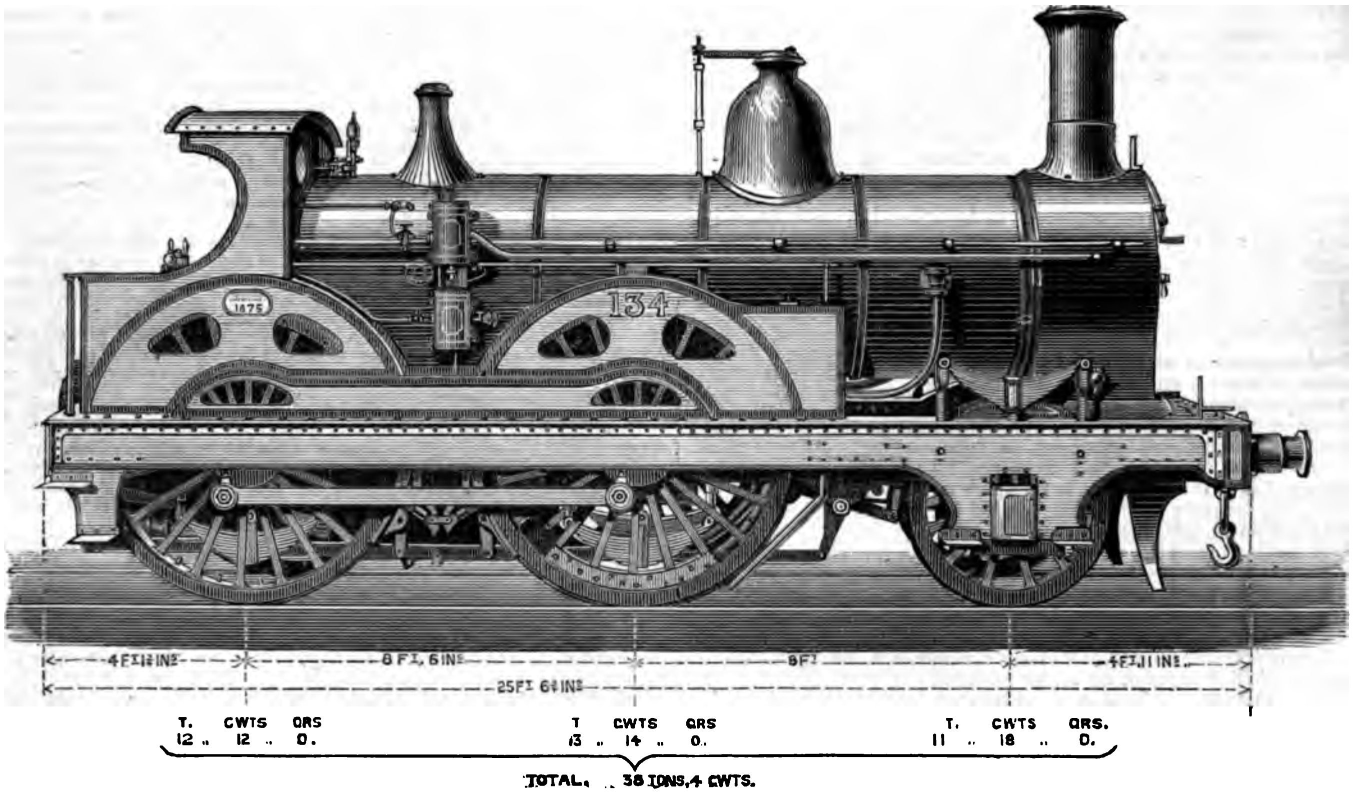
This engine was the one which was fitted with the Westinghouse automatic brake, and it ran the experimental "Automatic" train at the Newark brake trials in June, 1875. The engraving I now send is copied from a photograph which was taken during the time the engine was awaiting its turn, at that brake trial.

I purposely omit to send the drawing of the tender, as the engraving of the engine only will have to be very considerably reduced to be of a size suitable to the pages of the English Mechanic.

The Westinghouse brake is shown upon this engine, but by the time this letter appears it will have been removed and placed upon one of the large re-built 800 class of express engines.

The cause of the brake being removed is that No. 134 has a tractive force of 86·7lb., and therefore is not used for the Scotch express trains, as explained in my reply, page 148, No. 32578. There are four classes of Midland engines of a somewhat similar design, and general outside appearance to No. 134, but of a much more powerful type. No. 134 class has cylinders 17 × 24, coupled wheels 6ft. 8in. diameter, and a tractive force of 86·7lb. No. 96 class (see Vol. XXV, p. 41) has cylinders 17 × 24, coupled wheels 6ft. 2in. diameter, and a tractive force of 93·73lb. The 1282 class has cylinders 17½ × 26, coupled wheels 6ft. 6in. diameter, and a tractive force of 102 083lbs. The last new express engines were lately built at Derby; they are similar in power to the 1322 class of bogie engines, built by Dubs and Co. last year, but they have double frames, and no "bogie." The cylinders are 18 + 26, coupled wheels 7ft. diameter, and a tractive force of 100·285lb. The leading wheels have *inside* and *outside* bearings, and like all the engines built within the last two years they, they have plain splashers over all the wheels, and the balance weights are forged solid. One of these new engines, No. 1353, which commenced to run on the 28th of December last, has for the past few weeks been running daily between St. Pancras and Leicester, in order to test its performance upon a "3,000 miles trial." In January last this engine performed the "15 coach test" upon the Lincoln line. All this class of engines lately built at Derby are working very satisfactorily, and several others are under construction.

April 24th. C. E. S.



TRADE-UNIONISM AND ITS RESULTS.

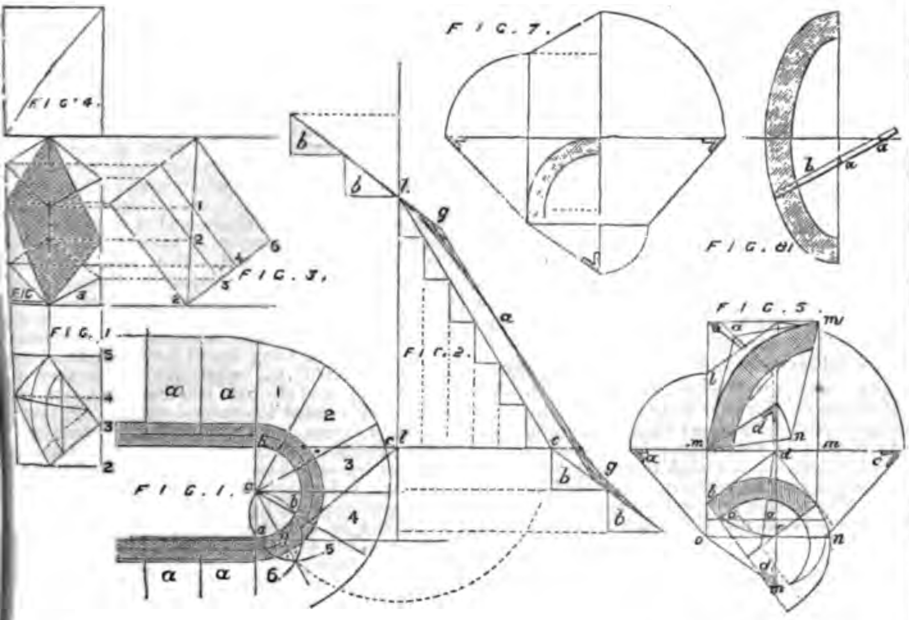
[14271.]—I cannot see that any number of "rascals" amongst the ranks of British workmen affects for good or evil the principle of trade-unionism (not "trades unionism," because there is no such thing as *a trades* union). If Sir Edmund Beckett wishes to do any good by his attacks upon trade-unions (and I am sure he does) the best plan would be to come amongst the leading spirits, and point out the errors in their management of affairs. British workmen are not afraid to be told of their faults, nor are they without the courage to defend their convictions; but they are very obstinate and strong-willed. They are not exactly afflicted with "invincible ignorance," but having bought and paid for their experience, they are at least as capable of judging whether trade-unionism is or is not good, as those who so vigorously attack it, basing their arguments upon so-called "facts," which (with all deference) are by no means proved. Sir Edmund heads two of the pages of his reprinted letters, "Union rules are robbery and slavery of workmen." Permit me to ask if there is a *lex non scripta* of trade-union rules, or in what part of the printed rules of any of the societies Sir Edmund finds the evidence for the statement that it is as "untrue as possible" that unions only fix the minimum wages? A "Master Builder" may also say that it is "utterly false," and we may have a chorus of aggrieved employers declaring that they are not allowed to pay their men *more* than a certain sum for certain work; but does any one really credit it? See what it implies. I suppose I may take it for granted that it is only the best men who would be paid more than the scale price or the agreed sum per hour, and yet we are asked to believe that these men are prevented from receiving a higher salary, because the union rules say "A carpenter is a carpenter, whether making mahogany doors for a drawing-room, or deal ones for a pig-stye, and at present 9d. an hour is the least and the most he is allowed to receive"—(Sir E. Beckett). Suppose in a town there were five masters, each employing 50 artisans—say carpenters—and suppose that of the 250 one-fifth were worth 1d. or 2d. an hour more than the others (that is, 10 in each shop), what would be the result if the union said "No, you shall not pay more than 9d."? Would the 200 be able to close all the shops, or would the 50 find themselves working under one roof? The idea may pass muster with those outside of "workshops," who have no notion of what working for an "existence" means; but not with artisans, who understand it just a trifle better. There are in every trade a percentage of workmen who, from their skill and ability can always obtain work; these men have no need of a union to obtain work, but they know that were it not for the action of the union their wages would soon come *down*—down, ay, to the level of the unionless "sweated tailors," who haunt Whitechapel, and poison the air with their presence. We are told that the price of a day's labour must always depend upon the number of labourers ready to do it, and we are quite aware of the fact; but permit me to ask if there is not *some* limit at which the downward tendency of prices must stop. It is so with large ironworkers—millionaires who are merely said to be *ruined*; but with artisans it is starvation. Given 500 bricklayers and work for 100 only, is the price to be reduced, so that while the 400 are still out of work the 100 are less able to help in their support? In all my experience I never heard of a case of men striking against higher wages being paid to some of their fellows, and I am bound to confess that their opportunities for so doing were few and far between, for employers are not apt at paying more unless they are asked—that is, practically compelled. I have heard of cases under piece-work, too, where men were expected to dance attendance day after day, and idle about the works waiting for something to do, and were actually threatened with dismissal because they accepted a few hours' work at a rival factory. I cannot follow Sir Edmund through all his assertions, but will await his *proof* that unions limit the maximum as well as fix the minimum of wages. Permit me in the mean time to call attention to a fact (a real one), which is remarkable, and which deserves attention. In the *Building News* of Feb. 22, p. 202, "A Builder" asks how it is that Mr. Lascelles can pay masons 2d. an hour more than the master masons of a certain town pay, and yet tender at a lower figure than he ("A Builder") did. Readers of "ours" would do well to buy the *Building News* of March 1, and read the whole of Mr. Lascelles's reply on p. 227; but here is a bit of it:—"A London builder doing a country job cannot afford to pay low wages. He wants to do the work quickly, and he wants all the best men he can get . . ., and *nothing but the offer of good wages will draw these men*. . . No London builder pays a shilling more than he is compelled." Now, I think that one fact, on the authority of a well-known and first-class employer, is worth a bushel of imaginary "facts," strung together as an attack upon "*an* (sic) union." They may impose upon *an* youthful understanding, but they are too glaring to be taken in by those who work in the shop. The "slavery" of the union is a very pleasant slavery to that undergone by those outside of its pale; and perhaps some one will kindly calculate where wages would stop with a lot of hungry and unscrupulous employers looking after a few jobs, and depending upon the residuum of the trade for their "hands." What would they *not* do if the union did not, in a way, control competition amongst employers? I have not yet seen a reply to that excellent letter of Mr. Joshua Rose's, on p. 315, Vol. XXVI.—the practical experiences of a clever workman disgusted, not with trade-unions, but with the systems adopted by employers who render trade-unions necessary. How many of our best men have followed his example, and left this country to obtain their "rights" in foreign lands? Surely those who can see so much of the injury done by trade-unions must have a very large beam in the other eye.

S. Mayer.

HANDRAILING.

[14272.]—I herewith send you a drawing on handrailing. My mode of contributing here is entirely by induction, and not by deduction, as is very often the case with those who contribute on handrailing, erroneous as it is with many. In the first place I shall proceed with Figs. 1, 2, 3, and 4. This is done by orthographic projection, for the sake of perspicuity, showing how the cube, Fig. 3, is cut obliquely the same as in Fig. 5, and which make the contour lines for the face mould. Now, to find out the section as in Fig. 3 proceed thus: First lay down the plan, Fig. 1, and draw the lines, 2, 3, 4, 5, from the angles of the cube; next transfer these points to Fig. 3, which will give the width of the cube. In this case make the line of section in Fig. 3 the same length as the diagonal line in Fig. 4, the perpendicular line of which will represent the height in the quarter. Well, next make the cube in Fig. 3 with the lines intersecting in Figs. 1 and 3; mark the line of section also. Now it is produced to make the section as shown in the dotted lines, Fig. 3. Without any further explanation I think that it is sufficiently elucidated to those who have a knowledge of orthographic projection.

Now we shall proceed with Figs. 5 and 6. First lay down the plan of the well as shown in Fig. 5; next make the line, *a a*, square from this line; make the height *m m*, and draw the diagonal line, *m m*, also. Next make the line *d g*. Make *g a* at right angle to *m m*; join *m a*, *a m*; make *m n* parallel to *a m*, and *n m* parallel to *a m*. This will produce the oblique section, as shown in the position in the plan, and face mould can be produced by means of ordinary lines, or by the trammel system. This can be done, as shown in Fig. 8, by means of a lath; the two lines on the lath mark out the semi-congregate and semi-transverse diameter, and should be notched so as to slip on the edge of the board and the upright piece; this will produce the ellipse. A cylindrical section may be considered the ellipse quite as much as the conic section.



Next you want to find out the bevel; proceed thus: Make the line, *b*, equal to the line, *a m*, one of the contour lines in the oblique section. This will be looking at the plan of the well at a right angle before you. Then from or with *n b* as radius describe an arc, *b a*, and again, with *a* as centre with radius, *a s*, describe another arc, *a c*. Again, with *c* as centre with radius *c n*, describe the arc, *n m*; join *c n*, *m o*, and *o a*. This will produce the diagram as shown in Fig. 7.

I also show in Fig. 9 the falling mould, for those who may wish to apply it on the rail. Mr. Riddell, in his book on handrailing, has dispensed with the falling mould, which comes near enough for practical purposes. First lay down the plan of the rail, as in Fig. 1, with the number of winders (in this case 6), and converging to the point, *a*, in the plan, from a line in the centre of the spin. Next find out the stretch out of the well—thus: Make *b a* = 2 *b a* in the well; then, with *a* as centre, with *a a* as radius, describe the arc *a b*, and again, with *b* as centre, with the same radius, describe another arc, *a a*. Through these points of intersection make the line, *a g*, make the line *c g*, and bring it out to *c c* by the dotted arc shown here. Next make out the number of winders on this line. Make the height *h b*, with two flyers at top and bottom; then make the line *l c*, which will be the pitch line of the winders; make the line a parallel to this to the depth of the rail, but, as I think that it goes through it too far at bottom, it would be better to make it to half the depth of the rail, which will be more accurate. Next make the two flyers, *b b*, *b b*, at the top and bottom, and ease [illegible], as shown here, which is the general method of [illegible]. This will complete the falling mould.

Concoil.

EMERY WHEELS.

[14273.]—I HAVE to thank you for your able critique upon my recent emery wheel paper at the Society of Arts. Will you allow me to make a few remarks in explanation? I am strongly of opinion that the solid emery wheel has its own special field, and is not suitable for every class of work, and this is one of the great difficulties the manufacturer has to contend with, inasmuch as users frequently do not share this view, and persist in attempting to get utterly unsuitable work from a wheel. Large masses of metal are unquestionably best treated in other ways, but the great point is to induce users, or would-be users, to believe that an emery wheel will not do work of precision without mechanical aid any more than a steel tool. Why should it? and yet every day persons are found blaming an emery wheel because it will not give, say, a true flat surface to work held against it in the hand, or on a simple rest, when, to obtain the same result with a steel tool, they would traverse the said work on a properly constructed sliding bed. The emery wheel wants as good mounting as the steel tool. Give it that, and there is much work it can do more economically than its older rival. As to the dust caused by grinding, in a properly constructed machine no injury can accrue, but adjacent tools may certainly suffer. Emery grinding, if used largely, should either be carried on apart from lathes and other machines of precision, or an exhaust fan used to suck off all the débris. This is easily applied, and is a very cheap and useful adjunct. In conclusion, may I add that my works at East Greenwich are freely open to visitors, whether intending buyers or not, every Tuesday and Thursday, from 10 to 6, where the most practical information obtainable by actual using may be obtained, and will be gladly afforded by my firm.

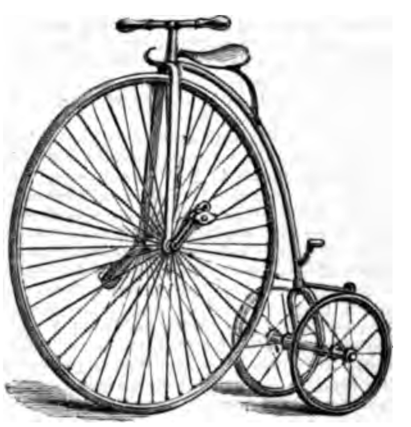
A. H. Bateman.

IMPROVEMENTS IN BICYCLES.

[14274.]—REFERRING to the improvements described on p. 132, in your No. 682 (April 19th), it will perhaps interest some of your readers to know how I converted a "Special Challenge" bicycle into a tricycle which can be mounted and dismounted whilst at rest; at the same time that it will turn sharp corners, and possesses all the best qualities of a bicycle, with the additional safety of a third wheel and double brake power. First I removed the old axle and trailing wheel from the lined fork of the backbone, and got a duplicate wheel to match. I then fixed in the lined fork an axle about 18in. long, the projecting ends of this axle outside the fork being each made with two cones, and upon each end I fitted a trailing wheel, the two small wheels being 12in. apart; that is to say, each 6in. outside the centre line of the driving wheel. A roller brake was fitted to each wheel, both brake levers being keyed upon one spindle, and both applied simultaneously by turning the handle in the usual manner. The central portion of the axle inside the fork forms a low step for the right foot, and there is a step (rather lighter than usual) fixed on the left side of the backbone. I inclose a rough sketch of the "converted special," as it now appears.

The fault of all tricycles hitherto made appears to me to be the great width apart of the two wheels which support the rider, the obtainment of a broad base being considered absolutely necessary for safety, the result being that when travelling upon an uneven road (all three wheels being always upon the ground) the swaying motion of the machine is at all times unpleasant, and sometimes dangerous.

My way of remedying this defect is to place the two hind wheels as near together as is possible, bearing in mind that the machine must be capable of standing alone, and of being mounted and dismounted whilst at rest; and I found by experiment that about 12in. apart gave the necessary stability; at the same time that the wheels being so near together the least inclination of the body will cause the machine to incline in either direction, as readily as a bicycle, so that sharp corners may be turned with perfect safety, and in running upon uneven roads there is no unpleasant swaying motion, as the machine runs upon whichever wheel is upon the highest ground.

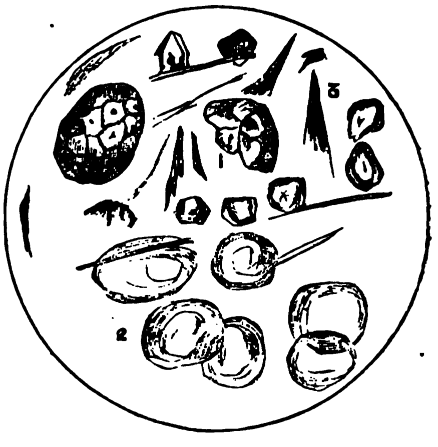


Alderley Edge.

ADULTERATION OF FOOD DETECTED OATMEAL.

[14275.]—THE OAT (*Avena sativa*) is the hardiest of all the cereals, the seed of which, after having the outer covering or husk removed and going through a process of milling, is called oatmeal, and which forms a most valuable article of food, being very rich in gluten, fatty matter, and phosphates, which are so necessary to the healthy development of the body. There are a number of preparations of oatmeal sold under various names as patent groats, which consists only of the very finest parts of the seed, and which forms a most valuable diet for invalids.

The ordinary oatmeal that is sold, like other articles used as food, is frequently adulterated, the adulteration being the admixture of barley meal, husk, &c, but by means of the microscope all these are easily detected. The starch granules of the oat are rather small and polygonal in shape, and the hilum is only visible in some of the granules. It also has a peculiarity of cohering together, forming rounded bodies, and when seen under polarised light does not exhibit the usual black crosses; while the starch of barley is nearly circular, and is much larger than that of the oat, and when seen under polarised light in glycerine exhibits a faint black cross. A small quantity of oatmeal under examination should be placed in a piece of muslin, and the starch carefully washed out in water. When the starch has settled, the water should be carefully poured off, and a small quantity of the starch placed upon a glass slide, and a drop or two of glycerine added, and the starch diffused through it, and then examined with a ¼in., when the presence of barley starch will be easily detected.



When husk or rubble is present, the oatmeal has a brownish or branny appearance; but when a little of the oatmeal is diffused through water, and examined with ¼in. power, the admixture will at once be detected, and also by the amount of ash. In the woodcut 1 is oat starch; 2 is barley starch.

Albert Smith.

KENTISH RAGSTONE AND CRYSTALS.

[14276.]—By letter 14218, p. 122, from Mr. Collins, deciding the case, I considered the controversy closed; but "G. J. H." has in letter 14254, p. 167, continued the discussion, taking exception to some statements of mine in letter 14217, p. 122, which were perhaps needlessly severe.

In the communication referred to, Mr. Collins might have been somewhat more explicit, and given some explanation with reference to his method of determining the crystalline form in this case, as several subscribers to the ENGLISH MECHANIC expressed to me a wish to know how Mr. Collins had arrived at his conclusion.

I inclose to the Editor some specimens of the crystals referred to, in which perhaps he will kindly see that the two planes in No. 1 are apparently at right angles, and indicate, I think, a cubic cleavage; while in No. 2 the planes include an angle of about 110°, appearing to indicate an octahedral cleavage; while No. 3, in my opinion, decidedly exhibits a rhombohedral cleavage. Other crystals split rough, not exhibiting any cleavage planes. These considerations, together with the close resemblance to the form of pentagonal dodecahedron, led me to believe them to be what I stated they were. But as so eminent an authority as Mr. Collins has decided that the crystals are short hexagonal prisms, with trihedral summits, I must acquiesce in his decision.

Hugh Clements.

THE ALKALOIDS OR ORGANIC BASES — ANILINE (MAUVE, MAGENTA, EMERALDINE, ROSEINE, VIOLINE)— CAFFEINE, NICOTINE, QUININE, MORPHINE, AND STRYCHNINE.

[14277.]—THE alkaloids or organic bases form a large and important class of substances. They have been termed *alkaloids* because most of them, like the alkalies, exert a basic reaction on red test-paper, and *organic bases*, because, like inorganic bases, they combine with acids forming salts. The inorganic bases are composed of two elements, while the organic are composed of three or four elements, of which nitrogen is an essential with carbon hydrogen, and often oxygen. They have been divided into the *natural* and *artificial*. The natural are found in plants and animals, and the artificial alkaloids are similar in composition and properties, and can be prepared by chemists.

The vegetable alkaloids contain carbon, hydrogen, and nitrogen, and most of them contain oxygen besides. They possess basic properties, and combine with hydrochloric acid and platinic chloride to form double salts, insoluble or difficultly soluble in water.

They possess alkaline properties, and neutralise the acids forming crystalline salts, have generally a bitter taste, and form the active principles of tea, coffee, tobacco, opium, pepper, cinchona bark, nux vomica, &c., in which they are found.

Of the animal alkaloids, quanidine and methyluramine contain carbon, hydrogen, and nitrogen; while others contain oxygen, besides such as urea found in animal urine, and kreatine and kreatinine found in the animal juices.

The artificial alkaloids consist of the amines and their analogues. These are monamines, diamines, triamines, and tetramines; and there are primary, secondary, and tertiary monamines and diamines. Then there are the phosphines, arsines, bismuthines, and stibines. For further information as to the nature of these artificial alkaloids the reader is referred to substitution products.

Most of the vegetable alkaloids are soluble in boiling alcohol, and assume the crystalline form on cooling. The plants containing the volatile bases are generally digested in weak alkaline solutions and distilled, when a portion of the ammonia comes over with the other products, which are neutralised with acid, evaporated and digested with alcohol, which dissolves the basic sulphate. This sulphate is agitated with a strong solution of ether and potassic hydrate; the etherial upper layer contains the volatile base which is obtained by distillation.

The vegetable bases, when dissolved, may be precipitated by a solution containing tannic acid, such as decoction of oak bark and leaves of the elm, chesnut, &c.—green tea and tincture of gall nuts forming insoluble tannates, so that tannic acid is an antidote against poisoning by these bases. These bases are separated from the acids with which they are generally combined in the vegetable, by adding water and hydrochloric acid or sulphuric acid to the vegetable matter, when the mineral acid displaces the vegetable acid and forms an easily soluble salt. And when an alkali, or an alkaline, earth is added, the organic base is precipitated and dissolved in boiling alcohol, from which it crystallises on cooling.

Aniline, one of the most important of the artificial alkaloids, is largely prepared from the liquor obtained in gas-making from coal, which contains aniline in small quantities and benzol, together with various other substances. Nitric acid converts benzol, C_6H_6, into nitro-benzol, thus: $C_6H_6 + HNO_3 = C_6H_5NO_2 + OH_2$, and by distilling two parts of nitro-benzol, three of iron filings, and two of acetic acid in metallic cylinders gradually raised to a red heat, when $CH_2(C_6H_5)$ aniline, with other products, comes over, which are redistilled at a temperature between 170° and 190°C., when commercial aniline is obtained. It is also formed by the reducing action of sulphuretted hydrogen on nitro-benzol, thus: $NO_2(C_6H_5) + 3SH_2 = NH_2(C_6H_5) + S_3 + 2OH_2$. Other reducing agents have a similar effect. It is obtained by distilling indigo with a strong solution of potassic hydrate, when anthranilic acid is formed, which is heated in a retort, when aniline is condensed in the receiver. It is redistilled to obtain pure. The reaction is as follows—viz.: $C_8H_5NO + 4KHO + OH_2 = (C_6H_5)NH_2 + 2COKo_2 + 2H_2$. It is also formed by the distillation of nitro-toluol with lime, thus: $C_7H_7NO_2 + CaO = (C_6H_5)NH_2 + COCao''$. Aniline is a colourless thin oily liquid, having a hot aromatic taste, and an agreeable odour. It is poisonous, a dozen drops being sufficient to kill a rabbit. It boils at 182°C., is very volatile, and does not freeze at − 20°C. When exposed to the air it assumes a resinous consistency and a brownish colour from the absorption of oxygen. It is slightly heavier than water, having a specific gravity of 1·028. It is soluble in water, and is dissolved in all proportions by alcohol and ether. Unlike the other alkaloids, it has no reaction on red test paper. It forms with acid a large number of beautiful crystallised compounds. It can be distinguished from every other compound by the beautiful violet produced by mixing it with a solution of chloride of lime, and with chromic acid it yields a black, blue, or green precipitate. It has a high refractive power. It does not conduct electricity.

From aniline a large number of derivatives and substitution products are formed, which throw considerable light on the theory of organic chemistry. The sulphate of aniline is used therapeutically, and is prepared by saturating aniline with dilute sulphuric acid, evaporating to dryness, and extracting with boiling alcohol, which leaves the sulphate in white scales on cooling. Cyanogen combines with it directly, forming cyaniline $(C_6H_5)NH_2(CN)$.

By substituting chlorine (or bromine) for the hydrogen in the phenolradical of aniline, we obtain mono, di, and tri-chlorine anilines, $(C_6H_4Cl)NH_2$, $(C_6H_3Cl_2)NH_2$, and $(C_6H_2Cl_3)NH_2$ respectively. The basic character gradually becomes weaker, until three atoms of chlorine replace three of hydrogen, when the compound becomes neutral.

Nitraniline has been produced by the replacement of one atom of H by NO_2. By far the most important application of aniline is in dyeing. The beauty, variety, and magnificence of the colours obtained from coal tar is unsurpassed.

From aniline we obtain the well-known colours—purple, magenta, emeraldine, roseine, violine, &c.

Mauve or aniline purple can be prepared by mixing equivalent proportions of potassic dichromate and aniline sulphate, when a black precipitate is formed, dried, and digested repeatedly with coal-tar naphtha until all resinous matter has been separated. The residue is dissolved by alcohol transferred to a retort and distilled, when the purple is left behind.

Magenta or *rosaniline* can be prepared by the action of mercury, nitrate, or aniline, or by the action of stannic chloride $SnCl_4$ on aniline. The liquid is boiled, water, added and reboiled, and saturated with NaCl, when this colour is precipitated.

Emeraldine is prepared by acting on a mixture of aniline and hydrochloric acid, with potassic chlorate to oxidise the aniline and produce a dark-green precipitate, which becomes olive green on drying.

Roseine is prepared by adding two parts of plumbic peroxide PbO_2 to one of aniline sulphate, and boiling. Filter and evaporate for some time when resin separates, now add an alkali when this substance is precipitated. Filter to separate the precipitate, dissolve in alcohol and evaporate, when a metallic-looking substance is left.

Violine is prepared by boiling two parts of sulphuric acid and one of aniline with some water and adding some plumbic peroxide, reboil and filter hot. Boil the liquid with potash, filter off the precipitated colouring matter, wash with water and dissolve in dilute tartaric acid. Filter and evaporate for some time, filter again and precipitate by an alkali, dissolve in alcohol and distil, when a bronze-coloured substance is left.

Caffeine or *theine* $(C_8H_{10}N_4O_2)$ may be extracted from tea or coffee by making a strong decoction in water, adding plumbic acetate, which forms a precipitate of plumbic caffeotannate. The lead is separated by passing SH_2 through the liquid. The caffeine is left in solution which is concentrated, and it is crystallised from alcohol in long white silky needles. Or put a paper cone over a watch glass on which there are some finely-powdered tea leaves, and heat over a spirit lamp, when crystals of caffeine will condense on the cone. Caffeine occurs in tea to the extent of from two to six per cent. In coffee one per cent. is found, and in the kola-nut of Central Africa twice as much. However, the usual quantity in ordinary tea is between two and three per cent. It has a slightly bitter taste, and is inodorous. It is a volatile or essential oil, and not caffeine that gives to tea its peculiar flavour and aroma. Caffeine contains almost 29 per cent. of nitrogen, about twice the amount contained in albumen. It appears from some experiments that the caffeine in tea causes the disintegration of the bodily tissues to be less than they otherwise would be. On this account it saves food to a certain extent. If about seven grains of caffeine be swallowed it perceptibly quickens the circulation of the blood, excites the imagination, and produces a peculiar kind of intoxication, resulting in sleep. When caffeine is oxidised it is converted into amalic acid $C_8H_7N_2O_4$, methylamine and hydrocyanic acid. The changes that caffeine undergoes in the system are not definitely known: Boiling water and ether dissolve largely, and alcohol and cold water sparingly. When heated it fuses, and it sublimes without decomposition. It forms crystallised salts with sulphuric and hydrochloric acids. It forms with argentic nitrate a compound which may be crystallised from boiling water. Strong nitric acid forms a yellow liquid, producing nitrous fumes, decomposing the caffeine, and when ammonia is added a fine purple colour is produced, and methylamine is eventually formed. When boiled with potash, methylamine is also produced.

The following table gives an approximate percentage composition of tea and coffee:—

	Tea.	Coffee.
Tannin	26	4
Fibre	20	35
Gum	18	9
Caseine	15	13
Water	5	12
Minerals	5	7
Fat	4	12
Caffeine	3	1
Sugar	3	6
Aromatic oil	1	trace
Starch	trace	trace.

Nicotine $(C_{10}H_{14}N_2)$ is prepared by evaporating an infusion of tobacco in water to a syrupy consistency, and adding twice its volume of alcohol. The upper layer containing the salts of nicotine is decanted, evaporated to a smaller bulk, mixed with an alkaline solution, and agitated with ether, which dissolves the nicotine. The mixture is decanted from the surface, and oxalic acid in powder added, when an oxalate of nicotine is formed, and falls to the bottom of the vessel. It is washed several times with ether, and the nicotine is separated by a solution of potash and ether. This solution is decanted into a retort, through which a current of hydrogen is transmitted. The ether and ammonia are expelled after being heated for a day to a temperature of 140° C., when the temperature is increased 40°, and the pure nicotine distils over.

Nicotine is one of the natural volatile oily bases, having no oxygen in its composition. It forms the active principle of the tobacco plant, being found in the roots, leaves, and seeds, forming from two to eight per cent. It is combined with citric and malic acids. It is a colourless oily liquid, having a specific gravity of 1·027 at 19° C, and boils at 250° C. It is very poisonous, one drop being capable of killing a dog. Ether and alcohol dissolve it readily, and water moderately. It is very inflammable, and burns with a smoky flame. When exposed to the air it absorbs oxygen, becoming brown and solid.

Nicotine may be written $\{N(C_5H_7)'''\}_2$, in which C_5H_7 would represent the H_3 of NH_3, and this substance would therefore correspond with two atoms of ammonia $(NH_3)_2$.

Iodine and chlorine, with nicotine, produce [illegible] red and blood-red liquids respectively.

Nicotine forms white precipitates with salts of zinc, lead, and mercury, but with cupric salts it forms a blue solution. It combines with MeI and EtI.

Nicotine causes the plane of polarisation of a ray of light to rotate to the left.

Quinine $(C_2OH_{24}N_2O_2)$ is prepared by boiling the pulverised bark of the yellow cinchona with [illegible] times its weight of water, acidulated with one [illegible] cent. of sulphuric acid, which dissolves the [illegible] present. The liquid is strained, and when cold [illegible] treated with sodic carbonate, and the precipitate formed is submitted to pressure and the action of alcohol, which dissolves the bases. On cooling, the cinchonine crystallises, and more is obtained by distillation, while the quinine remains in solution. The liquid is now neutralised by sulphuric acid, and the two bases, quinine and cinchonine, are separated by crystallisation, the sulphate quinine crystallising first, being least soluble, and the quinine is precipitated by adding ammonia to the sulphate.

Quinine can be separated from cinchonine by ether, which dissolves the former and not the latter. Quinine may be crystallised in silky needles by allowing its alcoholic solution to evaporate. [illegible] crystallises with six atoms of water. It dissolves readily in alcohol, ether, and acidulated water, but is comparatively insoluble in water. It combines with acids, forming acid and neutral salts, of which the acid ones are most soluble. Of these salts the sulphate is the most important, as it is extensively used in medicine.

Both quinine and its salts have a very bitter ste. Quinine has a decided alkaline reaction. hen ammonia is added to a mixture of chlorine, ater, and a quinine salt, a green colour is observed. hen distilled with caustic potash it yields quinoline $C_9H_7)'''$, an oily base. The quinine salts give ecipitates with oxalic, tartaric, and gallic acids d salts, and with argentic and mercuric nitrates.

When chlorine is passed through water in which inine is suspended the alkaloid is dissolved, various ades of colour being produced. Quinine causes e plane of polarisation of a ray of light to rotate the left. The sulphate of quinine crystallises in ow-white needles soluble in alcohol, and only to a ght extent in water. When heated it fuses, itting a phosphorescence. The acidulated solu- n exhibits the phenomenon of fluorescence. An id sulphate is obtained by dissolving the sulphate sulphuric acid, and concentrating. It is soluble th in alcohol and water, and crystallises in small edles. Iodine and the sulphate combine, forming t plates, which polarise light. The sulphate is pensive (the price has risen lately), and is, there- re, liable to adulteration. It is adulterated with e sulphate of cinchona, which may be detected adding ammonic hydrate and ether, when the ichona floats between the two liquids, and the inine is dissolved.

Salicine, when present, produces a red colour, ien sulphuric acid is added. Stearic acid is tected by its insolubility in dilute sulphuric acid. gar, by being soluble in cold water and boracic id, imparts a greenish tinge to the alcoholic me. Chalk, gum, gypsum, magnesia, and starch, ier adulterants, are insoluble in alcohol.

The citrate of iron and quinine is another prepara- n used in medicine, as well as the solution of the lphate in tincture of orange peel.

Morphine ($C_{17}H_{19}NO_3$), is the only one of the kaloids of opium that is soluble in lime water, and vantage is taken of this property to extract it m opium. An infusion of opium in water is iled with milk of lime, which dissolves the mor- ine, leaving the other opium alkaloids and undis- ved lime, which are filtered off. The filtered uid is boiled, and NH_4Cl added to neutralise the e, when chloride of lime is formed, ammonia is sipated by the heat, and the morphine is preci- ated. It is purified by dissolving in HCl, adding lk of lime, and reprecipitating by sal-ammoniac, en morphine is deposited in short rectangular sms containing two parts of water of crystallisa- n. Or an infusion of opium is made in water and ered, and the solution is concentrated and neu- lised with chalk. A solution of calcic chloride is led which precipitates calcic meconate, while the lrochlorate of morphine remains in solution. e meconate is filtered off and the liquid evapo- ed, when the morphine crystallises out as lrochlorate.

Morphine readily combines with HCl and $_3$COHO forming the hydrochlorate and acetate ich are frequently used in medicine, especially e hydrochlorate, to induce sleep or allay pain. is alkaloid occurs in opium, together with nar- tine, landanosine, papaverine, codeine, meconic id, &c. It is one of the principal narcotic con- tuents of opium, forming about one-tenth of it weight. Boiling water dissolves twice the quan- y that cold water does, in which it is sparingly uble, and it is dissolved freely by alcohol, but not t all by ether. The morphine salts are crystallised dily, and are insoluble in ether, but soluble in ohol and water. Morphine forms salts with thyl and ethyl iodides. Ferric chloride gives th morphine a blue colour; a mixture of H_2SO_4 nd HNO_3 gives a green, and HNO_3 alone gives an [illegible] colour. Tannic acid produces a bulky pre- [illegible]. Morphine changes the yellow colour of [illegible]ic paper brown, and both it and its salts [illegible] a bitter taste. Like quinine, nicotine, and [illegible] alkaloids, it rotates the plane of polarisation the left. The hydrochlorate is its most important [illegible]. It dissolves freely in water containing a little [illegible], and in alcohol. It crystallises in needles. [illegible] salts used in medicine are the acetate and [illegible]. Lozenges are also made containing 1-36th [illegible] grain each of the hydrochlorate.

[illegible]hnine, $C_{21}H_{22}N_2O_2$, is prepared by boiling [illegible] nux vomica in alcohol and water separately, [illegible] strychnine dissolved in water is obtained, to [illegible] magnesia is added, when the strychnine is [illegible] free, and is dissolved by boiling alcohol and dis- [illegible]. It is then dissolved in dilute sulphuric acid, [illegible] a sulphate of strychnine is formed, and am- [illegible] is added, when a sulphate of ammonia is [illegible], and the strychnine is precipitated. Or [illegible] ground seeds of the nux vomica are boiled with [illegible] slightly acidulated with H_2SO_4, and neutra- [illegible] with lime, which precipitates extraneous [illegible], while the bases remain in solution. The [illegible] is dissipated, and the residue is treated with [illegible] slightly acidulated, and, on adding ammonia, [illegible] with brucine is precipitated. These are [illegible] into nitrates, and the nitrate of strych- [illegible] crystallises first, leaving the brucine in solu- [illegible]. Strychnine forms about 1·70th of the St. [illegible] bean, and it is obtained from nux [illegible]. The nux vomica is about an inch in diameter, round and flat, tough, inodorous, and intensely bitter. These seeds are imported from the East Indies. They are very poisonous—a few grains being sufficient to kill a dog, but it appears that it does not produce the same relative effect on different species of animals. The ground nut and extract are also used in medicine. Strychnine crystallises from dilute alcohol in octahedra, but it is insoluble in absolute alcohol and ether. It is soluble in chloroform and the essential oils. Bromine and chlorine form substitution products that are still basic. A crystallised compound is formed when iodine is triturated with it, from which strychnine is obtained by the action of acids When distilled with KHO it produces quinoline, $N(C_9H_7)'''$, a colourless basic oily liquid. It forms a compound with ethyl iodide. Strong HNO_3 turns pure strychnine yellow, but if brucine is present an orange-red colour is produced. When strong H_2SO_4 and potassic dichromate are added to a small quantity of strychnine a violet colour is produced, changing to rose. When a strong solution of sulpho-cyanide is added to a solution, crystals are formed immediately. And crystals are formed if tartaric acid is added to a solution of a salt of strychnine, and also hydric potassic carbonate. Sulphuric acid forms a neutral salt with strychnine, with auric chloride, $AuCl_3$; the sulphate or other salt, gives a blue colour. Strychnine may be detected in cases of poisoning by rendering the liquid supposed to contain it alkaline, then agitate with chloroform, which will dissolve strychnine if present. On evaporation strychnine remains behind. It is taken up by HCl, and tested by some of the characteristic reactions given above.

Hugh Clements.

ON THE MEASUREMENT OF THE ANGULAR APERTURE OF MICROSCOPIC OBJECTIVES.

[14278.]—There are some points to which we wish to advert in the last three letters of Mr. Wenham, in the English Mechanic, on the subject of the measurement of the angular aperture of microscope objectives. In the first of the series (No. 14077), March 8, 1878, p. 629, that gentleman says that additional lenses used as examining lenses are apt to increase the apparent angle by elongating the focus. In our own experiments we have not found it so.

Again, he states that, if half the front lens of the objective is obscured by a screen touching it, half the light, but in some cases little of the angle is lost. In our observations when the screen is *in close contact* with the object-glass, and a biconcave lens, with a stop to keep the eye central, is used as an examining lens, half the angle as well as half the field is always cut off.

He then refers to the result of placing a small stop of known diameter on the front of the objective, in which case the sector angle is found to be larger than could be admitted by such a stop from a cone of rays issuing from the axial focal point. This subject is continued in his letters of March 29 (14152), p. 68, and April 19 (14226), p. 112, a narrow adjustable slit being substituted for the stop, and an immersion 1-5th and a dry 2-3rds being experimented on.

When the adjustment is *closed*, we agree in principle with Mr. Wenham; but the result is quite different, as we shall proceed to show, when the glasses are sufficiently separated. In all cases, as far as our limited means of experiment have enabled us to ascertain, when the adjustment is close, the sector angle is greater than what Mr. Wenham calls the "true aperture"—*i.e.*, that calculated from the focal distance and the diameter of the spot of light, or (which is the same thing) of varying apertures of less measurement than that spot. But we find, also, that there is a point in the adjustment at which the two angles coincide; and that, if the glasses be still further separated, the disproportion is reversed, and the *calculated angle much exceeds that given by the sector*. If, after this, the separation is carried still further, the calculated angle is increased, the focal distance shortened, the diameter of the spot of light widened, but the sector angle is lessened, because the back lenses will not allow a larger angle to pass.

To illustrate the preceding statements we adduce an experiment. Not having an immersion 1-5th, we took a dry 1-5th, of which the focal distance, close, is ·0266in., and the diameter of the spot of light ·04. These data give a measured angle of about 76°, the sector angle is 100°. The adjustment of this glass has a run of about 3½ turns. When opened 1½ turn, the diameter of the spot of light is ·0417, focal distance ·02, giving about 92° calculated angle. The sector angle comes out 91°. With another half turn back, the diameter of the spot of light is ·0421; the focal distance, ·073; calculated aperture about 100°; sector aperture, 84°. When the adjustment is fully turned back the back lenses will only pass 82°, while the calculated angle is 135°.

Mr. Wenham will now perceive the import of our query in the English Mechanic of April 12 (14206), p. 120, which he was so good as to notice in the following number of that publication (14266), p. 141. The remarkable point is this:—The condition of an object-glass in which it appears to resolve best is precisely that in which, though the sector angle is the largest, the aperture calculated from the focal distance, and the diameter of the spot of light is very much the smallest—*i.e.*, when the glasses are close. One would expect, *à priori*, that the resolving power would, under such conditions, be at the lowest. We refer, of course, to objects mounted dry.

In using the smaller stops there is a liability to enormous error—sometimes more than double—unless they are kept *closely in contact* with the actual surface of the glass. The setting of the objective may thus materially vitiate the result, unless this is attended to by preventing actual contact. We have found a difficulty in measuring the spot of light by dried milk; for, as the focuses of the two are not in the same plane, no sharp edge of the spot can be so obtained. When the milky surface is in focus the edges of the spot are undefined. We notice that the 1-5th used by Mr. Wenham seems to have had an unusually large spot of light —·07in.

In concluding this letter, we would remark that, though Mr. Wenham's last experiments show that a certain method of estimating angular aperture cannot be relied on, we are sure that he will agree with us that it would be unphilosophical to infer hence that all means of ascertaining that aperture must necessarily be vitiated with error in the same, or nearly the same, degree. We hope shortly, by the indulgence of the Editor of the English Mechanic, to give the results of some experiments upon another plan.

Martin M. Bull.
Richard Nickols, M.R.C.S.

Jersey, April 24.

CARL ZEISS'S NEW OIL-IMMERSION OBJECTIVE.

[14279.]—In my letter (14253) on above there are several typographical errors, which I think it necessary to correct. On p. 166, in the 10th line from below, the words "covers of" are transposed. It should read thus:—"An immersion fluid, the refractive and dispersive indices of which are as nearly as possible the same as those of crown glass, of which both the front lens and the covers of micro-objects consist."

On p. 167, line 35 from above, read:—"Professor Abbe calls the product of the *sine* of the angle," &c., and not "the size of the angle," &c.

On p. 167, line 19 from below, read:—Dr. W. J. Dickson, of Hackney (late of Falkland).

I would like to add to my letter (14253) that this oil lens is especially suitable for petrographic work, because unpolished rock sections will become quite transparent by the use of this oil, or if the section is covered it may be examined to a greater depth in consequence of the great amount of light transmitted by this new objective.

Some of my correspondents seem to think that the use of essential oils as immersion fluids might be prejudicial to the stand and the brasswork, but this is not the case, as a very small drop of oil of the size of a pin's head suffices at a time, and this can easily be wiped off with a little blotting-paper.

Glasgow, 27th April. **Adolf Schulze.**

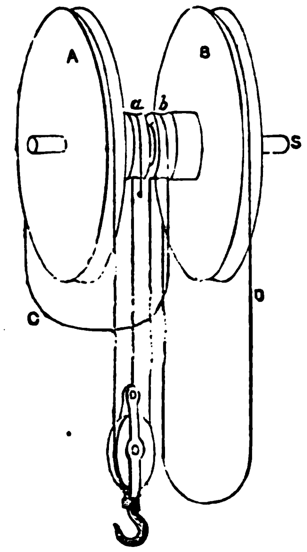
[14280.]—The letter of Mr. Adolf Schulze (14253 is very interesting; perhaps he will give us the result of a trial of his Zeiss oil-immersion ⅛ on Nobert's lines. From my experiments on a test-plate received a week or two ago from Nobert, I am inclined to consider the separation and sharp definition of the lines of the 19th band a much more difficult matter than the resolution of any test diatom which I have hitherto met with. By the aid of the reflex illuminator, used in the manner previously described by myself and others in these pages, I have been able to separate these exquisitely slight and fine lines with great distinctness, both with Zeiss' 1-25 and Seibert's 1-50 immersion.

These lenses, the latter in particular, of course require extremely accurate adjustment, and close attention to the intensity and incidence of the illuminating pencil to obtain the best result. Notwithstanding the laudation bestowed by Dr. Edmunds on his immersion paraboloid in a late number of the *Monthly Microscopical Journal*, the Wenham reflex illuminator is far superior to it for the resolution of difficult tests, as it affords the means of throwing a minute speck of intense light of the greatest possible obliquity and of any azimuth, directly on the object, without the confusion occasioned by side light, when the immersion paraboloid is used.

With Powell and Lealand's non-stereoscopic binocular prism, the eyepiece removed from the right-hand tube of the microscope, the reflex illuminator shows the cross lines of A. pellucida, N. crassinervis, and N. curvula, with the greatest sharpness; the same result may indeed be obtained with the immersion paraboloid, but a much greater expenditure of time and trouble is required. **Simian.**

THE COMPOUND PULLEY BLOCK.

[14281.]—It should be understood that in all differential blocks hitherto constructed, when the load is being raised, an equal portion is always sustained by the quick or power mover; hence the enormous friction incurred in these blocks. An abortive attempt to remedy this great evil has been the introduction of the modern toy winch plan, with unfortunately the fatal objection of breakages of the toothed wheels when under pressure of the load. This needs no comment. Now these difficulties are obviated in the present plan of block, there being only two movable parts—that is, the power pulley and lifting pulley, which turn freely on one fixed shaft. The circumferential speed of the lifting pulley is equal to the speed of the load when being raised, thus reducing the friction to its lowest limit. The special feature of this block is in the peculiar arrangement of the lifting chain, in combination with the compound pulleys, by which the maximum load can be raised with a minimum power exerted. The principle is direct leverage, which has hitherto been unattainable, unless by using toothed wheels and extra spindles. In the figure A and B are two pulleys, each having a small one cast on its inner side. These compound pulleys are fitted loosely on the shaft S, which is fixed in the frame (in ne piece)—not necessarily shown in the diagram. A single chain (a little longer than the height of lift), one end of which is fastened to the top of the bottom block, the other end passing over the small pulley, *a*, and descending on the front side with a small weight attached thereto. Starting from the point, C, an endless chain ascending, passing over the far side of the large pulley, A, then descending on the front side, passing under the bottom sheave; again ascending, passing over the far side of the small pulley, *b*; and again descending on the front side, and meeting at the starting point in the form of a loop. D is the small endless hand chain passing over the power pulley, B. It will now be seen how, by the leverage of the compound pulleys, the power is gained. Suppose the ratio of each pulley is as 4 to 1, then the power would be (4 + 2) × 4 = 24—that is, a power of 24 to 1. This block is one of greater speed and power than has been attained by any others.



Joseph Jewsbury.

Brookfields, Birmingham.

PUNCHING *v.* DRILLING.

[14282.]—Believing that many of your readers take an interest in the question of punching *v.* drilling, I venture to send you a brief report of the discussion which took place on the point at the meeting of the Mechanical Engineers, after the reading of Mr. Boyd's paper on experiments with steel boilers. The illustrations are copied from the engineering papers. Dr. Siemens, speaking of the effects of punching, said that the piece punched from a hole is never so thick as the plate from which it is punched; this being the case, one of two things must have happened during the punching. Either the piece punched out has itself been compressed, or the material which represents the difference between the contents of the hole and that of the "punching" must have been forced into surrounding material of the plate. The punching upon being weighed is found to have the same specific gravity as the plate, and the latter supposition must therefore be assumed as correct, and it must further be allowed that the material round the hole must have been more or less distressed by its forced re-arrangement for a certain distance or zone round the hole by the pushing into it of the quantity of material represented by the above difference. Mr. Riley has, however, found that, by leaving sufficient clearance between the punch and the die, the amount of this distress may be so reduced that the tensile strength of a piece of plate is as great after punching as after drilling, and in fact as strong as before either punching or drilling. The commonly observed reduction of strength per unit of area is attributed to incipient cracks induced by contending forces set up by the partial compression or molecular disturbance of the material round the hole, a plate readily tearing once a crack is initiated, in the same way as a strip of india-rubber tears when a very small cut is made in the edge. Mr. Tweddell referred to some experiments made by M. Barbar, with a view to determine the size of the zone of distressed material round a punched hole, and stated that with careful punching it was proved to be only about 0·5 millimetre. Mr. Adamson, however, contended that if it was necessary to reamer or drill out the zone round a punched hole, which by compression is caused to exert a bursting pressure all round the hole, he thought the hole might as well be drilled in the first instance. When the plates are riveted up with conical holes as they leave the punching machine, and the rivet firmly riveted in, the tendency to burst the plate round such a hole, first by the compression referred to, and secondly, by the conical wedge which the rivet forms, is such that many plates are incipiently burst along the seams before steam pressure is ever put on.

Mr. Tweddell referred to Kennedy's spiral punch (Fig. 1) which has been well tried by Mr. F. W. Webb, at Crewe, for punching steel boiler plates. The strength of the same steel plates, after punching by the ordinary and by the spiral punch, was found to be respectively 58,579lb. and 63,929lb. per square inch, showing an excess of strength after punching by the Kennedy punch of 5,350lb. per square inch. Further, in some test strips punched with two holes, one by the ordinary, and the other by the new spiral punch, the plates cracked in every case at the holes made by the ordinary punch. One of the members said that many years ago, having to punch some holes through ⅜in. plate of from 3in. to 4in. in diameter, he had tried the forms shown in Figs. 2 and 3. The form shown in Fig. 2 was first tried, but this caused a heavy side pressure upon the punching machine guides, and the form shown in Fig. 3 was then made, and the holes "sheared" through with ease, and by a machine which could not have done the work with flat-ended punches. Mr. Paget remarked that in punching plates for articles for knitting machinery, the piece punched out being that required, it had been found absolutely necessary to use shearing punches, as the article punched out with a flat punch was so much distressed that it would last only a few hours as compared with many months, when cut by shearing punch. The punch shown by Fig. 4 was suggested by another member, and will probably be found useful on thin plates; but an interesting point was introduced as to the method of finding the amount of clearance between punch and die. One good method was said to be to draw an acute-angled triangle having a base of 2in., and a side of 12in., drawing a line across where the width is equal to the diameter of the punch; it is only necessary to draw another line beneath, at a distance equal to the thickness of the plate to be punched, to obtain a diagram of the clearance, or in other words the diameter of the hole in the die. Perhaps some of your Crewe readers who have had experience with Kennedy's spiral punch will give us some further information, and say what is the probable result to the punch of piercing 500 holes in, say, a ⅜in. steel plate. Referring to the index of your last volume, I find that on p. 75 Mr. Salburgh gave a diagram of the above-mentioned method of finding the diameter of the hole in the die. His triangle, however, has a 1in. base, and a 5¼in. side, so that the figures appear to be arbitrary. Can any one say what should be the angle made by the lines forming the "apex" of the triangle.

M. I. M. E.

FIG. 1

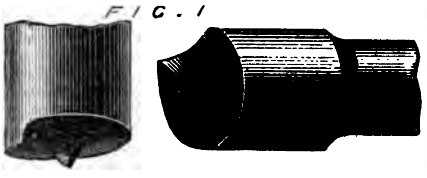


FIG. 2

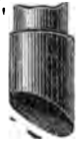


FIG. 3

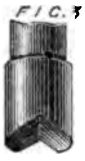
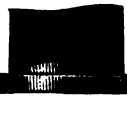


FIG. 4



A PORTABLE MUSIC STAND.

[14283.]—I send you a description of a portable music-stand, patented by Mr. J. F. Walters, of Boston, U.S., which may not only interest your readers, but suggest further improvements. The patentee claims for his invention simplicity, s
portability, and the facility of using one
desks at pleasure. It will be seen by a gl
the illustrations that the patentee has taken
of a stand from the arrangement of the u
the three legs of the stand turning back i
length of the main rod, while the desk is su
by a telescope prolongation sliding into t
The desk consists of a series of parallel rul
ported upon a centre piece. The lower ru
bent at right-angles and form a shelf for t
or music to rest upon. The rulers fold upw
seen in Fig. 2, and are supported in the des
slight projections upon the centre piece. Th
piece slips into a dovetailed groove (D, Figs. 1
which is fastened upon the telescoping ro
the standard, S; the desk resting at its centr
the centre of gravity directly in the centre
base. A modification provides for the use
desks, which are readily supported at any
angle.

FIG. 2

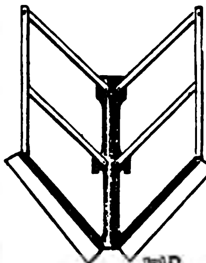


FIG. 1

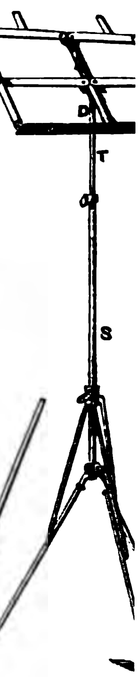


FIG. 3

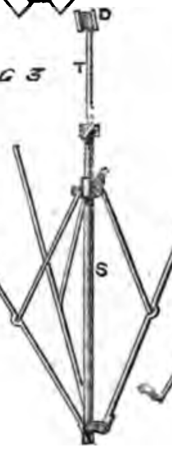


Fig. 1 represents the stand complete,
the single desk, and Fig. 3 the manner i
the various parts close together—the whol
when shut up, being scarcely more bulky
ordinary umbrella. It will be noticed that i
varied in height within very wide limits: i
low enough to suit a boy, or high enough
tallest man. T

PURIFICATION OF SEWAGE.-

[14284.]—In my two previous letters
voured to point out how little progress h
made by the Local Government Board
British Association for the Advancement o
in solving the problem set before them o
purify the sewage of towns—our great
nuisance. I also pointed out several err
bodies had fallen into in dealing with the
showing that we have gained nothing but
from these two great authorities without t
able to show how to do it. Let us now
the Institute of Civil Engineers have done
solving the great national problem of how
sewage and rivers in such a manner that t
will not cause a nuisance.

In February, 1877, Mr. Bazalgette re
able paper on the "Sewage Question," at
of the I.C.E., and a lengthened discussi
subject took place, in which many of the
took part. The paper is now publishe
"Transactions for 1877." It is quite ev
Mr. Bazalgette's paper was a lawyer's brie
client the sea. The whole of Mr. Ba
arguments were intended to show that
proper method of dealing with sewage wa
it all into the sea. There can be no doubt
the subject for that end in a masterly sty
paper, when analysed, shows that it is n
a collection of statistics; it altogether fai
that sewage can even be carried to se
causing a nuisance somewhere. He has
that sewage has ever been, or can be, pur
out causing a nuisance even in the sea; n
his paper prove that sewage cannot be s

during its transit to sea. Therefore his
failed in its object in throwing any new
e all-important question of how we are to
national nuisance. With the greater part
salgette's conclusions and remarks on the
uite agree, but from some of his introduc-
ments and inferences I wholly dissent.
gette commences his paper by asserting
sewage question has not made much pro-
r as discovery or invention is concerned
e last quarter of a century. Nor does
n to be much prospect of any new or
ight being thrown upon it in the future."
said that the sewage question had made no
&c., so far as the M.I.C.E. or L. G. Board
rned, I think he would have been about
when he applies that remark to the out-
l as inside the I.C.E. I must demur to it.
gette cannot know all that has been in-
discovered during the last quarter of a
nd I hope and believe he does not think,
of the M.I.C.E., that nothing on the
n possibly be known, discovered, or in-
utside the Institute." Allow me to say—
wn knowledge, not hearsay—that a great
een discovered and invented during the
r of a century with respect to the purifica-
vage and gas, although it has not been
road, or even dreamed of by the M.I.C E.
Government Board and Institute of Civil
appear to have got into a quagmire on the
estion, and have stuck fast in the mud.
n at the wrong end at first, and have been
the dark ever since.

algette says:—"The fact is the field of
on is nearly exhausted." Instead of the
nearly exhausted it has not yet been
rveyed. Engineers have provided certain
r towns in the shape of water-pipes, and
e form of drains and sewers, but they
et discovered or invented the lungs for
he venous fluid; but it does not follow
not be done. It appears to me that the
ad all got into certain ruts and grooves
n making, from which it was impossible
get out unaided. Each individual mem-
to be more anxious to prove what was
is neighbour's plans or suggestions than
what was really necessary to be done to
sewage. The whole discussion, from
to end, was nothing but a struggle for
one over the other, instead of a union of
rnestly striving to discover the best
purifying sewage.

think there is much prospect of any new
thrown on the question by the "Insti-
L. G. Board so long as they adhere to
t method of investigating it, but I cannot
Mr. Bazalgette that there is no prospect
re from any other source. The I.C.E.
Board do not constitute the talent of the
d, nor yet of England. I know that
ed men wrote and prophesied that it
d be possible to steam to America, but
ibility has vanished long ago. Not long
mpossible to convert pig-metal directly
but that impossibility has also vanished;
t was impossible to toughen glass—there
mpossibility in that. It was impossible
smoke a short time ago, but it is done
ow. Hundreds of operations that were
during the last generation have become
le and simple now.

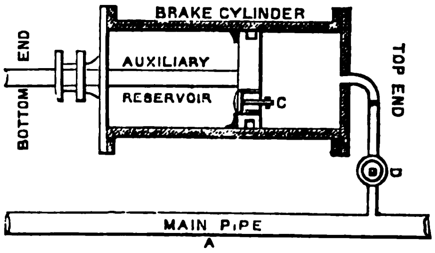
onished at Mr. Bazalgette committing
such a do-nothing opinion. Whatever the
others may be I have at all events good
not believing in the impossibility of
ewage. Lime appears to be a favourite
with all parties as a purifier of sewage,
l appear to think there is but one way of
hereas there are many ways of using it
members of the Institute do not appear
ve tried. There is a very simple and
ocess of purifying sewage which might
eously adopted in some places, and which
mooted at the Institute—namely, where
can be got on to a large clay field. The
be perfectly purified by mixing with it
k earth, by proper machinery, in suffi-
tity to form "slip," to be afterwards
bricks. That mode of dealing with the
rid of the sludge difficulty, and makes
s pure as most rivers. The heavy slip
down, and carries all the foul matter of
with it, and the supernatant water soon
is quite fit for passing into any stream.
es I have no doubt a fair profit could be
he manufacture of bricks by this plan,
field was near water or rail carriage,
bricks made from such slip would be of
quality, and would command a good
is true that this method could only be
very few places, and does not settle the
stion. I only mention the above plan to
the field of investigation is not yet

Wm. Burns.

(To be continued.)

ATMOSPHERIC AIR BRAKE.

[14285.]—In No. 682, letter 14223, there is a description of apparatus for working atmospheric air brakes, which apparatus is (as I understand it) rather complicated. What objections are there to the arrangement sketched below with fewer parts, the action of which is as follows?—The air passes along the main pipe, A, into the brake cylinder, by means of the pipe, B, and through a check valve, C, opening into bottom end of cylinder. When in this condition the air presses equally on both sides of piston, therefore it remains at rest; but on the air being let out from the main pipe it escapes from the top end of cylinder, but is prevented from escaping from the bottom end by the check valve, C; therefore the piston is forced to the top end and the brake is applied. In the event of the main pipe being broken and the brakes applied, they can be taken off by opening a pet cock placed in bottom end of cylinder.



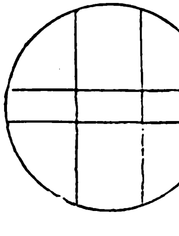
This arrangement cannot be used as a compressed air brake (but could be by the addition of a three way cock in place of the ordinary one shown at D, and one foot or so of pipe, and the position of the check valve altered), as I think such an arrangement would not be required, because it is very improbable that more than half of the brakes should get into such a state in one journey that they could not be used in the way they are intended to work. **J. D.**

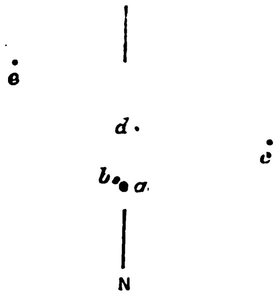
OBSERVATORY.

[14286.]—If your valued contributor, "F.R.A.S.," will not think it an intrusion, I should be glad to offer a reply to let. 14250 with the above heading, though specially addressed to himself. For, being of those who are, perhaps, rather too much "given to change," it has been my lot to possess various equatoreals in my time of from 4 to 10in. aperture, with buildings for their reception, and my experience has led me to form decided opinions on all three points stated by Mr. Richards:—

1. Brickwalls absorb heat, and they radiate it more slowly than wood, thus interfering with the equalisation of internal and external temperature which is so important to "definition." Six or eight light iron columns, on brick or stone foundations, are a good support for the wall plate, and at least half of the intervening boarded spaces should be made to open.

FIC. 1





2. "Balls" are far inferior to "rollers," supposing that by the latter expression is intended pulleys or wheels, about 8in. in diameter, revolving on a plain circular iron rail, of square section, supported by the wall plate. Five of such wheels would suffice probably.

3. For the finder I certainly prefer the following contrivance of my own to any of the three methods described. Wires placed as shown in Fig. 1 are available for approximate measurements, and indicate at once, in all positions of the telescope, how stars in the field are situated (*p*, *f*, *n*, or *s*), with reference to one another. Fine copper wires are better than thick ones, or than "hairs" either. It has not hitherto been "usual to illuminate the field of the finder," but this is a decided acquisition, and in their large instruments Messrs. Cooke now do so, the same suspended lamp accomplishing this which also illuminates the micrometer wires, the declination circle, and the position circle.

4. An iron pillar takes up less room in the observatory than a stone one of equal strength, and is less liable to be defaced, but the underground support should be stone or brick, and plenty of it—say, at least, a ton of masonry for every inch of aperture.

The following is a sketch to scale (4 minutes of arc to one inch) of my measurements of stars in the same field as "Castor" inquired about by "Mac" (let. 14222). I was always a bad hand at estimating magnitudes, but if *d*, Smyth's distant companion, be still rated at 11 mag., I should put *e* at about the same (perhaps rather fainter), and *c* at not more than 12 mag. **Antares.**

GRAVITY.

[14287.]—"F. R. A. S." having made, in letter 14027, a charge of serious inaccuracy against an entry in one of the tables in my "Descriptive Astronomy," alleging that a body would require 82 days to fall into the sun instead of 64, and having himself been corrected by several of your readers, I think I may fairly ask "F. R. A. S." now to withdraw the charge he made against my book.

G. F. Chambers.

THE YEAST PLANT—TIME OF FALL TO THE SUN AND TELESCOPIC APERTURES.

[14288.]—I have somewhere read that the fermentation which all alcoholic drinks undergo is due to the yeast plant. If this is true there are one or two things in connection with the fact that seem to deserve attention. Thus, there are some kinds of wine, such as grape and rhubarb, which will ferment without having yeast applied to them; while others will not. Now, I am not disputing the truth of the saying that all such fermentation is due to the yeast plant, nor am I affirming it to be so; but, if it is, we must either have a case of spontaneous generation, or else germs of the yeast plant must be floating about in the air, and must be very generally diffused; and, if so, why do they germinate in grape juice, but not in malt liquor? Perhaps some of your correspondents who have attended to the subject will give some information as to this.

In answer to Capt. Steel, p. 123, I may say that the space fallen through in the first second is about the ninth of an inch, and in the last second 5,264 miles. The analytical expression is

$$x^{\frac{3}{2}} = \tfrac{3}{2}\sqrt{2\mu}$$

or rather this is the first term of a series, but it will represent the true value within a fraction of a mile. It is remarkable that it is independent of a, and therefore is the same for all orbits in which $\frac{x}{a}$ is small.

Perhaps I have misunderstood "F. R. A. S." as well as "8½in. O.G.," but when he said, in letter 14134, that he was not concerned to defend a certain practice which was universal, I certainly did not understand him to mean that he was either partly or wholly against it, but that the fact of it being approved by all except "8½in. O.G." rendered a defence of it unnecessary. **W. G. P.**

VARIABLE STARS.

[14289.]—In the list of variable stars given by Mr. Sadler in letter 14060, p. 624, last vol., he gives the date of the next maximum of R Hydræ as October 7. I observed maxima of this star on the following dates:—1875, Feb. 10; 1876, April 12; 1877, June 13. These give a period of about 427 days, and fix the next maximum for August 24, 1878.

At the maximum of 1877 this remarkable variable was unusually bright, and fully 4 mag. At the maxima of 1875 and 1876 it did not exceed the fifth magnitude.

Mr. Sadler identifies the variable χ Cygni with 17 Flamsteed; but this is a mistake, the variable being not the χ Cygni of Flamsteed (17), but the original χ of Bayer (*s. f.* 17). Bayer's star was faint at the epoch of Flamsteed's observations; hence the mistake made by Flamsteed. **J. E. Gore.**

Dromard Rectory, co. Sligo, 20th April.

CLOSE DOUBLE NEAR CASTOR.

[14290.]—I have lately almost divided this object, even in an inferior state of the air, with about 400 on my 7½in. dialyte. ζ Cancri was, however, much easier, and had a black line between the discs, but I think it must still be under 1".

Champion Hill, April 26. **Herbert Ingall.**

DOUBLE STAR NEAR CASTOR.

[14291.]—SINCE I last wrote the exceptionally fine air of April 24 enabled me to examine OΣ 175 to advantage, when I found it perfectly split, with a minute black division, by powers of about 357 and 450 on my beautiful 9·38in. "With" speculum. Few nights, however, would be likely to admit of it. I should be very glad to know its measured distance.

I take the present opportunity of directing attention to Σ 1114, R.A. 7h. 20m., D.N. 9° 36′, and Σ 1129, R.A. 7h. 34·4m., D.N. 18° 21′. The former is accompanied by one minute comes, the latter by three. These and many other pairs I hope to introduce before long in a fresh edition of "Celestial Objects." **T. W. Webb.**

DOUBLE STAR.

[14292.]—ON Saturday evening last, April 27, I came accidentally across a fine double star in Leo, which, from its aspect, I at once concluded must be one of Smyth's, and as such included in "Celestial Objects," but on reference was much surprised not to find it there—an omission which I hope may be rectified at a future opportunity. It proved to be Σ 1529, R.A. XIh. 13m., D.S. 0° 58′ : 250°·88 : 9″·32 : 7 and 8 mags., yellowish white, ashy. It is singular that so conspicuous a pair should have been missed by both the Herschels; it was, however, measured by South. An equatoreal mounting will readily find it by a long sweep of about 1h. 23m. W. from γ Virginis; a large field will include both, γ being only 13′ N. of Σ 1529. **T. W. Webb.**

TRANSIT OF MERCURY.

[14293.]—POSSESSORS of small achromatic telescopes may observe the transit of Mercury on Monday next with considerable ease and comfort by projecting the shadow of the planet upon a sheet of white paper laid upon a swing dressing-glass which can be readily inclined at the proper angle to receive the image, and gradually altered as the sun declines to the horizon. The brilliancy of the effect will, of course, be increased if the window shutters are partially closed and the curtains drawn. A further advantage is afforded by this simple arrangement, insomuch that the planet's motion across the sun's disc may be witnessed by a number of persons at the same time.

The following are the transits which have occurred and are to come in the present century—viz., 1802, 1815, 1822, 1832, 1835, 1845, 1848, 1861, 1868, 1878, 1881, 1891, and 1894.

Newcastle-upon-Tyne. **M. H. B.**

BRILLIANT METEOR.

[14294.]—ON the evening of Wednesday last at about 8.10 p.m., a meteor of great size and brilliancy fell almost perpendicularly in the S.W. portion of the heavens. It was pear-shaped, of a pale but brilliant blue colour, and left behind it a train of corruscating fragments. It appeared to me about one-fourth the size of the full moon. Its course was very brief, and its general effect would doubtless have been more striking had it been perfectly dark at the time, which was not the case.

April 29th. **A. E. S.**

THE EYE.—To Mr. Lancaster.

[14295.]—I HAVE taken some observations on the eye of the gentleman who is the sufferer. He is totally blind in the right eye—in the left eye the pupil is much enlarged; he could not see your answer at all with his eye; he sees a deal better at times, and other times he can scarcely see at all. The cause of this is due to the pupil being so enlarged. The reasons he gives for the malady are that he got some copperas water into his eyes; he went blind in the right eye in four days, and nearly blind in the left.

Leghill. **W. A. Morton.**

ERRATA.—ORGANIC SUBSTITUTION, LETTER 14255, p. 168.—For deplacement, line 2, read replacement; in line 24, for lialoid read haloid; in the 2nd column, in 9th line from foot, for diacetanide read diacetamide; in the 3rd column, 28 lines from the top, for prethyl read methyl; in line 41, for introbenzol read nitrobenzol. — HUGH CLEMENTS.

Physic for Grasshoppers.—Poisonous qualities are popularly attributed to the castor-oil bean, the fruit of *Ricinus communis*. According to the statements of a California newspaper, this property extends to the leaves, sufficiently to make them of use in destroying insects. By distributing the leaves where grasshoppers were numerous, great numbers of the insects were soon killed. The effect of the poison upon the grasshopper is said to be apparent very shortly after it eats a portion of a leaf. The insect seems bewildered, vainly attempts to jump or fly, and finally, tumbling over, dies.

REPLIES TO QUERIES.

**** In their answers, Correspondents are respectfully requested to mention, in each instance, the title and number of the query asked.*

[32049.]—**Soluble Prussian Blue (U.Q.).**—You can make good ink without the gall ink.—TELESCOPE TELE.

[32078.]—**Bicycle Construction (U.Q.).**—The simplest way I can see would be to clip a small bracket on to the front of your spring, and then pivot a thumb-brake of rather a peculiar shape on to it.—X. X.

[32318.]—**To Remove Stains.**—Seeing the reply of "D." on page 146 I send the following list, which may be useful to many of your readers. The stains easiest to remove are those of sugar, gelatine, blood, and albumen; a simple washing with water is all that is necessary for all kinds of fabrics. *Grease spots:* For white linen or cotton goods, use soap or weak lye. For coloured calicoes, warm soap-suds. For woollens, soap-suds or ammonia. For silks, benzine, ether, ammonia, magnesia, chalk, yolk of egg, with water. *Paint, varnish, and resin stains:* For white or coloured cotton and woollen goods, oil of turpentine or benzine, followed by soap-suds. For silk, benzine, ether, soap; hard rubbing is to be avoided. For all kinds of fabrics chloroform is best, but must be carefully used. *Stearin, sperm candles:* For all kinds, use 95 per cent. alcohol. *Wine and fruit stains:* White cotton or linen, fumes of burning sulphur, warm chlorine water. Coloured cottons or woollens, wash with tepid soap-suds or ammonia. Silks the same, with very gentle rubbing. *Alizarine ink:* White cottons and linens, tartaric acid in solution; the older the stain the more concentrated the solution should be. Coloured cottons and woollens and silks, a weak solution of tartaric acid if the colour allows of its use. *Rust, nutgall ink:* White cottons and linens, warm solution of oxalic acid, dilute muriatic acid, followed by granulated tin. Coloured cottons and woollens, repeated washings with a solution of citric acid if the colour is fast. Silks, do nothing; all attempts only make things worse. *Lime, lie, alkalies:* White cottons and linens, wash with cold water. Coloured goods and silks, a weak solution of citric acid applied with the tip of the finger to the spot previously moistened with water. *Acids, vinegar, orange juice, &c.* White cottons and linens, wash with pure water, or warm chlorine water. Coloured goods or silks, ammonia, diluted according to the fineness of the tissue and delicacy of the colour. *Tannin, walnut shells:* White cottons and linens, javelle water (liquor sodæ chlorniatæ), warm chlorine water, concentrated solution of tartaric acid. Coloured goods or silks, chlorine water, diluted according to the tissue and its colour, each application to be followed by washing with water. *Tar, axle grease:* White cottons and linens, soap, oil of turpentine, and water, each applied in turns. Coloured cottons and woollens, first, smear with lard, rub with soap and water, and let it stand for a short time; then wash with oil of turpentine and water, alternately. Silks the same, using benzine instead of turpentine, and dropping the water from a certain height on the under side of satin. Avoid rubbing.—OBERHOF.

[32415.] — **Compressed Air - Chamber and Pump.**—I think "J. H. S." should really consult a maker, because his question involves the expenditure of so much time that it is scarcely likely any private individual would make the requisite calculations. A piece of lap-welded pipe, with proper ends, would be strong enough to resist 60 atmospheres; but I could not say that it would be the lightest metal of which to make the chamber. The pump will obviously have to be very strong, and should perhaps be a piston pump, with an accurate barrel.—J. T.

[32417.]—**Gilding Frames.**—The iron should be cleaned—preferably by pickling—and then painted with oil gold size. When that is tacky the gilding will proceed in the ordinary way.—ROMUS.

[32422.]—**Inlaying.**—An ordinary steel or iron saw frame, or else a machine; but the cut is made on the bevel, so that the upper surface of the veneer is slightly wider than the underneath surface.—ESSAR.

[32426.]—**Sel de Verre**—Is the scum on glass pots, called glass gall, or sandiver—a corruption of sel de verre.—ESSAR.

[32429.]—**Bicycle.**—To answer the question of an "Enthusiastic Scot" would mean to advertise a maker. I do not think he could do better than write to one of the bicycle-makers who advertise in your columns, and tell him he wants a good roadster. Then, if he will remember that price invariably depends upon quality, he will, I doubt not, be suited.—ORTHOS.

[32432.]—**Buttons made of Bone.**—I expect it is vegetable ivory that you mean.—TELESCOPE TELE.

[32438.]—**Tramway.**—There are tramways where longitudinal and transverse sleepers are used, and in such cases concrete may be dispensed with, provided the road is well drained. If water is likely to lodge beneath the sleepers they must be carried on a solid foundation of concrete, or the supporting gravel will speedily be washed away.—A. P. G.

[32442.]—**Heating Glue.**—No doub
or rotten glue in your pot. I have fo
you say. Keep the pot clean, and don
get too stale without putting fresh in.
TELE.

[32446.]—**Rusty Machinery.**—Tl
this query can only be given on inspe
rust-holes are in parts where there is l
machinery would, of course, be of u
much has to be taken off to get rid of
price would be the offer. Why not ca
—E. P. B.

[32446.]—**Rusty Machinery.**—It
whether the bearings are in order. I
that they could be made up again.
might be used again if they are no
away. Cannot give a proper opinion
seeing them. You could get a great d
off by soaking in oil.—TELESCOPE TE

[32447.] —**Electrical Indicator.**-
A. A. Watkins', reply to "An Old Re
gives a very ingenious and easily arr
doing what is required; but it seems
unnecessary trouble and expense to fit
board with mercury cups. Why n
annexed plan, which is less likely to ge
and much simpler? Fig. 1 shows
board with the two brass strips, E F a

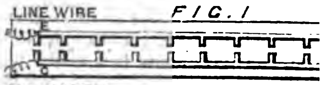


FIG. 1

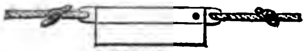


FIG. 2

SIDE VIEW

instead of the mercury cups pieces
project part way across the board, oth
the other strip projecting to within, s
the first. The projecting brasses woul
if made of wire in the form of a sta
being driven through holes drilled in t
at the required pitch, and the other
wood—they would serve to hold the
One strip might be plain, and the "
nector" always sliding along it wo
contact whenever it touched the wire s
shows two views of "current connec
fig. is drawn to scale). This will expla
pulleys may be fixed upon the board at
should be so arranged that a slight pre
made on the top surface by the "curre
so as to insure a good contact, an
friction will keep the surfaces bright.
should be covered, or inclosed in a b
the brass from the weather.—C. J. BR

[32447.] — **Electrical Indicator.**
oblige by correcting a slight mistake
positor in my answer to query 3244
Indicator"? At page 147, on the fifth
top, for "board" read "hand."—A. A

[32453.]—**Air-Pump.**—Any air-pu
provided it is large enough.—S. M. P.

[32457.]—**Steam Boiler.**—The pro
will entirely depend on the quantity
quired. Sufficient will flow through l
a lot of work; but if there is "no
gauge when all the taps are open, it mu
there is not sufficient fire in the fu
steam escapes. No one can give a
without more definite details.—J. T. E

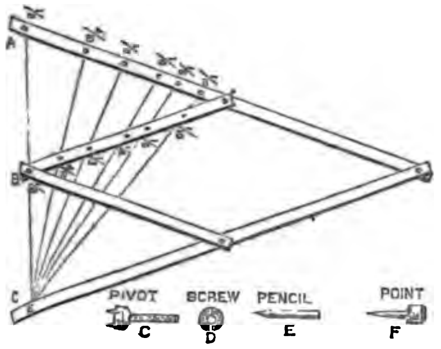
[32504.] — **Gong Buzzing.** — Mau
"Endymion." The gong is not crack
to say. I thought of testing for a cr
of hot water, and found a ticket recor
had been gummed on the inside, b
become partly detached. On remov
gong sounded clearly, and continues
the benefit of others possibly it is wo
in your columns that so small a thing
gong.—JOHN ANDERSON.

[32547.]—**Railway Rates.**—Has "
lute proof that the rates charged to th
facturer are lower than those charge
same weight and to the same station
may be able to obtain it, and send to
with any particular consignments he
away, and demand a reduction, or he
a quotation of any rate, and so chec
made to him.—R. W.

[32549.]—**Photo Lens.**—The lens i
I think, a half-plate; diameter of g
back focus about 6¼in.—very short
focus—that is, in comparison to others
that I have seen. It is a double combin
lens (not view), and marked "Ro
Inside the usual front hood is another,
aperture of 1¼in., and can be taken ou
I see that another reader has adopte
plume of "Perplexed Photo." In futu
and trust no one else will appropr
CYMRAEG.

[32565.]—**Pantagraph.**—It consists
wooden staffs of different lengths, two
divided proportionally on their lower
sketch, C is the pivot which fixes the i
a table or drawing-board, which m

mooth and level surface; F, an ivory point, serves o follow the outlines of the design to be operated pon; E, a short pencil, which reproduces the esign in exact copy, enlarged or reduced; D, a tiny crew, serves to fix nonius to the divisional points. Vith the pantagraph represented in the sketch a esign can be copied, same size or enlarged, pro- uced in the proportions of 1-2, 4-10, 1-3, 1-4, 1-5, nd 1-10. The original to be operated upon, and he paper of the required size to receive the copy, are xed with drawing-pins. If the design is to be opied same size, the pivot is inserted in *c*, the point



in *a*, the pencil in *b*. The right hand traces with the point the lines of the original, and the left hand keeps, with a very slight pressure, the pencil to the surface of the paper on which the copy has to appear. To enlarge a design to double its proportional dimensions, the pivot is placed at *a*, the point at *c*, and the pencil at *b*. To obtain enlargements or reductions in other proportions, the pivot is fixed to the divisional number on the left long branch of pantagraph and the point respectively; the pencil is placed at the divisional number on the left-hand short branch of pantagraph.—J. J. A.

[32569.]—**Bisulphite of Lime.**—It seems to me that "Gamma" knows less about bisulphite of lime than "F. R. M. S." does himself. It is prepared by passing sulphurous acid (evolved by the aid of heat from a mixture of charcoal and sulphuric acid) through water in which lime is suspended. It is in reality a solution of sulphite of lime in sulphurous acid.—W. H. K.

[32569.]—**Bisulphite of Lime.**—This chemical is made by passing sulphurous oxide through milk of lime. The sulphurous oxide is made by boiling sulphur and sulphuric acid together. The specific gravity of bisulphite should be 1·070. It has never been obtained in a dry state, but is always dissolved in sulphurous acid.—FERRUM.

[32576.]—**Dilapidations.**—I send further particulars of my case. The covenants of the lease say, "well and sufficiently repair, uphold, support, paint, glaze, yield up, in good and tenantable repair, reasonable use and wear excepted, all manner of needful and necessary reparation, cleansing and amendments. Lessor's agents to view the state of repair any year during the said term." I have always understood that the lord of the manor was the ground landlord. The house is well kept in repair, all rots and decays being made good, and has been painted inside and out, papered, and whitewashed. They have now sent a surveyor over the house and sent in a list which ignores all that has been done. The object is to harass and wrench the lease out of my hands, I believe. Can they make me do it over again? Could they make me, under the covenants which I have copied, take down brickwork which is out of the perpendicular? I shall be glad if some correspondent who has had experience in dilapidations will give me advice, and explain the meaning of "yield up in good and tenantable repair, reasonable use and wear excepted." The house has been built 87 years out of 99.—A POOR LEASEHOLDER.

[32593.]—**Boiler Incrustation.**—A most inexpensive remedy: Take two bushels of spent oak bark from the tanner, and boil it in the same amount of water for an hour or so. I find ten gallons of this infusion pumped into my three boilers once a week has kept them in good order for years. They are 30ft. × 7ft., and work eighty hours per week.—RATHMONA.

[32598.]—**Partial Greyness.**—"R. N. P.'s" recipe for preventing grey hairs by stimulating the scalp is not one which can be used with safety. On the contrary, eau de Cologne and cantharides will turn dark or light or any colour hair grey. Cologne, being composed of alcohol, must surely bleach dark hair grey, not immediately but gradually; and certainly washing the scalp with soap and water is by no means advisable, as soap has a great tendency, combined with water, to dry the scalp. If grey hairs appear in old or young, the scalp should not be brushed much, if at all. The hair should be kept cut short, and the head kept cool, and skin constantly moist, so that when heat comes through the exercise of the mind it consumes the moisture applied, and not the nutriment which is supplied naturally.—CONSTANT READER.

[32643.]—**Oxide of Hydrogen.**—The theory of the formation of peroxide of hydrogen is simple, but the operation when practically carried out involves many difficulties. The following is the process of manufacture:—Saturate some peroxide of barium with water in a mortar until a somewhat liquid paste results. Add to the latter, by small portions at a time, a mixture of one part of ordinary hydrochloric acid and three parts of water, stirring the mixture assiduously with a glass rod. The peroxide of barium is decomposed, and chloride of barium results, but no gas escapes. The decomposition is expressed as follows:—

$$BaO_2 + HCl = BaCl + HO_2.$$

As soon as a sufficient amount of hydrochloric acid has been added to saturate the baryta, small successive portions of sulphuric acid are poured in, by which treatment sulphate of baryta is formed and precipitated, leaving the supernatant liquor a mixture of hydrochloric acid and peroxide of hydrogen, as in the following formulæ:—

$$BaCl + HO + SO_3 = BaO\,SO_3 + HCl.$$

Sulphuric acid is now cautiously added, care being taken not to supply it in excess. Sulphate of baryta is separated by filtration through a cloth, and a liquid is at length obtained strongly impregnated with peroxide of hydrogen. This liquor is to be mixed with more peroxide of barium, and the operations already described repeated until a fluid strong in peroxide of hydrogen remains. Sulphate of silver now being poured in, chloride of silver deposits, and sulphuric acid re-dissolves in the liquor.

$$AgO\,SO_3 + HCl = AgCl + SO_3 + HO.$$

Finally the sulphuric acid is precipitated by a solution of baryta, added by successive small portions in such a manner that no more than the exact amount required for decomposition may be poured in. The liquid is once more filtered and evaporated under the receiver of an air-pump containing a dish of sulphuric acid. By these complicated operations, which I have partly taken from a work on chemistry, "Constant Reader" may be able to make peroxide of hydrogen quite pure, and in a high state of concentration.—GAMMA.

[32643.]—**Oxide of Hydrogen.**—Solution of peroxide of hydrogen may easily be obtained by triturating a fragment of peroxide of barium (about the size of a pea) with some water, adding to it, while stirring, a mixture of about 30 cc. hydrochloric acid and 120 cc. water. The solution keeps a long time without suffering decomposition. In default of peroxide of barium, impure peroxide of sodium may be used instead, which is obtained by heating a fragment of sodium in a porcelain capsule until it takes fire and letting it burn.—THEODORE EVANS.

[32653.]—**Microscopic Photo of Bank Notes.**—If Mr. Lancaster or any one else will send seven stamps to the London Stereoscopic Company, 54, Cheapside, London, they can have a carte de visite returned of two £10 notes, with the words "Ten-or notes preferred to those of Sims Reeves." They are very well done, and are rather larger than the one that I did. They are marked copyright. I think if the Bank of England were to see after this we should soon know whether it was right or wrong—at any rate, I do not see why I should have my negative taken away while others print them by hundreds.—OXYGEN.

[32658.]—**32in. Focus.**—The best thing to do with the telescope is to remove present object lens and get an achromatic one, and an astronomical eyepiece, then you will make it into a fair telescope. As it is evident from your query that the tubes are good ones you can, if you like, use the single lens for eyepiece, but it will give a little colour, and will not define so well as an astronomical eyepiece. The whole of the lenses for eyepiece and object-lens would cost you about 7s. This will enable you to tell whether it will pay you or not to alter it.—W. J. LANCASTER.

[32662.]—**Violin.**—Spohr's "Violin School" is a first-class work. Its cost is about 30s., but it is really a good violin tutor. A less expensive work, and also a good one, is Loder's "Violin School." It costs about 12s. I give the prices from memory, but the cheaper works sold at a shilling and eighteen pence are, as a rule, to be avoided, as some of them contain much that is mere trash, while others are not sufficiently progressive, jumping, within the limits of a few pages, from simple and suitable exercises to those that would require a Paganini to perform them.—CLYDE.

[32665.]—**Siphon.**—You can make a siphon, with some trouble, to work easily, if you want to use it for acids, &c. The way to do it is to have a siphon of the ordinary form, but having a piece of glass tubing fused on to the long leg near the top. This piece should be about 2in. long; then get an ordinary thistle funnel with a stem about 4in. long, and connect the two tubes with a piece of indiarubber tube, and have a pinch tap connected to indiarubber, so that you can stop the flow when required. Having all in position fill the funnel with the acid, then open pinch tap, and allow the liquid to flow into long leg until filled, then close pinch tap, and the fall of the liquid will pull the other over. Another and simpler method of starting fluid is, when using a bottle, to cover the neck, with the exception of a tube held in the hand, through which, when you want to start the funnel, you merely blow into bottle; then the fluid rises into siphon, and runs over into long leg.—W. J. LANCASTER.

[32665.]—**Siphon.**—There is no siphon which starts into action on the fluid reaching a point lower than the bend.—GAMMA.

[32666.]—**Heart.**—Thanks to "Theo Izod" for his very gentlemanly reply. Would he kindly say if he thinks electricity in any form would be beneficial? I have had medical advice, but have received no benefit. Symptoms are: pulse small, veins apparently empty, coldness of extremities, eyes bloodshot, a red ring round top of finger-nail, and incapable of bodily exertion, all the result of mental oppression.—W. BAMARD.

[32667.]—**Telephone.**—The magnets must be quite hard before they are magnetised, which means that the bars of steel must be heated to higher than a red heat, and cooled by being plunged into cold water or oil (I prefer the former); then clean them with emery paper, and magnetise by moving each half alternately along the two poles of the magnet; or, if you have a magnet large enough, lay the bar across from pole to pole, and rub from end to end with a turnscrew, or any other tool, some twenty or thirty times. This you will find will make good magnets of your steel.—W. J. LANCASTER.

[32671.]—**Flexible Stamp.**—One ounce of glue, one ounce of treacle, one ounce of glycerine, half-ounce of red ochre. Soak the glue in cold water, and before adding the glycerine.—ALBERT SMITH.

[32673.]—**Tool for Turning Brass.**—There are a number of tools used for turning brass in the lathe, among them being right hand, left hand, planisher, cutting-off tool, &c., but the easiest way for you to do would be to get a set of tools already forged, then make up anything else you may want. If you get the above and a round nose burnisher, a few milling tools, &c., you will be able to do some turning. Of course, there are screw tools, and a host of others you will want.—W. J. LANCASTER.

[32676.]—**Cooking by Gas.**—The time to cook by gas seems to be about the same as with a range, and, of course, the boiling must be the same time, with this exception, that the gas stove cooks so regularly, and in regard to boiling you can regulate the supply of gas so as to have a simmer, or to boil at any speed. I much prefer meat cooked in a gas stove to meat cooked before a fire—in fact, we never use the fire now.—W. J. LANCASTER.

[32678.]—**Dyeing Goat's Hair Black.**—To "J. W.," DUBLIN.—Boil ¼oz. of chips of logwood in a pint of soft (rain) water for 5min., take a soft brush, and apply the water in which the logwood was boiled upon the hair which is to be dyed. When thoroughly done, and while wet, apply the following solution:—1oz. of green vitriol (or so-called copperas) in ½pint of water. This solution must be applied whilst the first is wet. If darker shade is wanted, more logwood must be used.—CONSTANT READER.

[32680.]—**Foul Closet.**—Will "J. H. S." answer the following questions? I may then be able to help him. Is the closet of the sort known as a pan water-closet, or a sanitary? Upon what part of the closet was the air-pipe fixed, what are its dimensions—*i.e.*, diameter and length—and what is it made of? Finally, are the joints of the soil pipe gas-tight? If they are not the sooner they are made so the better, especially when connected with a tidal river.—G. L., Southend.

[32680.]—**Foul Closet.**—Perhaps the trap is imperfect, or a joint in the soil-pipe or drain has given away. Have soil-pipe and drain from w.-c. downwards closely examined. The air-pipe to roof is a good plan; it allows the foul air to escape, which at times of extra pressure would be forced through the water in trap, and so cause a bad smell in room.—J. A. P.

[32680.]—**Foul Closet.**—From the description given of the position of the closet, near the fire-place, I am not at all surprised to hear that the smell continues, even after the plumber has done probably all he can do to remedy the nuisance. The very unpleasant smell will probably be found to come from a fungus under the flooring, caused by the sewer gas, and propagated by the moisture and heat. I knew an instance some years ago, when a gentleman spent a considerable sum to get rid of the "stink," but could not until after the chamber floors had been examined (and under which the fungus was very generally spread), and to a large extent re-laid, although some months previously the water-closet had been pulled out and thrown amongst lumber. So long as the fungus continues the smell will also, in spite of any amount of ventilation.—THE YORKSHIRE YEOMAN.

[32681.]—**The Rhine.**—I have passed up and down the Rhine in different seasons, and I dare say that the beautiful scenery there at any time offers ample enjoyment for the traveller. I would prefer the spring; if not the ripe grapes on the mountains in the month of September would have more attraction than the fresh green hills. There are many small quiet places with attractive surroundings. I would recommend you to embark in Cologne (Cöln), go up the Rhine to Mannheim, choose your place en passant, and return to the place selected with another steamer. Heidelberg, near Mannheim, on the Neckar, is, perhaps, one of the most attractive places. St. Goar, between Coblenz and Mainz, is a nice quiet little place. German money will be required, and I consider Hamburg the best place to procure same; you will there get more than the value of English money in German money. About the cheapness I will only remark that an Englishman in Germany always is considered to have plenty of money, and you will likely be charged more in any place than a—DANE.

[32681.]—**The Rhine.**—First of all, a little knowledge of the language is indispensable, as in the quiet valleys of the Rhine and Moselle an interpreter can scarcely be depended upon. Secondly, fix upon a certain place, and proceed there direct, stop until tired, and then take a tour up or down the Rhine, as the case may be, stopping at those places that are worth seeing, and hurry home before the end of August. The best—that is, the warmest weather, is from the latter half of June to the latter half of July or the first half of August. By getting about two pounds changed into German money, you will do well, but take your cash over in gold (not paper money), as you will then gain about 2½d. to 3d. in each pound. I know many a nice quiet valley on the Rhine or on the Moselle, and can recommend some of them if "S. T." will say what scenery he prefers.—P. T. OTTO.

[32682.]—**Telephone.**—You cannot work well with an earth current; better have double-line wire, this always works well; besides, you are not so subject to other currents when using double-line wire as when you use earth currents.—W. J. LANCASTER.

[32682.]—**Telephone.**—The connection between copper wire and visiting card must be bad. Solder it on, and I have no doubt you will then succeed. An inch or two under ground will be sufficient to answer.—C. O. G.

[32683.]—**Legal.**—I think C has a remedy against B, because he, being a trustee, is bound to manage the trust property for the benefit of the person entitled in remainder as well as of the tenant for life. If B will not yield to reasonable complaints, and requests that he should keep the property in repair, C's remedy may be found in an action in the Chancery Division of the High Court of Justice for the administration of A's estate, and, if thought proper, for the removal of B from the trusteeship. At the same time, C and all legal querists should recollect that in answering their questions as to the course to be pursued we can only consider the one or two facts before us, and that a consideration of the whole of the circumstances might entirely alter our view, not of the law, but of the way of enforcing it.—SPERANS, Lincoln's Inn.

[32685.]—**Camera Obscura.**—In this arrangement, as you have it, you have succeeded in magnifying a small picture. The object should be to condense a panoramic view. Your apparatus should resemble a photographic camera with the mirror inside. I have not examined any of these constructions, but you must have a lens on the outside to condense the picture on the mirror, and another inside (as you have it), to enlarge the image to the size of the table.—Os.

[32685.]—**Camera Obscura.**—The upper arrangements of camera obscura are good, with the exception of the mirror; this should be out of ⅛in. patent plate—then the double reflection would not be so easily seen. But better than this is a prism. This gives no second image at all, and gives a much more perfect image than the other form. The table should be a deep concave, and the cover should be whitewashed frequently. The lens should be of a meniscus form, and about 8in. diameter, and 6 to 7ft. focus, not more, then the lens should be fitted into a frame, which should slide easily in a groove in E in your sketch, so that it could be focussed, and the table also should be fitted with a screw like a music-stool; or you can have four cords attached to the table around the outside, and then have four pulleys at the top of the building, and counterpoise weights outside, so that the table may be moved in any direction.—W. J. LANCASTER.

[32686.]—**Ferrotype Plate.**—Draw the diagonals, A G and D B, intersecting and bisecting in C, the centre of the rectangle, from C draw a line, ⊥ A B, meeting A B in *a*, bisect A *a* in *b*, from *b* draw a line, ⊥ A B, to meet the line A E in *c*; from *c*, centre, and *c b*, radius, describe an arc to touch the lines A B and A D, from C; through the centre, *c*, draw a line to meet the arc in *d*. Lastly, bisect C *d*, and the half of C *d* will be the length of the radius to each of the required circles.—S. J.

[32686.]—**Ferrotype Plate.**—The solution of this problem is very easy; "Cyanogen" is quite right in the form in which he states it. Given a rectangle to find the position of the centre of a circle, which shall touch two adjacent sides and pass through a given point. In the case put, this point is the intersection of the two diagonals of the rectangle. Referring to the figure given with the question on p. 150, it is quite clear that the centre of a circle which is to touch the sides, A B and A D, must lie on the diagonal, A E. Place the letter P to indicate the point required, and draw perpendicular P Q and P R to A B and A D respectively, and join P C. Then the problem is to find P, so that P Q, P R, and P C shall be all equal to each other. Now, if we take A as the origin, P Q and P R will be respectively equal to the co-ordinates of the point P; and the co-ordinates of C are $\frac{17}{8}$ and $\frac{13}{8}$ respectively. Put P Q = P R = x; and if for convenience we take ⅛th of an inch instead of one inch as the unit of length, we get—

$$PC = \{(17 - x)^2 + (13 - x)^2\}^{\frac{1}{2}} = x,$$

which, by reduction, comes to—

$$x^2 - 60x = -458,$$

whence

$$x = 30 \pm 21{\cdot}0238 = 51{\cdot}0238 \text{ or } 8{\cdot}9752.$$

Dividing by 8, to reduce the unit again to inches—

$$x = 6{\cdot}3779 \text{ or } 1{\cdot}1219.$$

The former gives the position of the centre of the circle, H C H; the latter gives the position of the centre of the circle, A F C. If from the point A "Cyanogen" measures 1·1219 inches along either A B or A D, and then with a set square at that point draws the perpendicular, P Q or P R, the point where that perpendicular intersects A E is the point he seeks. The same distance measured from G will give him the other circle, G E C.—F. B.

[32690.]—**Size.**—Macerate your cuttings in water to incipient putrefaction, then wash with solution of sulphurous acid; add alum and boil.—A. SMITH.

[32691.]—**Marine Engine Cylinders.**—To "J. B. F."—The advantages of using compound cylinders in marine engines, instead of high-pressure cylinders worked expansively, are so many that to dwell at any length on them all would take up more space than I have, I am afraid, at my command. It may suffice at present to mention one or two, leaving the others for a future occasion. In the first place, I presume that "J. B. F." means by high-pressure cylinders those of the non-condensing type. If that be so, and if high-pressure cylinders were used, the surface condenser would be dispensed with altogether. Now, I need not inform him that salt-water contains above 30 per cent. of saline matter, which settles at the bottom of marine boilers, and which, if allowed to accumulate, would render them useless. This matter is discharged into the sea through the "blow-off" pipe; but in being so discharged a quantity of heat is given off, which, of course, must be made up as often as this process takes place. More cold water must, therefore, be pumped into the boiler to take the place of that which has already been discharged. This, in its turn, deposits more salt; but with the surface condenser this blowing off process does not take place half so often as it otherwise would. The condensed water being free from salt is retained in the hot well and pumped back into the boiler; hence it will be evident to "J. B. F." if, on commencing a voyage the boilers were filled with fresh water, that that water would last the whole of the voyage, provided there were no leakages; but as there are always leakages a little salt water (unless filters are used) must be pumped back into the boiler. This, then, certainly means a great saving of fuel, and were it for nothing else low-pressed cylinders would be preferred to any other. Compound cylinders are still more economical than low-pressed ones, and if they do take up a little more of the engine-room yet it must be remembered what is lost in engine room is more than gained in boiler space, as it takes a much less boiler to drive a compound engine than it does either a high or low-pressed engine of the same power. In the compound engine the heat which is lost in passing the steam from the high to the low-pressed cylinder is so minimised as not to be worth considering, as most of marine cylinders of whatever type have a jacket, or cavity, between their inner and outer shells, through which steam is continually circulating. They are also coated with felt or horse-hair and wood, which, being non-conductors of heat, keep the cylinders so warm that the temperature varies but little.—C. M.

[32695.]—**Loco. Notch.**—Locomotive enginemen notch their engines back when running to allow the steam to work expansively—that is, the steam is not allowed to follow the piston the whole length of the stroke; but on the contrary, the supply from the boiler to the cylinder is cut off by means of the valve gear when the piston has only travelled a portion of the stroke, and the steam thus shut into the cylinder expands like a compressed steel spring against the piston for the remainder of the stroke.—C. J. BONSER.

[32696.]—**Magnets.**—To MR. LANCASTER.—I thought I had written all this before, but, probably, through always trying to be brief I have been too brief. However, the steel must be well-hardened and tempered just to a straw; then magnetise by laying the bars across the magnet, and rubbing in direction of length with the keeper, or with any iron or steel tool, until the magnet is as strong as you want it.—W. J. LANCASTER.

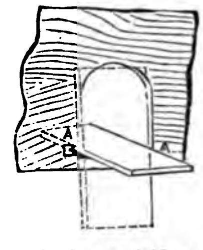
[32703.]—**G. W. R. Engines.**—In answer to "Capolus," there is no such engine on the G.W.R. as the Flying Dutchman, and even if there was, it could not go for 25 years without any repairs to its boiler, and no locomotive could go for 20 to 25 years without any attention to its boiler. The Bristol and Exeter express that leaves Paddington at 11.45 is known as the Flying Dutchman, and is drawn by the following engines as far as Bristol, from whence the old B. and E. engines take it on—Balaclava, Estafette, Hirondelle, Great Britain, Prometheus, Rover, Sultan, Warlock, Timour, and Tartar—and that is the only reason I can imagine for your supposing that there was an engine of that name.—TAMERLANE.

[32703.]—**G.W.R. Engines.**—Surely the person who makes this statement has got but a remote idea of the durability or strength of locomotive boilers. Perhaps he is confusing them with stationary boilers, which work generally under the pressure of 80lb., and are not continually being oscillated by bad roads. Even in this case it must be an extraordinary boiler to work that period of time, at least without a considerable amount of patching, and a thorough repair. The high pressure of locomotive boilers, the complications for rapid evaporation, incrustation, forgetfulness on the part of attendant, are facts which in themselves contradict the assertion. The age of a locomotive boiler is at the most 14 years, and if the person could only have an inspection at the termination of this period he would say: "I question if I could wear trousers patched like that." The train has obtained the name "Flying Dutchman." There is no engine named after it.—CLARE.

[32704.]—**The Cats and the Pigeons.**—I would suggest that the alighting boards should be secured with hinges, and held in position by a light spring, which would bear the weight of the bird, but which would give way beneath the weight of a cat. The outside board could be connected with another board inside, so that when the outer board was depressed the inner one would rise, and close the aperture. This contrivance could be made in one piece, and weighted with lead on the inside. This would obviate the necessity for springs; or a perch could be used instead of the board, if said perch were fixed at a right angle to the face of the pigeon-house, a cat would have some difficulty in obtaining foothold.—Os.

[32704.]—**The Cats and the Pigeons.**—If W. Wilson, LL.D., will fit a pulley and weight to the alighting-board of his pigeon-house, he will effectually keep cats out of the cote. The weight should be so adjusted as to balance the board, plus the weight of four or five pigeons. The cat probably comes on to the board with a leap; the board drops, and the cat with it, often so alarmed that she makes no second attempt. If the cat gets on to the board from the roof, a series of stout wires, about 18in. long, fastened at one end into a half circle of wood, and nailed on to the wall over the entrance, is an effectual barrier. I have had both the above in operation for years.—N. SIRCH.

[32704.]—**The Cats and the Pigeons.**—If Mr. Wilson will arrange an alighting-board at the entrance of his pigeon-house, which is hinged at each side to the wall (A A in Fig.), and projects as much into the house as it does outside, and then attach lumps of lead to the inside half which would more than counter-balance the weight of a pigeon standing on the outside, and yet would be insufficient to balance the weight of a cat, I think he would find that they would be unable to enter, as when a cat alighted on the board it (the board) would fall down, yielding to her weight, and so she would slip off. But, supposing, by any chance, she held on, still she would be unable to enter, as the inside half of the board would cover the entrance, as shown in the Fig. by dotted lines.—A. A. WATKINS.



[32704.]—**The Cats and the Pigeons.**—If W. Wilson, LL.D., will attend to the sketch he will have no need to be afraid of cats. The hole that the pigeons go in at should be about 4½in. wide, and 6in. long, or 6in. high; a board 14in. long is fitted in the hole; in the centre a pair of small brass hinges is fixed under the front of the board, so that the board will drop if a cat jumps on, and it must [illegible] about 2lb. of lead fastened underneath at the [illegible] so that it will stand the weight of a pigeon. If [illegible] wish to know if there has been any cat on [illegible] night, it can be made to bind when it is up, and [illegible] have to be put down in the morning. The [illegible] sketch will be easily understood. Fig. 1, open; Fig. 2, shut; *a*, lead; *b*, hinge.—JACK OF NO TRADE.

FIG. 1

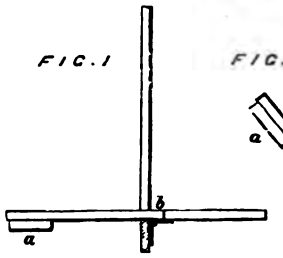
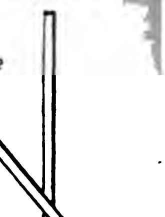


FIG. 2



[32704.]—**Cats and Pigeons.**—I think the correspondent will find the following an effectual cure for cats:—Have the alighting board outside his locker work on hinges, and have another board inside on hinges, so that it will come up and cover the holes from the inside. Have a string fixed on the outside board, passing through an aperture in the front board of the locker, fastened to the [illegible] (A small pulley wheel is best for the [illegible] on.) Have them so balanced that a [illegible] on to the board outside would n [illegible] directly anything slightlier heavi [illegible] board outside would go down in fr [illegible] and in doing so would pull the b [illegible] the holes. Of course the hinges [illegible] opposite ways on the different b [illegible]

[32704.]—**The Cats and the Pigeons.**—If Mr. Wilson will refer to page 48 of Vol. XXII., No. 548, he will find a description and illustration of a plan which I invented when keeping pigeons under similar circumstances. He will see that the principle of the contrivance is to make the greater weight of a cat effect what that of even two or three pigeons would not do. In my case there was only one entrance hole, but it would be easy to arrange for several. No cat ever managed to get in so long as I kept pigeons.—H. G. Moberly.

[32704.]—**The Cats and Pigeons.**—Is the pigeon-house on a pole or against a wall. If it is on a pole get an old saucepan with a large hole in the bottom and put the pole through it, and fasten 30in. below the pigeon-house. Or you could drive some nails in the post and then point them.—Telescope Tele.

[32705.]—**Electro-Magnetic Engine.**—If you have obtained a method of increasing the power of magnets to such an enormous extent by all means patent it; you will speedily come upon the applications. Assuming that the power of a given electro-magnet exerted upon a piece of iron, say 1,000 of an inch away, is called 10, then by removing that piece of iron to 6in. distance, and, if you can, so increase the power of the same magnet to cause same attraction as in former case when close up, you would then have increased the power of the magnet over 50,000 times, and this is a considerable augmentation of power.—W. J. Lancaster.

[32707.]—**Spectrum Analysis.**—I shall be glad to forward "Cyanogen" a table of spectra, if he likes to send his address to me.—H. Hellewell, Boothroyd-lane, Dewsbury.

[32707.] — **Spectrum Analysis.** — Write to Browning for chart of the spectra, or get a second-hand copy of "Roscoe's Spectrum Analysis." You will find numberless charts of spectra in various elementary chemical works and works on physics, but none containing all the spectra. These you would have to map out yourself, unless you get one of the larger works containing them.—W. J. Lancaster.

[32708.—**Coasters.**—The coasters trading to Plymouth and Cornwall do not "regularly" take passengers, but most of the captains will give you a passage for a moderate remuneration. The vessels are mostly small, being chiefly schooners and yawls. Adye Douglas.

[32710.]—**Organ.**—Plainly a breach of contract, but unattended with any serious consequences, unless the price of "plain metal" and not zinc has been charged. The former being a composition of lead, antimony, and tin, is both heavier and more expensive than the latter. Zinc should have been specified.—Tonometer.

[32711.] — **Faulty Battery.** — You should not amalgamate your zinc plate. See if your connections are now quite clean, and add a little more sulphuric acid; also see the zinc plate don't touch the carbon one.—Albert Smith.

[32711.]—**Faulty Bichromate Battery.**—The reason this ceased to act most likely is, that the liquid was exhausted, which it very soon is. This constitutes the objection to the otherwise nice batteries.—W. S. A.

[32711.]—**Faulty Bichromate Battery.**—The bichromate cell is good for about 40 to 50 minutes, so that if you used it for 2 hours you used it up, and it will require fresh acid and bichromate, then all will be well.—W. J. Lancaster.

[32711.] — **Faulty Bichromate Battery.**—You had far better use a Daniell battery if you wish it to be always in working order, and it would be sufficiently powerful for your purpose. Your cell wanted re-charging with fresh acid or a fresh addition of bichromate.—Os.

[32715.]—**Patent Camera.**—I am rather surprised "Newton" did not send you any particulars as to working with the camera. In the first place the bath is useless; and, secondly, the camera is clumsy. Better by far work in a small tent than in the camera, but to work you will require the following chemicals: Collodion, nitrate of silver solution, developing solution, fixing solution, and transparent varnish—then the process is simple. (1.) Clean plate well, and see that all smears are removed; then plunge into bath solution, leave it there for two minutes then remove, and put into dark slide and expose; afterwards take out of dark slide and develop with developing solution until sufficiently visible to see details just coming; then wash, and fix with fixing solution until clear; let dry, and varnish. —W. J. Lancaster.

[32715.]—**Patent Camera.**—I think the camera must be similar to one I purchased from Newton, of Fleet-street, some 24 years ago. It had below it a japanned tin well, into which were fitted 4 vertical guttapercha baths, to contain, respectively, nitrate of silver solution, developing solution, water, and hyposulphite of soda. On the top was a flat sliding bar, through which passed into the interior of the camera a stout sliding brass rod, having at its lower extremity a clamp to hold the glass plate. The mode of using this camera was as follows:—A piece of ground glass being attached to the end of the rod, the cap was taken off the lens, and the picture focussed on the glass, after which the lens was again covered. A glass plate, having been coated with collodion, now took the place of the focussing-glass, and the door at the back of the camera being closed, by shifting the sliding bar the plate was brought over the bath containing the nitrate of silver solution, and, by means of the sliding rod, plunged into the bath, and allowed to remain in it a sufficient time to be properly coated with iodide of silver. The plate was then raised, and put into the proper position for receiving the picture. When it had been sufficiently exposed the bar was shifted until the plate stood over the bath containing the developer, into which it was plunged. Small windows of yellow glass at the front and back of the camera allowed the progress of the development to be watched, by raising the plate from time to time, without opening the camera, and, when sufficiently developed, it was brought over the water bath, and after being plunged into that, over the hyposulphite bath, in which the picture was fixed. Graduations in the bar and the slide through which it worked enabled the operator to know whereabouts to place the plate. Though this ingenious plan certainly enabled one to dispense with a dark room or tent, there were many disadvantages attending it, which was doubtless the reason why this kind of camera has become quite obsolete. As it would have been fatal to the nitrate of silver solution to allow the brass clamp at the bottom of the rod to touch it, the upper portion of the plate had to be kept out of the solution. Unless the baths were filled to the brim, still more of the plate would remain unacted on by the solutions, and if they were so filled the slightest movement was apt to send the contents of one bath slopping over into the next, or into the tin well, which soon became eaten into holes. I was very glad to give away my camera many years ago. If Geo. V. Barton has taken his lens to pieces, he must be very careful to put the glasses back into their original position. He cannot do better than buy for 1s. one of the cheap treatises on photography, such as that by Jabez Hughes, which will give him all the information he requires upon this and other matters.—G. C. C.

[32717.]—**Water Barometer.**—Procure a barrel to hold say 35 to 40 gallons of water, then get 26ft. of 1in. gas-pipe, and 6ft. of 1in. glass tubing, have a tap well made fitted on to top of pipe, and another at the bottom in the tube; the top tap should be cemented on to the glass tube, and the glass tube well cemented into iron tube, thus forming a tube 32ft. long. Now to fill the tube turn bottom tap off, and pour very gently a stream of water into tube, and continue pouring until the water flows over tap at the top, then turn the top tap off, and turn bottom one on, when the surface of the water will fall until it reads correctly. The tub should be about two-thirds full of water.—W. J. Lancaster.

[32719.]—**Engineer Students in the Navy.**—Candidates must not be less than fourteen, nor more than sixteen years of age. The subjects of examination are:—

		Marks.
Arithmetic		300
English:		
Writing from dictation	100	
Composition	100	
Grammar	150	
		350
French:		
Translation into English	100	
Grammar	50	
		150
Geography		100
Algebra (up to and including quadratic equations)		300
Geometry (first six books of Euclid) ...		300
		1,500

750 marks required to pass.—C. E. K.

[32720.]—**Canvas Canoe.**—The following is the description of one I made a few years ago, cost about £2, but cannot give the dimensions, as I kept no account of it, but "H." will find several good designs in past numbers of English Mechanic; but if "H." wants it for sailing don't forget to have good broad and deep keel. 1. Get a piece of pine the length of keel wanted, 2½ by 4 deep, bottom edge about ¾, then mortise in stem and stern posts, afterwards screw on a piece of iron ¾ wide, ⅜in. thick, along bottom of keel, and up outside stem and stern post; then get 5 or 7 pieces of similar iron; ¼in. thick will do; have holes bored in centre of each, also several on each side of the centre; stretch a line from centre to centre of stem and stern posts, then screw the ribs to top of keel at the centre hole; then bend and shape them according to the design. Be particular that the ribs are the same distance on each side from the centre line, or it won't run true; afterwards get some boards ¼ or ⅜in. thick. If you are near a timber-yard they will soon saw them for you from a deal; then rivet the boards round outside the ribs; don't lap them. The ends of the boards should be let into the stem and stern posts, so that they are flush; then pitch all over outside, and while the pitch is wet strain over some strong sail cloth (I used rick cloth), and tack down close and even all round, and then give two coats of pitch all over outside; when dry put a piece of pine round for gunwale. By pitching first you are able to paint the gunwale, which could not if it got pitched over. The advantage of boarding is that you are not afraid of putting your feet through the canvas. Mine was an open boat; but "H." will not have much trouble to cover it with canvas, and paint it over.—Eldnar.

[32722.]—**Vignetting Ferrotypes.**—Have a vignetting glass in front of dark slide, then expose in the regular way, or make a cotton wool vignetting frame to go inside camera; then expose in the ordinary way.—W. J. Lancaster.

[32722.]—**Vignetting Ferrotypes.**—Direct positives may be vignetted by suspending in front of the camera a large piece of cardboard with an oval aperture. It must be "out of focus," and might be allowed to swing a little. I have not tried this, but have seen it recommended in a photographic journal. Perhaps an ordinary vignette glass might be fixed inside the camera in front of, and at a short distance from the sensitive plate. These, of course, are only suggestions.—Os.

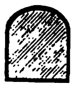
[32724.]—**Canaries.**—Give the canary a bath of tobacco water, but be very careful how you do it. Change the birds into a clean cage and let them have plenty of water to wash themselves fresh every morning. Directly I put fresh water in the cage my birds begin to wash, and I have never known them to have parasites. Put a large china pan (it must be shallow) in the cage. Lime-wash the old cage and put it away for two or three months; at the end of that time give it another coat, and after that has been on a little while wash with soap and water, rinse with clean water and put out in the air to dry. The cages should be cleaned out at least once a week, and the perches scraped and sand-papered.—Telescope Tele.

[32724.]—**Canaries.**—The red parasites which infest birds' cages can certainly do them no good, as they are just as much vermin to them as bugs, &c., are to the human race. I have found that the best way to destroy them is to wash the cage with Condy's Disinfecting Fluid and water (to be had at any chemist's), which certainly does no harm to the birds. I should not advise you to try the insect powders, as they must contain poison in a more or less degree.—Adye Douglas.

[32724.]—**Canaries.**—The small red parasites that infest canaries are most injurious to the bird, which gets no sleep, as the vermin come out at night. If the "Perplexed Photo." will get some Keating's Insect Powder, soak a teaspoonful in a teacup of boiling water, let it get cold, and then dose the bird with showers of it by means of a ray-dispenser, he will soon get rid of the insects. It should be done every day for a week, then stop for a week, and do it again. The corners and cracks of the cage are probably full of eggs and insects. It should be scalded by pouring boiling water over it.—M. Sirch.

[32725.]—**Birds' Perches.**—Round perches are the best. Have several perches by you, and change them every week. Let the old perches get dry, scrape, and sand-paper. That is how I do—then you keep the birds' feet healthy.—Telescope Tele.

[32725.]—**Birds' Perches.**—At one time I kept over a hundred cage birds, most of them canaries. I found the following the best section for their perches, as they have the round part to stand on (as on a branch), but yet had a grip for their feet at the corners. See that you do not allow their nails to grow too long, but cut them regularly or they will hang themselves with their long nails by catching them between the wires.—Adye Douglas.



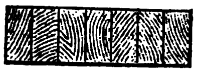
[32725.]—**Birds' Perches.**—Smooth and round perches are instruments of torture. Let "Perplexed Photo." get some twigs of the elderberry tree, varying in size from the the thickness of his little finger to that of his middle one. Give perches of different thicknesses. The bark is rough, but not harsh, and there is a certain elasticity in the perch most grateful to the bird. If "P. P." will scoop out a little bit of the pith at each end of the perch, he may, by examining it in the morning, find hundreds of the red parasites in the holes. A dip into boiling water destroys the vermin, and the perch may be used again.—N. Sirch.

[32728.]—**Machine Oil.**—This should not dry or clog. The adulteration consists in mixing cheaper oils with the dearer. Test with sulphuric—one drop of acid to 20 of oil:—Nut oil, yellowish brown; olive oil, dark yellow; neat's foot oil, dirty brown; tallow oil, dirty white; sperm oil, light red; linseed oil, green. With solution bichromate of potash, nut oil turns brown and lumpy; neat's foot oil, ditto; tallow oil, reddish brown; sperm oil, brownish red; linseed oil, brownish. Fish oil treated with chlorine turns black.—A. Smith.

[32729.] — **Chemistry.** — The carbon monoxide unites with half a volume more oxygen to form carbon dioxide. There is, therefore, one volume of carbon dioxide formed, and one and a-half volumes of oxygen left.—H. Hellewell.

[32731.]—**Fireproof Room for Bank.**—You have an impossible job to do; there is nothing fireproof under the sun. A fire-resisting room may be made with at least a 14in. wall of firebrick well set in cement, standing (if not on the ground) on a groined firebrick arch, with a similar arch over. There may be two doors—one of English oak inside to resist fire, the other a Milner or Chatwood door to resist thieves.—Alfred Tozer.

[32731.]—**Fireproof Room for Bank.**—For a room, say 12ft. wide (any length you like), it may be built in the basement of the bank of 14in. Flemish bond brickwork, with a high pitch arch of the same thickness to form the roof. If the side walls are not backed up by earth or the ends of other walls, to resist the thrust of the arch, especially when anything heavy falls on the top, they must be double the thickness, or a flat roof substituted composed of rolled iron joists 7in. deep, 12in. apart, with 1½in. hard wood laths laid between the bottom flanges, the whole covered with 18in. of concrete. The door should be one of Chatwood's or Milner's best fire-resisting. There should be a grating in the floor leading to the sewer, to carry off the water which would find its way under the door from the engines if the building was on fire. Were it not required to be burglar as well as fire-proof, 9in. timber joists laid so as to touch each other thus :—



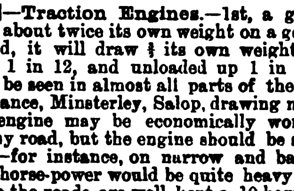
And covered on the top and ends with 6in. of concrete would do, and two 3in. solid oak doors 12in. apart would resist many hours' fierce fire where a common iron door would fail. Unless it is intended to store some chemical which ignites or explodes at a very low temperature, it is not necessary to have any non-conducting material between the walls, but the bricks used should be the best hard stocks, laid in cement. I may add that the plan of laying timber joists close together for fire-resisting floors was advocated many years ago by Mr. Braidwood. The system of securing the joists tightly together, and protecting the underside has been recently patented by a firm in London.—J. L. SAVAGE.

[32732.]—**Traction Engines.**—1st, a good one will draw about twice its own weight on a good level road. 2nd, it will draw ¾ its own weight up an incline of 1 in 12, and unloaded up 1 in 7. 3rd, they may be seen in almost all parts of the country —for instance, Minsterley, Salop, drawing minerals. 4th, an engine may be economically worked on almost any road, but the engine should be suited to the road—for instance, on narrow and badly-kept roads a 6 horse-power would be quite heavy enough, but where the roads are well kept a 10 horse-power would be more suitable. 5th, "Aveling's Locomotive Acts," Spon and Co.—STEAM.

[32734.]—**Attaching Drill Chucks.**—The spindle and chucks are grooved out like a tap used for cutting threads on metal. The thread part is grooved out on the four sides, so that the thread of one fits into the groove of the other, and a slight turn of the chuck tightens it. It does very well for drills of middling size.—TELESCOPE TELE.

[32734.] — **Attaching Drill Chucks.** — This method is perfectly feasible, and would save time, but very little. If not carefully done it might render the screw useless. It is rather difficult to describe without the aid of a diagram. You file away two opposite sides of the male screw, and also two opposite sides of the thread in the female screw, one will then slip into the other without turning, and less than a half turn will secure it; or you might file four faces on the screw, leaving only the corners of the thread. Then cut with a triangular file four notches in the thread of the internal screw. The device would not, I think, be of any practical use, as a chuck is easily screwed on by setting the machine in motion. Its principal use would be in removing the chuck from machines which have no reverse motion.—OS.

[32734.]—**Attaching Drill Chucks.**—I send sketch showing my interpretation of "E. G.'s" description. A is the mandrel, on which the opposite quarters have the thread cut away (something like a screw tap), and B represents the end of the chuck, showing female screw, which has been similarly treated. It is obvious, I think, that A can be pushed into B, the portions of thread on the former passing through spaces of the latter, and vice versâ, and that by giving a quarter turn the chuck will be tightened.—GLATTON.



[32736.]—**Batteries.**—Two No. 2 Léclanché cells would suit your purpose very well, as they give a powerful current, and are easily kept in order. A single battery at one end would answer for both bells, if you put them each in the same circuit with the battery. I shall be glad to give you any further information you may require on the subject of cleansing, charging the battery, &c., or fixing the bells and pushes.—J. HARRIS, C.J.

[32736.]—**Batteries.**—To make a cheap and efficient battery for electric bell, get a quart jam-pot, also a glass cylinder such as used for benzoline lamps, about 4in. by 2½in. Tie a piece of canvas over one end, and place that end downwards in the centre of pot. Get some gas carbon, manage to chip off a piece a few inches in length, make about 1in. of it red-hot, and dip into a piece of melted paraffin candle. When cold, drill a small hole near the end, insert the end of a piece of covered wire, fill up hole with solder, pitch it over, and this connection, if carefully done, will never give out. Put this piece of carbon in the outer space of course, with the wire end up, and pack tightly in with small pieces of carbon the size of peas—no smaller; cut a piece of cardboard to fit in round the top, and run pitch over the cardboard, leaving a small hole for vent. Now get a piece of wood to fit in top of glass cylinder, or, better still, a glass stopper such as are on sweet-bottles. Get a piece of brass or iron tubing or mould of some sort, place a piece of stout iron wire about 6in. long in mould, and pour in melted zinc to cast a rod as long as required. Bore a hole through glass stopper with drill and turpentine. Now put about 2oz. of crushed sal-ammoniac in the inner cell, fill about two-thirds with water, and place the zinc rod in the solution; slip the glass stopper over the wire in rod. The stopper will then cover up the cylinder, exclude dust, and prevent evaporation. Then solder a piece of copper wire to the iron wire, and a useful cell is the result, costing less than a shilling. I have three of them—made in August, 1876—to ring three bells many times a day. They have only required refilling with sal-ammoniac on one occasion. The first cell I ever had was purchased for 3s. 6d., and the connection failed in two months. Since then I have made my own, as above. One battery is sufficient for two bells; I suppose you do not wish to ring both at once. I think the nearer battery is to bell the better. The touch may be 50 yards away, or further perhaps.—C. O. G.

[32738.]—**Butterfly Catching.**—I think "Young Entomologist" could catch plenty of red admirals and peacocks at Chislehurst, and even in the parks and gardens in London. If he should be so lucky as to catch the swallow-tail will he kindly let us know through these pages? Let him keep camphor in his drawers and boxes to prevent them being eaten up after he has set them out and they are dry.—AN ENTOMOLOGIST AND M.S.A.

[32739.] — **Microscopical.** — To RANDOLPH RICHARDSON.—The rings should not be pure tin; I find mine were an alloy of zinc. 10 grammes of gelatine should be mixed with 25cc. of distilled water, and about 5 grammes of copper sulphate should be used. The action is as follows:—The dilute acid acts upon the zinc cell, and causes it to give off hydrogen, when in its nascent state decomposes, precipitating the copper in the metallic state in the gelatine; it is best done with silver salts.—RANDOLPH RICHARDSON.

[32741.]—**L. C. and D. R. Engines.**—The L. C. and D. have at present 6 tank locomotives of No. 62 class, numbered respectively from 59 to 64. All of them are rebuilt from old types. No. 59 was rebuilt at Loughedge Works, Wandsworth, in 1878, and was formerly named Sondes, made at the same works in 1865. No. 60, rebuilt in 1876, was named Sittingbourne. Nos. 61, 62, 63, 64, were rebuilt either in 1876 or 1877. I do not possess the dimensions of No. 162 class of express bogie engines; they have been frequently asked for, and I shall be glad when they make their appearance.—G. L. P.

[32748.] — **Transparent Paper.** — Would not castor oil be better?—M.S.A AND M.A.M.S.

[32748.]—**Transparent Paper.**—I take the inclosed from a back number:—"Dissolve a given quantity of castor oil in one, two, or three volumes of absolute alcohol according to thickness of paper. Apply with sponge. The alcohol evaporates in a few minutes; the paper then is ready for use. The opacity is then brought back by immersion in absolute alcohol."—X. X.

[32750.]—**Circular Saw.**—Make a box of wood about ¾in. thick, hinge a cover to it, let the under-side of it come level with upper part of sliding cylinder of poppit, bore a hole through bottom of box, bolt it down with a screw passing through lathe bed; let the saw cut its way through the cover, place the saw on a turned mandrel, and screw it firm, place a carrier on it and mount it between two centres.—M.S.A. and M.A.M.S.

[32750.]—**Circular Saw.**—I have a small circular saw, which I drive in the lathe in the same way as a piece of iron for turning. For a bench I have a rest flat at the top, to which I screw two pieces of sheet iron, leaving a space between for the saw to work in; and at the other end of the pieces I have a block of wood screwed, of the same height as the rest holder, to keep them level. I have also slots cut on one side for working a guide in, which is held by thumb-screws below. I find the above plan to work very well for small jobs.—A-WHAT.

[32754.]—**Mercury.**—A small quantity of mercury can easily be distilled in a small retort at a slow heat. It will need careful watching.—FERRUM.

[32757.]—**Mining.**—The following formula will show how to obtain "the resistance equal in both directions," and verify the examples given:—

$$F\left(\frac{L - E}{L + E}\right) = x.$$

F = Friction; L = full load; E = empty load; x = gradient. Your second question I can't answer. —ROSCOE.

[32767.]—**Safety-valve Question.**—"A Farmer" would get a pressure of over 131lb. per square inch if he were to place the 32lb. weight as stated, for $\frac{32 \times 24}{2} + 28 = 412$lb. total pressure on valve, which, divided by area of valve, = 3·1416 inches = 131lb. At 24 inches distance from a weight of 13·375lb. (13lb. 6oz.) will be cor 3·1416 × 60 = 188·496lb. total pressure requi

$$\frac{(188{\cdot}496 - 28) \times 2}{24} = 13{\cdot}375\text{lb.}$$

If the weight of 32lb. has to be used, then fo distance from fulcrum : $\frac{(188{\cdot}496 - 28)}{32} \times 2 =$ or, say, just 10 inches.—A. W. E.

[32767.]—**Safety-valve Question.**—I thi Farmer" will find the following worked out c for him:—

$$\begin{array}{rl} \cdot 7854 & \\ 4 & = 2^2 \\ \hline 3{\cdot}1416 & = \text{area of valve} \\ 60 & \\ \hline 188{\cdot}4960 & = \text{pressure on valve} \\ 28{\cdot} & = \text{weight of valve and lev} \\ \hline 12\ )\ 160{\cdot}4960 & = \text{pressure to be overcom} \\ \hline 13{\cdot}3746 & = \text{weight;} \end{array}$$

∴ 13lb. 6oz. is the weight wanted.—J. SMIT

[32771.]—**Wood Lice.**—"A. G." had bett perly ventilate his cellar, and then thoroughl wash it all over, mixing with the lime-wash sulphuric acid. By this means he will ge these pests.—C. J. BONSER.

[32772.]—**Decayed Finger Nails.**—I sh vise "A Constant Reader" to consult doctor, as there is, evidently, some disease bones of his fingers.—C. J. BONSER.

[32778.]—**Temper of Taps.**—The best temper taps is to heat them to a red heat, a plunge into water. This process hardens the soften them dip in oil, and place them in a until the heat causes the oil to take fire, then diately dip again into water, and they will b for use.—C. J. BONSER.

[32778.]—**Tempering Taps.**—I have te lots of taps by reducing the temper from the l then holding the tap inside a red-hot wroug collar about 1¾in. × 2in. long, commencing the tap at the largest end. On working it little you will get a good straw colour all ov dip in salt water.—X. X.

[32780.]—**Snider Rifle.**—1. Tow or cotto and Rangoon oil. 2. Smoke, then rub over w seed oil (boiled), so as not to disturb the blac let the oil dry. 3. "The Rifle, its Theory an tice," by Arthur Walker, Westminster: Nichols and Sons, 25, Parliament-street; or on Rifle-Shooting," by Captain Heaton; L Longman, Green, Longman, Roberts, and 1864. But there may be a later edition. the second edition.—A-WHAT.

[32780.]—**Snider Rifle.**—There should be culty in keeping the rifle clean. A wooden c rod, some flannel, and a little good oil, being materials required. The best oil I have used goon oil; but if it cannot be got some of the oils, mixed with a little petroleum, will do flannel may be conveniently cut in circular about 2½in. in diameter. After using the rifl it as soon as possible. If "Caw" can obt *Volunteer Service Gazette* for March 10, 1 will find methods given for blacking rifle For my part I prefer blacking mine with the from burning camphor, which gives a splendi black. The "Rifle Shot's Manual" (price published by Clowes and Sons, 13, Charing contains many useful hints on target shoo T. J. HUTCHINSON, 8th L.R.V.

[32780.]—**Snider Rifle.**—Eighteen years' ence dictates the following:—1. Woollen r good oil—say, neatsfoot—with a little therein. Have two rags (or three if "Caw" ticular) with a string and piece of lead atta each. A bullet cut or hammered so as to drop down the barrel, answers for the lead adm Drop this with the attached string and ra breech, draw the rag through barrel there dozen such operations I find ample, finish with clean dry rag. 2. There is a compositi for this, but I believe ivory or other black ru with turps or blacking will answer well. my sights. 3. Get the "Official Musket structor," which is published in combinatio "Rifle Exercises." This also answers quer in full.—C. O.

[32780.]—**Snider Rifle.**—There is no method of cleaning a rifle than by using circular brush, which is drawn through the It thoroughly cleans the grooves, which is t desideratum. It is used by several crack s our corps, and may be obtained of any gun-m a few shillings. With respect to re-blacking say it is a gun-maker's job, and had better alone. All the rifle shots with whom I have contact never use anything but smoke from a camphor, &c., which answers admirably. seen several works on rifle shooting, but ne one to be compared with "The Rifleman's panion," by Francis Lock. It is published by and Co., 25, Camden-road, N.W., and contain valuable hints on training, position, and a drill, changes of light, allowances to be m wind," &c. Its price is 4s. 6d. post f WIMBLEDON PEST, 3rd Northumberland.

iregorian Tones.—If Mr. Bell will
. "Catechism of Part-Singing," price 1s.
l Co.), he will learn all about the
ones. As 20 pages are devoted to the
ink it better to refer him to the book
py a large space in the MECHANIC with
—NE SUTOR.

3one Manure.—Bone manure cannot
properly on a small scale—the plant is
e. I do not know of any machines made
hand. Trust to a good manufacturer,
manures analysed.—FERRUM.

3reat Western and Metropolitan
None of the G. W. R. broad-gauge
ne "Hirondelle" class are numbered; it
ıld Bristol and Exeter engines that are
I think the "Hirondelle" tender holds
tons of coal when full. The tender is
he Midland and Great Northern tenders,
s broad gauge, it is accordingly much
; longer as well. The engines working
etropolitan are—those belonging to the
a, the Metropolitan District, and Great
o. 4 class); over that portion of the
n Moorgate-street and King's-cross,
Northern, Midland, and Chatham and
addition to the other three; over the
n, St. John's-wood, the Metropolitan
the Metropolitan District, those of the
n District, the Metropolitan, the Great
id London and North Western. To all
the said engines are of the same dimen-
Midland 204 to 209 and the L. and N. W.
The S. W. R. have some of the same
how many I cannot say. The reason
use the letters H. K. R. M. and S. for
e compartments is to enable passengers
r more easily which compartment they
is plan of using letters wide apart being
ng than if consecutive letters were em-
MERLANE.

Iodine.—Iodine is manufactured on the
by burning dried seaweed in shallow
rly the whole of the vegetable matter is
The heat fuses the salts of the seaweed,
ool it forms a solid grey mass, which is
This kelp is broken into small frag-
digested in water. About half of it dis-
soluble portion consisting of chloride of
of potassium, carbonate of soda, iodide
and various other salts. On the solution
g evaporated, the chloride of potassium,
llises, whilst the iodide of sodium is
solution. This mother liquor, as it is
listilled in a leaden retort with oil of
black oxide of manganese, and iodine
I believe all seaweeds will yield iodine.—
C.J.

- Iodine.—I take the following from
mistry for Schools":—"The kelp (the
tain ocean seaweeds) is digested with
h dissolves out many salts. This mixture
evaporated, and the less soluble ones
as they are deposited, until a mother
rich in iodides, is obtained; this is then
manganic dioxide and oil of vitriol, and
distilled at a gentle heat in a leaden
the evolved vapours of iodine condensed
f glass globes. $2Na + MnO_2 + 3H_2SO_4$
$_4 + MnSO_4 + 2H_2O + I_2$. This opera-
e performed on a small scale by intro-
ut ¼oz. of potassic iodide, KI, into a
ther with an equal weight of black oxide
ese, adding some slightly diluted hydric
id distilling slowly."—E. B. H.

NSWERED QUERIES.

◆◆◆

ws and titles of queries which remain unan-
e weeks are inserted in this list, and if still
are repeated four weeks afterwards. We trust
ill look over the list, and send what information
he benefit of their fellow-contributors.

last "Telescope Tele" has answered 32049;
1078.
okbinding.—To Mr. R. Smith, p. 586.
tonator, 586.
etropolitan Railway Engines, 586.
ase for Red Clay, 586.
ooden Spoons and Turners' Paint, 586.
dical, 586.
pe Composing Machine, 586.
xture of Iron, 587.
e Recent Arctic Expedition, 587.
odel Gas Engine, 587.
wer Gas, 587.
per Cartridge for Rifles, 587.
rcle in Polygon, 587.
ibert's Object-glasses, 587.
and N. W. R. Tunnel, 587.

Sc. Examination, p. 48.
rist, 48.
acht Boiler, 48.
lephone.—To "Cob," 48.
indmills, 48.
lance Wheel, 48.
g Skins, 48.
arge Telescopes, 48.
ngularity of Connecting Rod, 48.
acking Cane, 48.
nduction Coil.—To "Sirius," 48.
he Organ, 48.
Electric Bell, 48.
Lunar Photographs.—To "A. A. C.," 48.

QUERIES.

◆◆◆

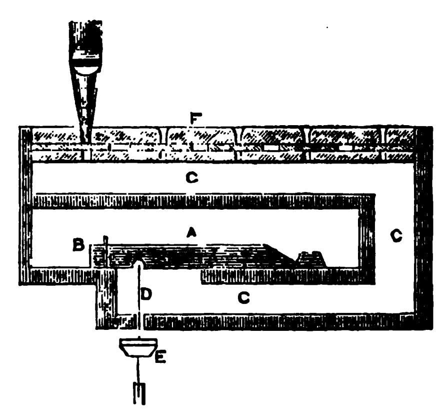
[32799.]—**London University Matriculation.**—What books shall I need in addition to those mentioned below for the June, 1879, examination? Greek: I have no Greek books. Latin: "Bryce's Latin Grammar." I have read seventh book "B. G., Cæsar." French: "Grammaire des Grammaires." Mathematics: "Todhunter's Euclid" and his algebra and "Colenso's Arithmetic." Natural philosophy: no books at all. Chemistry: nothing except "Buckmaster's First Stage." Geography: Anderson's. English history: Bullock's. English Grammar: Morett's.—VERCINGETORIX.

[32800.]—**Grating Noise in Telephone.**—Can any reader tell me how to get rid of the grating noise which, to a great extent, spoils the working of my telephone? The noise, which is like that caused by the making and breaking of a galvanic circuit, is intermittent, frequently interrupting the conversation, but during its absence the voice of the speaker is most distinctly heard. The wire stretches over a field and five or six houses, a distance of 200 yards.—EPSILON.

[32801.]—**Peculiar Action of Glycerine.**—I hope some correspondent will give me some information on the above, communicated in the number of the MECHANIC for March the 1st, letter 1405. What is the chemical action that takes place when bicarbonate of potash or soda, borax and glycerine and water, are mixed together? The experiment is so interesting, and at the same time so inexplicable to my mind that I shall be glad if some correspondent will explain it.—FREDERICK LONG.

[32802.]—**The Leolanche Battery.**—I should be thankful to learn from some one of my fellow-subscribers to the ENGLISH MECHANIC (1) whether this battery is suited to medical galvanism, (2) whether the elements from which electricity is evolved make any difference to the patient or the human body into which it is passed. I doubt whether the carbon of the Léclanché can be good, and have a strong suspicion to the contrary.—NOVICE.

[32803.]—**Organ Windchest—No Springs.**—Will any practical reader kindly pronounce his opinion on this diagram? I think, if the pallets were made of sufficient weight, springs might be dispensed with—a great advantage, if possible, as they are so apt to get out of order. I am building a small organ, but do not wish to waste time and money on a perhaps hazardous or stupid idea, without getting opinion of one who can say yes or no with authority. Now to explain. A, windchest; B, pallet; CCC, the channel; D, stout wire and sticker to raise pallet; E, soft leather pad on button to prevent possible escape of wind; F, table, slides, &c., as usual. Would channel require to be of larger dimensions on account of the little longer distance wind must travel to reach upper side of windchest?—F. M.



[32804.]—**Dr. Olbers' Disruption Theory.**—The illustrious astronomer of Bremen propounded a theory to account for the existence of those minute masses of matter found in the space between Mars and Jupiter—where Kepler, assuming a law of progression, had predicted a new planet would be found, and where, according to Bode's empirical law, a planet should exist (number 28, or the fifth term in his table). I should be glad to learn from "Fellow of the Royal Astronomical Society," or from any reliable source, whether Olbers' theory is held by astronomers now. Dr. Lardner and others regarded it as one of the demonstrated truths of astronomy. Is it a fact that the orbits of Ceres and Pallas "projected on the plane of the ecliptic actually intersect each other?" Is it true that some, if not all, of the planetoids pass through a common point in space? Do the inclinations of the orbits of the larger and smaller bodies coincide with the theory of a disruption of a large planet? To me the hypothesis seem to be sound.—TYRO.

[32805.]—**Underground Telegraph Line.**—Could any of our electrical contributors give me any information as to the manner in which insulated telegraph wires are laid inside the lead piping used to protect them from injury when put underground? I do not understand how the wire is put through a long piece of pipe.—MEPHISTOPHANES.

[32806.]—**Testing Leakage in Gas Mains.**—Would any of "ours" kindly inform me the best way of finding and testing leakage in gas mains? Also please explain the method sometimes adopted to ascertain the percentage of leakage by means of the "governor," in a plain and simple manner as I am not extra good as regards scholarship.—HYDRAULICAN.

[32807.]—**Gas-Testing Meter.**—I have got a gas-testing meter to fix, but first I wish to know the most modern and usual manner of fixing the same. Also how much is allowed as regards "too fast" or "too slow" without trespassing on the limits of the Act of Parliament regarding the same? A diagram of the manner of fixing would be much esteemed by an—HYDRAULICAN.

[32808.]—**Invisible Ink.**—Would any of the numerous readers of the E. M. kindly give me a receipt for making a good invisible ink? I have tried many of the recipes given in books and back vols., but I find that the writing remains faintly visible. The best I have used was bought in Paris. It turns a bright blue on being exposed to a slight heat, and the writing instantly fades away, so as to be scarcely traced, directly it is removed to the ordinary temperature. How is it made, and how could it be rendered entirely invisible? Should any particular quality of paper be used?—STROMBOLI.

[32809.]—**Aerophone.**—Could any reader give me a description of the aerophone with diagrams? I saw a description in the *Times* of the 20th ult.—GEORGE DASHWOOD.

[32810.]—**Grinding Dry Soap.**—Would any of your readers please to inform me what machine is used for grinding dry soap by hand, and which will be the cheapest to purchase? Also would a hand-mortar machine do?—ANON.

[32811.]—**Basso.**—I have a contra-bass that is hard to play. What is the cause? If the back is thicker than the belly what will be the effect? Is the back and belly too thick? It varies from 4 to 5-16ths of an inch thick on the edges, and is much thicker in the middle under the bridge. It has a large oak block where the neck joins the body. Would it be safe to put a deal one in instead? Would it lessen the tone if I put a fourth string on? I shall be glad if any reader can help me out of the difficulty or recommend a work on the subject.—C. B.

[32812.]—**Induction Coil—Wire—Batteries.**—1st. In making an induction coil, the secondary to be in three divisions, the two outer divisions to be No. 35 wire. Will it be against the effects of the coil any if I put No. 32 wire on the centre division? 2nd. I have a quantity of No. 35 copper wire in a great many different pieces. What is easiest and most effectual way to join the ends to make it all as one piece? 3rd. What is the difference in strength and sustaining power between a Grove's platinum battery, 5 × 3, and a bichromate of potash bottle battery holding about half a gallon?—COIL.

[32813.]—**Plaster Ornaments.**—I should feel greatly obliged if any of "ours" could inform me of the process of casting plaster ornaments with gelatine. We put alum in to hasten the setting and to keep the plaster cool so as not to melt the gelatine, but we find it makes the ornaments very yellow after a day or so. Is there any thing used to take the yellow out or to keep the casts white? Also is the gelatine coated with anything to make them last longer? I am at present making a Portland mantle piece of a marble pattern. I should like to know if I could get anything to coat the cement with after it is dry similar to what is used for enamelled slate mantelpieces.—SUBSCRIBER.

[32814.]—**Emery Stones.**—Will some of your readers kindly state what is believed to be the best form of mill—the most economical as regards power, first cost, maintenance, and mininum of waste—for grinding down emery stone? Pug-mills, also mills with chilled cast-iron faces, are, I believe, used. The emery powder has also to be sifted in some machine.—NAXOS.

[32815.]—**Telescope.**—I have a telescope of 29in. focus and 1¾ O.G. glass, but it is not very powerful as it is an old make. The frame is good. Could any of "ours" give me advice where and how to procure powerful glasses to make it strong enough to distinguish bullet marks when at target practice at 1,000 yards range?—GALLOVIDIAN.

[32816.]—**Removing Indian-Ink Blots, &c.**—Can some brother tell me if there is a chemical which will do this and so save a lot of drawings from the waste-paper basket?—X. X.

[32817.]—**Magnetising Steel Wire.**—I want to permanently magnetise 100 feet of steel wire about the size of an ordinary darning needle. Will some correspondent kindly inform me how?—AJAX.

[32818.]—**Gallium.**—What are the speculations upon which the prediction of the existence of gallium was based by M. Lecoqu de Boisbaudran, Mr. Newlands, and M. Mendelejeff?—DONALD McD.

[32819.]—**Joule's Magnet.**—Will "Glatton," "Sigma," or some other correspondent, kindly answer the following questions? 1. Is cotton-covered preferable to silk-covered wire for the construction of this magnet? 2. What is a neat and simple way of fixing the ends of the wire so that they cannot slip from their places? 3. Where shall I find the original description of this form of magnet?—KHEYM.

[32820.]—**Electrometer.**—Will some correspondent kindly describe for me or inform me where I shall find a description of Marey's modification of Lippmann's capillary electrometer?—KHEYM.

[32821.]—**Pygidium of Lacewing Fly.**—On what part of this most beautiful yet horribly stinking insect must the "pygidium" be looked for? I have searched for it several times unsuccessfully, though not altogether unpractised in the dissection of insects. Is the "pygidium" an organ belonging to only one sex? Is the fearful smell confined to one sex?—CHRYSOPAPERLA.

[32822.]—**Stellar Photometry, &c.**—To "F.R.A.S."—The information contained in the Annual Report of the Harvard Observatory, to which "F.R.A.S." refers in let. 14245, would without doubt be of great interest and use to many amateurs, myself among the number; and we owe "F.R.A.S." thanks for having brought the matter under notice; but will "F.R.A.S." tell us whether the report is generally obtainable, and if so where; for of course possession of it for reference would be highly desirable. I beg to thank "F.R.A.S." for the kind way in which he has answered concerning the transit of Mercury. Of course the many he has helped in his valuable letters would be truly glad to help him in turn, if it were in their power to do so. I possess at present only a small altazimuth telescope. I fear my transit observations will not be of much value.—MAG.

[32823.]—**Legal Question.**—A married lady (call A) has had hitherto two trustees to her marriage settlement, one a married gentleman (call B) and the other a young unmarried lady (call C). B has lately died, and C is about to be married. Query: in what way has the death of B affected the trusteeship, and does it now alone rest with C, and what is to be done in the case of the marriage of C? Does her trusteeship cease with her marriage, or does her future husband assume any rights in this matter? Was B able, *i.e.*, entitled to nominate in his will a successor in his trusteeship? If the death of B and the marriage of C dissolves all powers, how is the property left to A to be dealt with? Replies to these queries will oblige—A. W. E.

[32824.]—**Suspension of Ultramarine.**—Can any reader tell me how I can keep ultramarine (artificial) in suspension or in solution?—F. M.

[32825.]—**Unfermented Bread.**—I have read with considerable interest the letter from "A Physician," No. 14203, page 119, respecting unfermented bread, but not being in a position to get the exact weights as described by him, and having no chemical friend who has the necessary articles, would that gentleman kindly tell me how I can measure the 80 grains of soda, also the quantity of water, salt, and hydrochloric acid, by any utensil generally found in a household and oblige—A Would-be Baker?

[32826.]—**Midland Drivers and Firemen.**—Would "C. E. S." or any of our subscribers say what is the maximum pay of engine-men on the Midland, and also what is their pay when appointed from firemen to drivers? Also what pay do firemen have on being appointed as such, and what is their maximum pay, and whether they are obliged to be a certain height and age?—G. W. Fireman.

[32827.]—**Normal Sulphuric Acid.**—Thanks to "H. L. S." for the trouble he has taken, but will he kindly assist me further? I may say my real object is to analyse soap, and I think, perhaps, oxalic acid would do for that purpose, but as I am but an amateur chemist should like a few hints as to how to proceed, method of calculation, &c. Are there any books published on this subject? In my query (32693), on p. 150, read "proportion" instead of "preparation."—Derby.

[32828.]—**Carbonate of Soda.**—If carbonate of soda is added to water holding lime in solution the latter (or a portion) is deposited after a time as carbonate (?) of lime. What state is the soda in when that reaction has taken place? If sesquicarbonate of soda is treated with tartaric acid tartrate of soda (?) is produced, with the evolution of carbonic acid. Is that so? Then if previous to the mixing, chlorate of potash is added in small quantity what is the resulting compound?—S. M. P.

[32829.]—**Edison's Sewing Machine Motor.**—I saw in the *Telegraphic Journal* (for March 15, I think), that Mr. Edison had invented a sewing machine motor, consisting of a vibrating tuning fork, actuated by a pair of electro-magnets and a battery, the circuit being interrupted "timeously" by the arms of the fork. Between the arms is a ratchet-wheel, and each arm carries a pawl working into the wheel, one at the top, the other at the bottom. By this means the wheel is rotated and imparts its motion to a sewing machine! Does any one know the particulars of this new motor, or has the *Telegraphic Journal* been led astray by the application of the tuning fork to a model sewing machine?—Nun. Dor.

[32830.]—**Trigonometry.**—I intend to sit at the May examination, and I find that in the last and other years there are questions such as: The three sides of a triangle are 8, 15, 17, find the angle without logarithms; also the three sides of another triangle, whose sides are 2, 3, and 4, find the obtuse angle without logarithms? The only tables that are allowed to be used are at the end of examination paper, but these questions have to be solved without the aid of any tables. Will some of your mathematical correspondents assist me in as simple a manner as they can, and they will bestow a great favour on one who is self-taught? I have Todhunter's "Trigonometry for Beginners," but I find no rule for questions of this kind.—Anxious.

[32831.]—**Toy Balloons.**—Will any reader inform me how these are made, and what machinery is necessary?—One in Distress.

[32832.]—**Expansion Valves.**—Would any reader kindly give a diagram so as to enable me to get out the sizes of expansion valves for any degree of expansion?—Arthur Alfred.

[32833.]—**The SS. Great Eastern.**—Would any one oblige by giving the dimensions of the engines of the above—just the principal dimensions?—Arthur Alfred.

[32834.]—**Disconnecting Compound Engines.**—A Clyde tug-boat is fitted up with these engines, which is a new style, and which, I believe, will very shortly come into general use. The Walrus is 114ft. long, 20ft. beam, and 10ft. 6in. deep. The low pressure cylinder is 34in. diameter, and the high pressure 18in. diameter; both pistons have a stroke of 24in., and the nominal horse-power is 50. There are two propellers, 8ft. diameter and 11ft. pitch, and these are overlapped to keep them within the lines of the vessel. The high pressure engine is simply a non-condensing engine, having neither condenser nor pump. The condenser (surface) is, of course, connected to the low pressure; also the air circulating, feed, and bilge pumps. When they are connected they work in the usual way of compound engines; but if the vessel is wanted to turn in a small space the engines are disconnected, the high pressure exhausts through a receiver-valve into the waste steam-pipe, and when the low pressure is used alone the steam is admitted into the valve-chest through a reducing valve, and exhausts into the condenser. The boiler is an elliptical tubular, 9½ × 9½ × 14ft. high. On her trial trip she ran the measured mile in 5 mins. 30 secs.; she afterwards ran with only the low pressure working, over the same distance, in 9 mins. 11 secs. I believe they are Rankin's patent. Would any reader who has had some experience with the above kind of engines give a little information on them, and if they are used on any of the coasters?—Arthur Alfred.

[32835.]—**Three-cylinder Engines.**—I should like to make a three-cylinder engine for myself, with about 2½in. or 3in. cylinders. I wish some of your numerous readers would give me a description of one. I think I have a knowledge of them, but I don't know how the two hoops are got over the crank that just keep the connecting rod ends and the crank pin together.—Mechanic.

[32836.]—**Organ Matters.**—Having almost completed a wind-chest at which I am working, I am anxious to know if it is really necessary that I should add a concussion bellows thereto, as it is only a small chamber organ of half a dozen stops? Hopkins, in his work on the organ, page 294, No. 1230, says that they are in some cases better omitted. I should, however, like a practical opinion upon the matter. Whoever answers this will oblige by saying what size the bellows would have to be if needed? The soundboard is 2ft. 6in. by 5ft. Will some one also kindly explain the effects of different pressures of wind—viz., 2in., 2½in., and 3in.? Is it a mere matter of taste as regards what pressure of wind you choose for your organ. Some will say by all means use a heavier wind for a large organ than you would for a small one. I have read of a number of our readers employing a 2½ wind for their chamber organs, whereas on the other hand I read of Green, the organ-builder, employing only a 2in. wind for a cathedral organ. If I put my organ upon a heavy wind, could I not regulate the tone by plugging the wind-way of the pipes, that is, the pipe feet?—Storace.

[32837.]—**Star in Hydra.**—Closely *s. p.* π Hydræ, Proctor, in his "Atlas" (Map 7), shows two 5m. stars. The *f.* star of these two (the nearer one to π) is not in Harding's "Atlas," or Lacaille's "Catalogue." In July, 1877 (in the Punjab), I failed to see this star with a binocular. Will "F. R. A. S.," or other astronomical reader, kindly say if the star is found in the B.A.C., or any of the modern catalogues?—J. E. Gore.

[32838.]—**Cooking Stove.**—I have to thank "W. J. L." for his kind reply to my question. The oven I have in use is simply an oblong tin box, with a round hole in the bottom to admit the flame from an American gas-stone on the Bunsen principle, and half a dozen small holes on top to carry off the consumed gas. If the flame passed through a worm entering the bottom, and out at the top, it would give the requisite heat, and the risk of bad gas would be avoided. An oven of this kind would be of great use during the warm weather. Will my previous correspondents favour me with a suggestion?—G. B.

[32839.]—**The Analogy Between Light and Sound.**—Referring to Prof. Barrett's lecture on the above, there is a part of the statement which I find very difficult to comprehend. He states that light travels at the rate of 186,000 miles in a second, and that a wave of (green) light is 1-50,000th of an inch in length. It, therefore, follows that there must be formed (186,000 × 1,760 × 36 × 50,000) 589,248,000,000,000 waves every second. I should be glad if some one would certify this as a fact, and also how a wave of light is measured? To me it is incomprehensible that a continuance of waves at the rate of 589 billions per second must be formed and appreciated by the eye before one can perceive a green ray.—Inquirer.

[32840.]—**Reflectors.**—Turning over my old Mechanics the other day, I found that "F. R. A. S.," on October 18th, 1867, recommended a correspondent to get a Browning 4½in. reflector at £16. The 4½in. reflector advertised now by Mr. Browning is £24 4s., and I should be much obliged if "F. R. A. S." would kindly state what is the difference between two reflectors of equal aperture by the same maker that should make one worth so much more than the other? Also whether he considers either of these as equal in every respect to a good 4in. refractor?—Permian.

[32841.]—**Tapper Bells.**—We have four tapper bells in our shop ringing in offices in four different parts of the town. Is it possible for all four to be rung from one battery in the shop? If so, please say in what way? A drawing, showing all connections, will oblige—T. Brown.

[32842.]—**Electro-plating Bath.**—Would some of "ours" give me the necessary instructions for making the above from nitrate of silver? and oblige—D. Strathearn.

[32843.]—**Musical Box.**—I should be glad to know how I can put to rights a musical box that has several of the little pins in the barrel broken, and some bent. I had an accident with it in this way:—It was playing slowly, as if it wanted oiling or cleaning, and thinking the stiffness of its action lay with the little upright shaft with the fly, I was about to remove it without thinking of the consequences, when the barrel caught the sleeve of my coat, and jammed it fast in, from the force of the spring being no longer retained by the worm and the worm-wheel. How can the broken pins be got out, and how are they fixedi n?—W.

[32844.]—**Astronomy.**—Will "F. R. A. S." kindly enlighten me on the following?—How far in mathematics shall I have to work before I can go in for studying nautical astronomy? Would you advise me to purchase a telescope at the time I commence studying it? If so, what kind of one would you recommend, having £10 or £15 to spare? Also, what books would you recommend me to get as I proceed? Excuse me asking such simple questions, as I am not acquainted with any one possessing a telescope or advanced knowledge of astronomy.—Dosrhe.

[32845.]—**L. C. and D. Brake Power.**—Can any correspondent inform me if the above company have replied to the circular of the Board of Trade on the brake question; and, if so, whether they have determined upon what brake to adopt? I have noticed that the mails are fitted with the Westinghouse brake, but I believe that is all. I should feel obliged also if any one could supply me with the exact distances and gradients from Herne-hill to Rochester and Strood?—G. L. P.

[32846.]—**Model Locomotive.**—I am about making a model locomotive, and would thank some friend of "ours" to give me some information on the following points:—What should be the size of a boiler to supply two oscillating cylinders 1½in. stroke, ¾in. bore? Would a small boiler with a given amount of heat keep up a pressure better than a larger one with the same heat? What is the best material to make the boiler with? How can the spirit lamp be best fixed? Is there any cheaper oil than methylated spirits?—A Nominal Engineer.

[32847.]—**Colourless Varnish for White Wood Articles.**—Can any correspondent tell me what kind of varnish would be suitable for fretwork articles made of satin wood? They get soiled very soon when exposed in a sitting-room.—H. Allingham.

[32848.]—**Jamin Magnet.**—Would "Glatton," or some other reader, kindly inform me whether the above magnet can be used in making an electric bell; and, if so, please give size of iron tubing? Also quantity and gauge of cotton-covered copper wire to be used?—E. P.

[32849.]—**Matt Size.**—Will any reader oblige by informing me how to make matt size for matt hatt gilding, and also in what manner you apply the water? I have tried several times without success to obtain that peculiar deadness which I have seen on the flats of some that I have had done.—Derby.

[32850.]—**The Separation of Mang**
Would Mr. Allen, or any other of your chemic
kindly inform me through the columns of you
paper how manganese can be commercially
from an ore containing nickel and cobalt?—T.

[32851.]—**Bicycle Wheel.**—Can any read
me how to make a bicycle wheel 50in. in dia
have a steel rim, and I wish to make a gun-meta
I turn the axle can I then get the gun-metal
securely? Also how are the front wheel spokes
when I was trying to make one before I got t
in one side and they burst out as I put the oth
other side? How can I make the head? I
Stanley, but do not know how it is fitted t
Mechanic.

[32852.]—**Air-pump Valves.**—Will any
reader having a knowledge of the best forms of
adapted for a pressure of 40lb., for working an
hammer in lieu of steam, kindly give me a wor
ing the same?—C. F. Clew.

[32853.]—**First B. A. London.**—Will a
kindly inform me what Greek grammar is nec
the pass examination? Also which is the best
to use?—Undergraduate.

[32854.]—**Induction.**—If I send a curre
battery round an electro-magnet I get a curre
in a secondary wire of a certain strength—*i.e.*,
doing a certain amount of work. But if I
secondary wire on an armature, and bring it
near the magnet, I get a stronger current.
comes the extra strength?—R. P.

[32855.]—**Electric Light.**—What is the
number of Bunsen's cells capable of giving a
cient to illuminate a space 30 × 20? Golding
5 or 6 will give a dazzling light. This is only
volts., but Jenkins says 80 volts. are required t
intensity sufficient.—R. P.

[32856.]—**Battery for Electric Railway**
—In the English Mechanic of February 8th a
slot signal is described. I should feel obliged i
reader would inform me what description of
used for working it? I intend shortly to mak
signal, and should like to use the same desc
battery.—I. S.

[32857.]—**Stearine.**—Any information a
simplest method of manufacturing stearine (
acid) for composite candles from tallow on a
scale would oblige—Scap-maker.

[32858.]—**Steam Boilers.**—In Mr. Robert
"Treatise on Steam Boilers," page 18, he gives
for the diameter of the larger circle of curvat
oval tube—$D = \frac{2 L^2}{S}$ where L and S are respec
major and minor axes of the ellipse. Of cours
only be an approximation. Perhaps some read
kind enough to show how it is obtained, and
Chester.

[32859.]—**Microscopical.**—Will some kin
scopic friend tell me whether Lord Osborne'
exhibitor is a good oblique illuminator for sh
lines and dots on difficult tests; or whethe
recommend any other piece of apparatus which
—Diatomaniac.

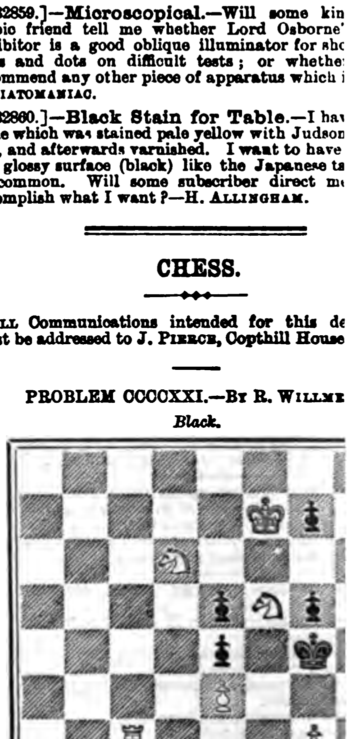
[32860.]—**Black Stain for Table.**—I ha
table which was stained pale yellow with Judson
dye, and afterwards varnished. I want to have
fine glossy surface (black) like the Japanese t
so common. Will some subscriber direct m
accomplish what I want?—H. Allingham.

CHESS.

All Communications intended for this de
must be addressed to J. Pierce, Copthill House

PROBLEM CCCCXXI.—By R. Willme

Black.



White.

White to play and mate in four moves

Solution to 419.

White.	*Black.*
1. R to Q 7.	1. B to B 5.
2. Q to K 3 (ch).	2. P takes Q.
3. Kt to Kt 3 mate.	

Notices to Correspondents.

Correct Solutions to 418 by J. G. F. (a fine
J. W. (good), and by J. P. T.

he English Mechanic

AND

ORLD OF SCIENCE AND ART.

FRIDAY, MAY 10, 1878.

ARTICLES.

THE TELEPHONE HARP.

E announced some time ago that an entertainment had been given at ston, consisting of a lecture on the teleme, with a telephonic concert, introduc- the newly-invented telephone harp, ented by Mr. M. J. Matthews, and conucted by Messrs. Mason and Hamlin. nks to the courtesy of our occasional espondent, we are enabled to describe instrument and to illustrate the method onnecting the telephone with the piano p, and with the ordinary American organ. believe that the telephone harp is about be introduced to English audiences by . Gower, Mr. Matthews's associate ntor. The modified form of the pianop, shown in transverse section in Fig. 1, tended to be used in combination with lvanic circuit and a telephone, for the pose of transmitting musical tones or graphing messages between points ly distant from each other. The transsion of musical tones, both from tuning ks and free reeds, has been accomplished ore, but never with so much precision l purity of tone as by the new instrunts, which transmit to the receiving telene a perfect harmony, in which the rate tones are clearly distinguishable from another. The invention consists entially in the use of duplex vibrators—t is, for every note there is a primary tallic tongue or reed for producing the sical tone, and a secondary tongue tached to the primary reed in such a way as to vibrate with it and to have imparted to it an independent vibration of its own. For each vibrator there is a contact point in electric connection with the galvanic circuit over which the musical tones are to be transmitted. This point is so adjusted, relative to the supplementary or secondary tongue, that while the latter does not touch the point while at rest, it is brought into contact with it and completes the galvanic circuit directly it is put into motion by the blow of a hammer, the pluck of a plectrum, or the force of a column of wind. Fig. 1 is a representation of the telephone harp in vertical transverse section, showing the connections with the battery and the telephone. The action-rail, E, extends from end to end of the instrument, and carries on its rear side, in an inclined position, a series of flanges, F, in the lower forked ends of which the hammer butts, G, are pivoted. The upper side of the action-rail carries a series of flanges, H, to the forked ends of which are pivoted short levers, I, provided at their rear ends with adjustable buttons, *f*, serving as stops, limiting the movement of the levers in one direction, while the small spring, *g*, tends to keep the stop, *f*, on its seat. The "jack," J, is pivoted to the front end of the lever, I, and is provided with a shoulder, *h*, which is made by the pressure of the spring, *i*, to engage with the butt of the hammer, G, when the "jack" is in its highest position, and the hammer stem rests on the rail, K. L is a screw pin in the under side of the key, resting on the lever, I, and imparting the motion of the key to the "jack," and thence to the hammer. M is the soundboard which extends from end to end of the instrument, and N is a metal rail, bearing at two or more points on the soundboard, and having in its front edge a longitudinal groove in which the steel tongues or vibrators are secured by a gib and set-screw. Attached to the steel vibrator, O, and in about the position shown, is the secondary vibrator, *m*, much thinner and more delicate than the tongue, O, and having its free end tipped with platinum. Above the platinum-tipped end of the secondary tongue, *m*, is a platinum-pointed set-screw, P, working in a metal holder, P′, supported on the wooden rail, Q, that extends from end to end of the instrument. R is a metallic rod extending the full length of the instrument and carrying a series of coiled and bent spring wire circuit closers, *n*, which are so placed that normally they are nearly in contact with the upper ends of the wires, *o*, set in the metal holders, P′. A threaded pin, *p*, carrying an adjustable button, is inserted in the under-side of the key in such a manner that when the key is depressed the end of the spring wire circuit closer is brought into contact with the wire, *o*—the circuit being thereby closed and again broken when the key is released by the spring recovering its normal position. The metal rod, R, is connected by a wire, *r*, to one of the poles of a battery, S, the other pole of which is connected by the wire, *s*, to one of the poles, *t*, of an ordinary Bell telephone, T. The opposite pole of the telephone is connected by the wire, *u*, to the bar, N, which carries the metallic vibrators. The cushioned button shown attached to the flange, F, is provided for the purpose of limiting the backward motion of the "jack."

FIG. 1

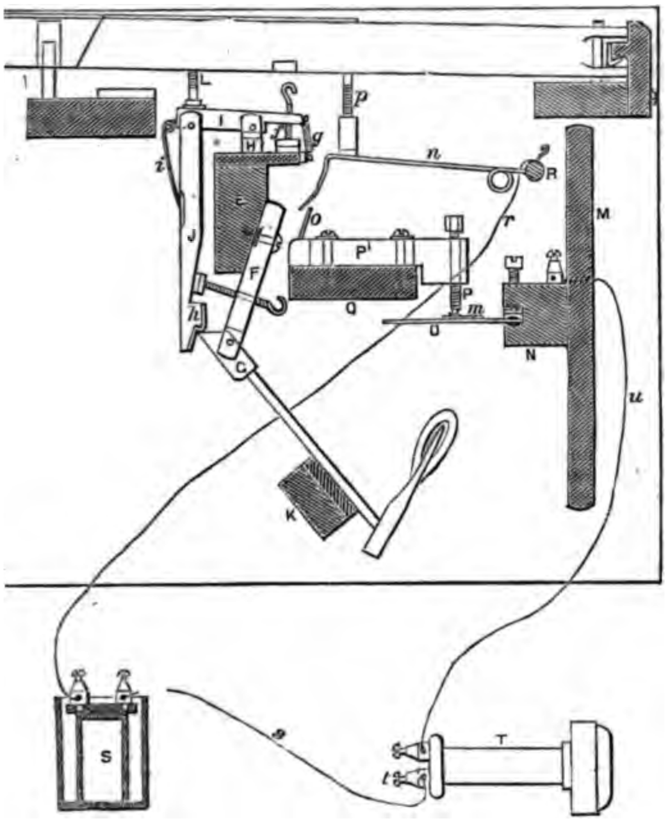
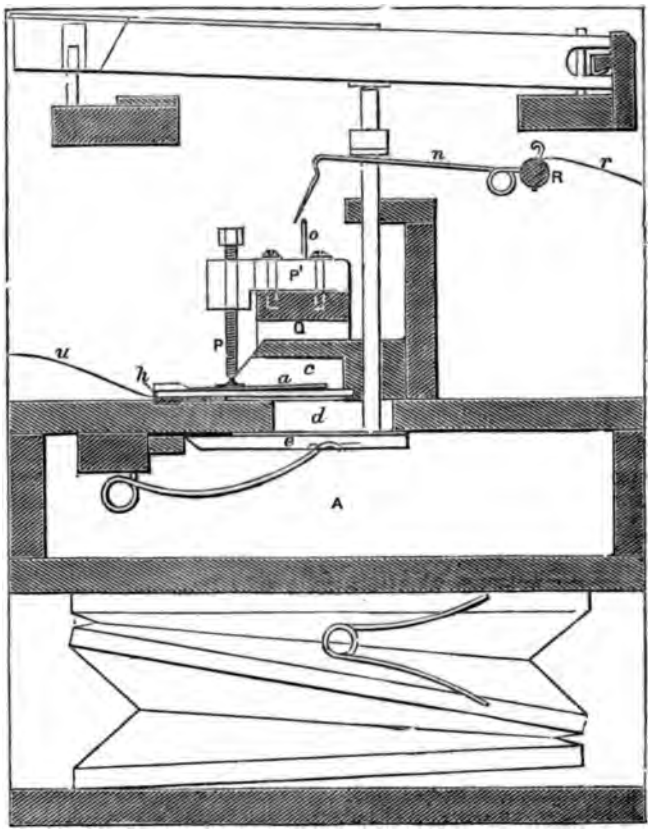


FIG. 2



Referring now to Fig. 2, which is a transverse section of a telephone organ, we have the application of the invention to a set of free reeds, as found in the well-known American organ. Similar letters refer to similar parts, and it is not necessary to repeat the description. The reed, *a*, is provided with a secondary reed, *m*, which makes contact with the point, P, when the key is depressed Each reed is inserted in a cell or tube, *c*, over an opening, *d*, closed by a valve or pallet, *e*, which is opened by the push pin when the key is depressed. Under the heels of the reed-frames, and running from end to end of the set, is a metal bar, *h*, in contact with the reed-frames, and connected by the wire, *u*, to one pole of the telephone, while the wire, *r*, connects the rod, R, to a battery, the latter and the telephone being connected in the manner shown in Fig. 1.

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From the foregoing description the action of each instrument will be understood. When the primary vibrator, *a*, or the tongue, O, is put in motion by the passage of wind or the blow of the hammer, the secondary and more delicate vibrator, *m*, is brought into contact with the point, P, at each vibration of the primary reed or tongue. The vibrations thus set up and regulated are communicated to the wire, *u*, and through it to the diaphragm of the telephone, which, for instance, may be located at New York and the instrument at Boston. The duration of the tone delivered in New York is determined by the length of time which the circuit-closer, *n*, is held in contact with the wire, *o*, although the vibrators themselves may continue to move for an appreciable time after the circuit is broken. By this means a sharply defined note is heard at the receiving end of the line, as well as at the transmitting end, and the quick response to the touch facilitates the rapid transmission of messages over long lines of wire on land, and renders the invention specially adapted for use in connection with submarine cables. For this purpose an alphabet of 26 distinctly different musical notes has been selected by the inventors, and we presume that telephone harps, when constructed for telegraphic purposes only, will be limited to those notes, and the few supplementary tones required for special signals. The battery power employed consists of two or more Léclanché cells and an induction coil, but that is a detail which obviously depends on the electrical conditions. So also the use of a Bell telephone is not imperatively required, any other form of practically useful telephone answering the purpose. The secondary vibrators and the contact screws are faced with platinum to prevent the corrosion of the metal, and to retain the accuracy and purity of tone. It is possible to adjust the contact screw so delicately that a continuous note may be obtained for eighty-five seconds after the large tongue has been struck by the hammer. This fact will not be without interest to those who are seeking to obtain from steel vibrators struck by hammers tones which shall combine the advantages of the piano string with those of the free reed. It will be seen that by means of either the telephone harp or the telephone organ both melodies and harmonies may be transmitted to a distance, and when some means of reinforcing the sounds emitted by the telephone is devised, the invention will have other uses than that for which it is specially designed. As it is, it is probably the best method of transmitting telegraphic messages by means of musical sounds.

REVIEWS.

Popular Astronomy. By SIMON NEWCOMB, LL.D., Professor U.S. Naval Observatory. London: Macmillan and Co.

THE character of this work is fully equal to its title; it is emphatically *popular*, at the same time it is as emphatically *scientific*, and bears the impress of being the production of a master-mind. Ordinary astronomical readers are well acquainted with the earlier systems that were promulgated to explain the motions of the bodies circulating around the sun, of which one only has survived—viz., the Copernican. One of the systems prior to this, in the order of time, our author regards with a truly philosophic eye. Of the Ptolemaic he says:—"Let us now dwell for a moment on some considerations which will enable us to do justice to the Ptolemaic system as it is called, by seeing how necessary a step it was in the evolution of the true theory of the universe. The great merits of that system consisted in the analysis of the seemingly complicated motions of the planets into a combination of two circular motions — the one, that of a fictitious planet around the celestial sphere; the other, that of the real planet around the fictitious one. . . . . Seeing this, it took a very small step to see that the sun, and not the earth, was the centre of planetary motion," and from this the development of the heliocentric theory was extremely simple. Indeed, in no other way, as our author says, "could it have been developed." In the same philosophic spirit Professor Newcomb criticises the work of Copernicus, Kepler, and Newton, and places the results very lucidly before his readers. In the second part of his work the Professor treats of "Practical Astronomy," and describes its utility in the following terse language: — "Place an astronomer on board a ship; blindfold him; carry him by any route to any ocean on the globe, whether under the tropics or in one of the frigid zones; land him on the wildest rock that can be found; remove his bandage, and give him a chronometer, regulated to Greenwich or Washington time, a transit instrument, with the proper appliances, and the necessary books and tables, and in a single clear night he can tell his position within a hundred yards by observations of the stars." This is an important operation, and may be well considered as a great scientific achievement. The methods that have contributed to produce such a result, the instruments employed, modern improvements in them, and the construction of new ones suitable for exploring the most recent fields of astronomical research, are most amply treated of in the second part of the work, as well as the determination of the distances of the sun and fixed stars. The third is devoted solely to an examination of the sun and his family, and embodies notices of the latest discoveries in the vast region known to us as the "Solar System." The results of the labours of astronomers in searching into the physical nature of the sun, the constitution of the planets, the connection between comets and meteors, and other characteristics of the system, are placed before the reader in a most interesting light, which cannot fail of inducing an increased attention to astronomical pursuits. Leaving the boundaries of the "Solar System" the author wings his way to the "Stellar Universe," and, having passed a starless gulf in which no celestial body is found, he enters on a region where such are but sparsely distributed, and speaks of our attempts to form a theory of the structure of this vast region as yielding but a glimmer or two of light amidst the profound and almost boundless darkness. How and in what manner the unnumbered suns that shine upon us during night are distributed in space observation fails to tells us, and approaching the deeply interesting question of a plurality of worlds fitted with conditions for sustaining animal life, our author further tells us that "observation can afford us no information on the subject." If, when about to close the book, we are brought to a stand-still on some questions, we cannot do so without calling to mind that the Professor has been our conductor through the richest field of scientific research. Commencing with the dawn of the human intellect he leads us onward, showing us how that intellect is developed as light streams upon the structure of the physical universe, piercing the mists that enshroud our mental vision until we obtain a correct idea of the number and distribution of the larger bodies which surround us, the immensity of the number of the smaller bodies, and above all the littleness of man on his earthly abode—a mere speck in this vast and wonderful universe.

The Human Eye; its Optical Construction Popularly Explained. By R. E. DUDGEON M.D. London: Hardwicke and Bogue.

THIS little treatise on the optical construction of the human eye is a clear and untechnical explanation of that wonderfu organ by a gentleman who has devoted many years of thought and study to the subject. To a certain extent it is a repetition, as it needs must be, of facts already well known, but a considerable portion of the book is occupied with an enunciation of the novel views which at one time were peculiar to Dr. Dudgeon. In a couple of pamphlets on the "Dioptrics of Vision," and "The Mechanism of Accommodation" —issued in 1871-72—he promulgated his theories of aqueous vision, air lenses, and visual accommodation, and since then further experiments have not only helped to strengthen the views of the author, but have led to their corroboration by some German authorities. The accommodation power of the eye for near and distant objects is one of its most striking peculiarities that has always attracted the attention of physiologists and investigators. Helmholtz and many others considered that accommodation for near vision was obtained by an increase in the convexity of the crystalline lens, caused in some manner by the action of the ciliary muscle. This hypothesis, however, was known to be faulty; for if the advance of the anterior surface of the lens and its increased convexity were the means by which the eye was adjusted to near objects, it must needs be accompanied by a diminution of the peripheral circumference of the lens. But the majority of competent observers have failed to notice any diminution of the peripheral circumference; while a fact bearing against the hypothesis of the ciliary muscle acting upon the elastic structures enveloping the lens—causing a diminution of their tension—is the difficulty, so far as the hypothesis is concerned, that the eyes of persons advanced in life remain perfect for distant accommodation, but, as a rule, lose the faculty of near accommodation almost entirely. The experiment employed in the observations is the reflections of a candle held near the eye, and observed in different positions while the organ is adjusted for near and distant vision. For the normal eyes of young persons a little practice will enable any one to dispense with apparatus, but Dr. Dudgeon used a microscope of lin. focus, so arranged that the three images of the candle could be observed as they are reflected from the cornea, the anterior surface, and the posterior surface of the lens respectively. His conclusion is, that the actual change in the crystalline lens is merely a change in the direction or slope of its anterior surface, produced by a slight movement of rotation on its vertical axis from without inwards. Dr. Dudgeon explains his views and supports his theory in an able manner, and as his book contains a popular account of the principles of optics as applied to the eye, any intelligent reader can follow him with interest into the mysteries of an attractive subject, and test the theories by experiments.

The Moulder's Ready Reckoner. By DAVID NEAVE. Aberdeen: A. King and Co.

AN essentially practical work like Mr. Neave's "Moulder's Ready Reckoner" is sure to be of considerable utility in the foundry, and is scarcely to be judged by the standards which would be applied in the case of more pretentious works. By examples and demonstrations the author has endeavoured to simplify the rules in mensuration which are most used by moulders, and goes so far as to say that although his book is full of decimals, his readers, who do not understand them, may do without them. Decimals are, however, so easy to understand when once the pupil gains an insight, that it is a pity Mr. Neave did not devote a page to an explanation of the power of the dot. The tables and rules given by Mr. Neave will be useful to others besides moulders, for the former contain the weights of many common castings, and the latter instruct the reader in the methods of finding them.

Bible Plants. By John Smith, A.L.S.
London: Hardwicke and Bogue.

The veteran botanist has in this little book presented us with a history of the Bible plants, and a review of the various opinions regarding their identification, which will have an abiding interest to many thousands of readers. During his long service at Kew, Mr. Smith was frequently appealed to for information respecting the plants of the Bible, and his questioners were not unfrequently surprised to learn that many of the well-known plants mentioned in the Bible were by no means the same as plants bearing similar names nowadays. For instance, there is little doubt that the apples of the Bible were apricots; our lily of the valley is not the lily of the valley of the Bible, nor are our tares, the tares which "his enemy came and sowed among the wheat" (Matt. xiii.) The difficulty of identifying the Bible plants is increased by the fact that the same Hebrew word is in some cases applied to different plants, while in other cases different names are given to the same plants. Mistakes, too, have occurred in translating the Hebrew into Greek, and the Greek into Latin and English; but happily the similarity of the Arabic names with those given to the plants in Hebrew helps in the identification, and as there are only about 100 plants, Mr. Smith's book may be accepted as tolerably correct. The author has gone to the best authorities, and has weighted carefully their arguments and conclusions, and then bringing his own knowledge to bear on the questions, has presented us with a book which we may accept as probably absolutely accurate. Several excellent plates by Mr. Fitch complete an interesting and useful work.

Practical Taxidermy. By Montagu Browne.
London: "The Bazaar" Office.

If we object to Mr. Browne's "literal" translation of taxidermy, as coming from the Greek words meaning "skin art," we shall not find fault with his method of treating his subject when he comes to deal with practical details. Indeed, the work is nothing more than a treatise on taxidermy, for the author tells us not only how to stuff the hare, but how to catch it. Those who wish to learn how to skin and stuff the mammalia, fish, birds, and reptiles, and how to catch and preserve butterflies, will find ample directions in Mr. Browne's manual, illustrated with numerous engravings. Mr. Browne, we find, objects to using skins of birds to kill the larvæ infesting them, and prefers dressing them with benzoline, which, he says, is not only a perfect destroyer of insects, but is positively beneficial to feathers. He also has a good word to say for the insect powder prepared from the Russian tansy (Pyrethrum roseum), which has always, in his hands, kept insects away from skins over which it was strewn—the only objection to its use being that it stains light-coloured skins with its fine brown dust. Amateur taxidermists, too, will owe Mr. Browne thanks for making known several non-poisonous preparations which may with advantage replace some of the horribly poisonous compounds recommended in other works on the art. Corrosive sublimate and arsenic may be necessary in some cases, but if their use can be avoided, the amateur will do well to leave them to professionals, and trust to the harmless preparations which Mr. Browne has found to be successful.

Handrailing on the Block System, by Wm. Twiss (Abel Heywood), is a simple mechanical method of constructing a wreath from the plan and elevation of the stairs. It is clearly explained by the author and inventor, and deserves the attention of carpenters and joiners.—*The Philosophy of Man and Creation*, by John Coutts (Pitman), is a book containing 250 pages and a large number of words, but we are afraid it would require a book of the same dimensions to explain the author's meaning. "With a small prism," says Mr. Coutts, "and a ray of light, which is the first manifestation of force, there may be shown the division of pure light into a trinity and a sevenfold unity, in the shape of the prismatic colours; and by the Fraunhofer's lines upon the spectrum, there may be manifested every element in creation, in its subdivisions, as it is related to the sevenfold division, the trinity and the unity in the pure light." And so on.—*Rational Spelling*, by Dr. G. Harley, F.R.S. (C. F. Hodgson), is a letter addressed to the Earl of Beaconsfield on the feasibility of introducing a conservative national scheme of rational spelling reform, and the author gives an instance of the mode of working of the first section of his scheme, which consists in the abolition of duplicated consonants, and is supposed to facilitate education and thereby contribute to the intellectual development of the nation. We have heard a great deal lately of the time "lost" by children in learning to spell—a conclusion arrived at by calculating how much more quickly spelling could be learnt by the pet system of the authors; but although we are willing to admit that the higher education—or even the sound education—of the masses will tend to the "intellectual development of the nation," we must be allowed to retain the conviction that education consists of something more than spelling. A means of *axelerating* the acquirement of knowledge would doubtless be of *inexpresible* value under *al* circumstances, but we are afraid that the mere *droping* of an *f* would not *efect* much change for the *beter*.—*The Pattern Maker's Assistant*, by Joshua Rose, M.E. (Van Nostrand, New York; E. and F. N. Spon, London), is the reproduction in book form of the articles which we reprinted at the time of issue in the *Scientific American*, with additions. We need scarcely say that it is an excellent work.—*Studies in Physical Science*, by W. J. Millar, C.E. (Marlborough and Co.)—These so-called "studies" read more like the sort of papers one is accustomed to hear at mutual improvement societies, or to read in the columns of provincial papers. Some have already appeared in serial form, but why any should be found between boards it is difficult to say, unless it was to make a book. *The Popular Science Review* for April (Hardwicke and Bogue) contains, amongst others, a suggestive paper by Mr. Savile Kent on "A New Field for the Microscopist," a study of the flagellate protozoa, and an appreciative article on "The Radiometer," by Dr. W. H. Stone.—*Natural Philosophy for General Readers and Young Persons*, by E. Atkinson, Ph.D. (Longmans), is the third edition of what is popularly known as the "smaller Ganot." It is a book well adapted for the upper classes of schools, and also as a present for boys and girls who exhibit an interest in natural phenomena. A few pages of new matter have been added, amongst which we notice the telephone, which is clearly explained with the aid of illustrations.—*Hints on Reflecting and Refracting Telescopes*, by W. H. Thornthwaite, F.R.A.S. (Horne and Thornthwaite), is the third edition of that useful descriptive manual, to which the author has wisely added "Hints on Refractors." The Berthon equatorial and the Berthon Observatory are illustrated and described.

We have also received *Tramways*, by D. K. Clark, C.E. (Crosby Lockwood and Co.); *Tramways*, by Ewing Matheson (E. and F. N. Spon); *Handbook of Practical Telegraphy*, by R. S. Culley (Longmans); *Rock Blasting*, by G. G. André, F.G.S. (E. and F. N. Spon); *Industrial Chemistry* (Payen's), edited by Dr. B. H. Paul (Longmans); *Principles of Machine Construction*, by E. Tomkins (W. Collins, Sons, and Co.); *The Polarisation of Light*, lecture by W. Spottiswoode, M.A. (W. Collins, Sons, and Co.); *A Descriptive Treatise on Mining Machinery*, by G. G. André, F.G.S. (E. and F. N. Spon); and *A Manual of the Carbon Process of Permanent Photography*, by Dr. Paul Liesegang, translated by R. B. Marston (Sampson Low and Co.).

THE WATCH AND HOW TO REPAIR IT.

By Seconds' Practical Watchmaker.

(Continued from page 6.)

Balance Slightly Foul of the Third Wheel.

SUCH a statement as this, at first sight, might be considered a joke, because in the general calliper of watches the third-wheel is planted far away from the balance, but there are movements of the half and three-quarter plate centre-seconds' construction, of Coventry and Liverpool manufacture, in which the third-wheel is so planted that the balance works under it. Fig. 61 represents such a model. The balance, B, and the third-wheel, A, constitute the parts necessary for reference in the present instance, though the illustration will be referred to on another occasion. It will be seen that the balance, B, works under the third-wheel, A. Now, it is no uncommon circumstance to find in a watch of this description that the freedom between the under part of the balance and the upper surface of the escape-cock, G, is very close, and that the balance requires to be quite flat to insure freedom of those parts; hence, workmen frequently raise the balance without due regard to the danger of the upper portion of the balance-rim, B, rubbing the under part of the third-wheel, A; and instances do occur that a workman may direct his attention to the under side of the balance, at the same time omit to look further; and if the thought occurs, the mind becomes satisfied that there is sufficient freedom. But, alas! there are many trippings connected with watch-work; and, as is too often the case with workmen, hurry to produce a certain amount of work, important "*littles*" are passed by and thought "near enough." The sketch, 61, is shown with the balance very close to the third-wheel (though much closer in the instrument), in order to direct the attention of the jobber to the necessity of looking with care at this apparently simple defect. For instance, when these freedoms are very close, and the balance-staff upper hole is wide—*i.e.*, too large—the least preponderance of the balance by side-shake permits rubbing of the balance against the third-wheel. How seldom do we find that such class of watches as here referred to have properly-sized jewel holes to the balance pivots? Again, a very small amount of excess of end-shake of the balance-staff will endanger these freedoms. Therefore, the flatness and end-shakes of the balance staff and third-wheel are indispensable.

Roller of Lever Watch, to Remove when Rusted on or Very Tight.

Seldom has the roller to be removed from the balance-staff; when occasion requires its removal—for instance, to put a new "ruby-pin"—and it is so firmly fixed that, instead of its coming off by the usual method, the balance would become loosened on its collet. In such case workmen should be cautious not to use force, because if the balance be twisted round from its original riveting, its truth and solidity are disturbed; therefore, the following method may be adopted with advantage. Fig. 62 represents a steel stake, A, as fixed in the vice. B is the form of its upper part, as viewed from above, having a slot filed in it from its point, A, towards its centre. Fig. 63 represents the roller as placed upon such stake, which passes between the bars of the balance. C is a section of a brass punch having a hole drilled in its end, which should be somewhat larger than the pivot of the balance-staff, in order that it may pass freely over the pivot, but rest upon its shoulder, whether the shoulder is coned or otherwise. The end of such punch should be so formed that if the face of it were to lie with its hole immediately over that of the roller, it would be free of the "ruby-pin;" therefore, by filing a portion of the body of the punch *flat* will insure such an arrangement as represented at D. It will be evident that when the back of the roller lies upon the stake, the punch, C, held upon the shoulder of the balance-staff pivot, that, by striking the end of the punch with a small hammer, the most tenaciously adhering rollers must be removed. Of course, the flatted side of the punch must be towards the "ruby-pin," else by a too sudden removal of the roller the pin become broken.

Verge, too much End-Shake Cause Slight Stopping of the Watch.

The verge having excess of end-shake has often caused trouble to "jobbers," especially when the foot-hole is considerably eccentric to the "passage"-hole of the potence. It has been frequently observed that, after a modern made verge has been worked-in, the watch frequently stopped, the cause of which seemed to defy detection. The term "modern verge" implies one of recent make, which generally has a longer lower pallet than those of former days. So soon as the watch was moved or opened it would start going. An experienced workman having such a trouble before him will direct attention to the potence to see if any impediment lies therein. If he sees that the lower hole is eccentric to the passage hole, he will notice whether the upper part of the lower pallet is foul at any point of it. Providing he is satisfied that the upper-pallet is free, two defects are suspected: 1st. That the edge of the pallet catches against the side of the passage-hole, and if that be free, he will suspect that the upper part of the lower-pallet catches the upper part of the "jaw" of the potence—*i.e.*, the opening in which the pallet moves. Hence, when the watch is lying upon its face, the pallet acts freely, but when it is lying with the dial upward, the excess of end-shake of the verge allows the lower pallet to go more into the passage-hole of the potence, also nearer to the upper part of its "jaw;" the result being stoppage of the watch until reversed in position.

To test the Freedom and Extent of Vibrations of a Verge Watch.

Most watch jobbers of the present day are familiar with the troubles and disappointments they have experienced connected with verge-watch repairing, and I believe that many will coincide with me when I state that a very large proportion of such troubles have resulted in connection with the "verge" pivots and their "holes." Many workmen, after having put a new hole or holes to the verge, and put the watch together, are troubled to obtain a *free action* of the vibrations of the balance, and not unfrequently "pass" such as the best that (as they consider) can be done with it. Many causes may be assigned for want of *freedom* in the action of a verge escapement, but new *verge* holes are very often the chief cause of failure, and the defective hole—for seldom are both at fault—cannot be detected because the pendulum spring has a property of carrying the balance in its excursions differently to motion which would result if the pendulum spring were removed; therefore, before putting a new verge hole, remove the pendulum spring. To test the freedom of the pivots in their holes, hold the frame with the cock downwards, press the balance upward, and if it fall freely it may be passed as worthy a trial. Next reverse the position of the frame, so that the balance is upward, and in a similar manner as before press the balance upwards and decide as to its freedom in that hole. Then, when the escapement is completed, and the watch "together," place the balance in its place without its pendulum spring, whereby its freedom, or want of such, can be detected much more readily than it could be if the pendulum spring were attached—holding the movement so that the freedom of each hold can be tested. The small amount of time occupied in removing and attaching the pendulum spring will be compensated by the readiness with which workmen can decide as to the seat of any defect in either hole, because the motions of the balance are slow, added to which the distance of the balance motion can be noted, and if its vibrations be free when acting on the lower pivot, and less so when acting on the upper one, workmen can, without any doubt, proceed to rectify the defect.

Fusee Click-work Failing.

To remedy such requires but little thought. However, it may be worthy noting that if a ratchet should have its teeth much worn, also thin at their points, sometimes by "filing them up," saves putting another, especially when the click is not thin; but if so, repairing a ratchet that is thin should not be attempted.

FIG. 61.

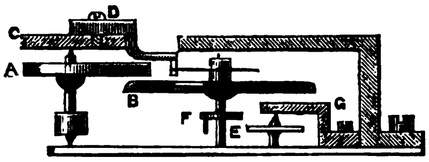


FIG. 62

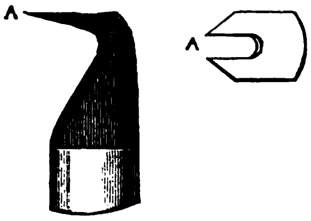
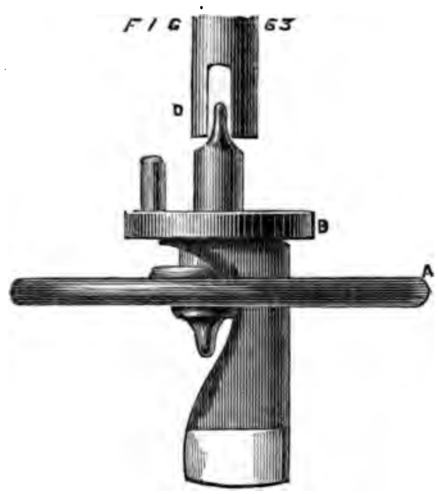


FIG 63



Repairing Verge Escapement.

When new holes are required to the escapement of a verge watch workmen should notice whether the balance is upright with the slide, because in many instances a defect may be remedied with very little additional time. Some old watches are often met with where the slide at the "circular silver piece" has become much raised through the application of another "curb," and that, when the "curb" is moved for regulation, such bulged part of the slide becomes more raised, and the balance being out of upright in that direction causes those two parts to become "foul." There are others which have the balance and slide with very little freedom, yet not upright, and when either of the verge holes becomes a little enlarged the balance rubs upon the slide. Now, if this defect be seen to before proceeding to take the watch to pieces, should a new dovetail or follower hole be needed, no other trouble is involved except putting the balance upright, which is frequently accomplished by putting the cock square — that is, by screwing it firmly down after the watch is to-pieces, resting its
edge upon a hard filing block, and stril
edge of the upper plate with a small m
even the handle of a pillar-file. Suc
ment refers only to a case where the
"leans" to either *side* of the cock, b
the balance is out of upright *endwise*
cock, the usual method of putting a ne
hole" must be followed. This defect of
not being *upright* I am sorry to sta
often neglected when, by so small an
of trouble, it might be made correct, in
as, when a new cock hole is required, th
way of proceeding is to drill a hole thro
old stopping—larger than the previous
probably the old "stopping" may be
—put in another, and after having ri
and smoothly finished its surface, the n
fitted, and the balance not upright, by
round the newly-applied "stopping"
instances the upright of the balance is
Then, should it happen that the balan
is unequal on the verge body, it can be c
by a new follower hole or another dove
that, should *either* of the two last-nam
be required, *two repairs* can be effected
little more additional trouble than one.

Slight "Stop" of Lever Watch

Watches that have a silver "index
should be carefully examined by rep
that part, because it is no uncommon
rence to find a small portion of a hair f
cleaning brush fast between such piece
upper-plate; sometimes so short has it
off not to be noticed. It has happened
occurrence of this kind caused cons
annoyance, inasmuch as the watch was
for the purpose of preventing undue w
after which it had the fault of stoppin
certain intervals. There was nothing to
the cause—for, as it had been to p
recently, the workman was reluctant to
thing to it, hoping to see it stopping;
a long time to no effect; ultimately, t
short bristle was discovered. In this i
the balance-edge and the curve of th
piece were very close, which preven
detection.

Another analogous case may be cite
produced similar results. A very fine h
the brush became fixed between the
head and the rim of a compensation
whereby at every vibration such hair
the edge of the upper plate at the
hollow. This impediment remained ful
months undiscovered, when the employe
tired of repeated complaints, gave th
another workman, who was successful
covering the cause of "stopping."

French Verge Watch Stop by the Cock

Though this kind of watch is be
scarcer every year, one occasionally m
appearance, and through a little care
recently one proved rather troublesom
kind referred to is a small-size one wit
the barrel-hollow very deep in the uppe
so that there was more than usual
necessary to get the chain on. Am
repairs the barrel-hollow had been "
out" to free the barrel. When the wa
complained of as "stopping," the w
was unwilling to take to pieces a w
troublesome to get the chain on it ag
the upper-plate could not be removed
the fusee flying out—hence, many a
were made to rectify it without taki
pieces again. When so done it was fou
although the barrel had been freed
hollow, the tap-end of the cock-screw
the steady-pin of the cock projected be
turned surface of the barrel-hollow; a
the *opening* in the barrel-cover caught
the end of the cock-screw. The tap
screw, as well as the steady-pin, was sh
and no further trouble resulted.

Diamond End-Piece not Screwed D

The security of jewels in their setti
their "seats" cannot be too carefully a
to. It matters not to which kind of w
jewellings belong, for, if the "end-p
say, of the cock or the escapement d
meet the "hole setting," the continue
of the watch will cause the hole to
loose, and the result will be that thro
jewel-hole being "toppled," the pivot

have a result similar to a *tight hole.* the constant pressure resulting from will cause much irregularity, as if the e too small for the pivot. Again, if it hat there is very little space between l" of the balance, and the cock jewel t is more than probable that, as the vibrates the jewel setting will be upon the "ball" of the balance. The eds no further remark.

gular Going of Verge Watches.

very common complaint that verge "go" irregularly. Many are the hich produce such, but there is one to which, if attended to, will save a deal ble, and assist in producing better It is no uncommon circumstance to the curb-pins, or the opening in the excessively "wide," and that, when ator (or curb) is somewhat central, the n-spring acts fairly and freely between ; but, as the curb is moved towards to check a "gaining" of the watch, successive movement of that curb the n-spring becomes pressed inward the centre of the watch, whereby the n-spring is so forced from its free at, instead of the regulating tending the watch to lose, the opposite effect ed. Therefore, it should be always by jobbers that, when the curb is at w"—*i. e.,* nearest to the pendulum-ud—the spring should be quite free e curb (whether it be by pins or other-nd that, as the regulator is moved "fast, the pendulum-spring be free s curb. Also that the freedom of the n-spring between such curb be limited four times the thickness of the spring. be attended to—other points of the ing fair—better time and results may from the *much-abused* verge watch.

ver Watch "Fall-off" or Stop.

be noticed that some lever watches potence roller hollow turned out ll size, and when such is the case we the "chain hollow" freedom leaves of the potence somewhat thin. It has l that by the removal of the potence of "pliers," the circular form of the llow has been destroyed—inasmuch as part of the potence has been forced y the pressure of the pliers, and when without being noticed endangers the of the roller—table-roller. Instances urred that, merely by the excess of e of the balance-staff pivots in their he edge of the roller has rubbed the pressed-in part of the potence, in a "noise," when listened to, and vibration.

(*To be continued.*)

THE LATHE.—III.

y Fred. Hoffmann, Engineer.

andle is riveted into the crank when ; the hole may be drilled a little oval, an easy thing to do, to prevent the orking loose and turning round, and ter-sink should not be too shallow. a variety even in handles among diffe-kers (see Fig. 1). Some make the e shape of a trowel-handle, and some while others again cover their handles e. This last is decidedly the best, as the handles are excessively cold, and perhaps, no trade in engineering there is so little exertion required, the man cannot turn to any great th his hands very cold. Of the two ethods, the last is the easiest to forge and to the taste of many men looks turning the crank part of the handle is made like Fig. 2, generally in a ck; it is then turned and bored, and elded on to any length, and after-aped, often on a special shaping used for shaping radial and circular This plan of welding on a piece after-bles the bosses of any sized handle ed on quite a small lathe. The boss rilled and bored, and turned after-a mandrel. We now come to the second sliding piece of the slide-rest. This should overhang the third piece on the side remote from the face-plate, so that it will not be in the way of any work fixed for turning, and so that a hole may be drilled to let out the dirt and water (Fig. 3). The second piece is formed with a boss on the under side, which fits into a corresponding recess in the third piece, and in which it should turn loosely, but without any shake. This circular groove allows the two top pieces to be set at any angle, and also prevents the two locking nuts from getting jammed in their grooves when altering the taper. A mark should be made, showing when the rest is set parallel with the centres, and other marks may be put on with advantage—for instance, taper 1·8 for plugs of cocks, &c. The circular gutter for the locking nuts may either be square or V-shaped, and is cut on the lathe (Fig. 4). When a number of lathes are being made, these locking nuts may all be turned at once on a plate. There should be plenty of room left for tightening up these locking nuts with a spanner, and if this is not done, they cannot be tightened properly, and the consequence is that in turning anything parallel, the slide often swings round, especially when the top piece is at the end of the second piece. These nuts may either lie entirely under the level of the slide above (Fig. 5), in which case the nut is very shallow, and a specially thin spanner has to be used, or else they are made to lie entirely outside the slide (Fig. 6). The sliding surfaces should not be too broad, and should be cast undercut at the ends as in Fig. 7.

FIG. 1.

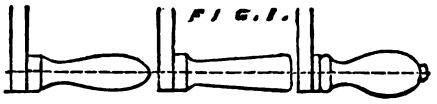


FIG. 2.

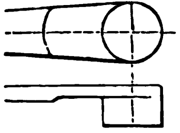


FIG. 4.

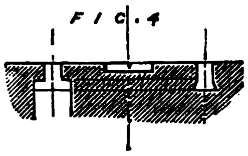


FIG. 3.

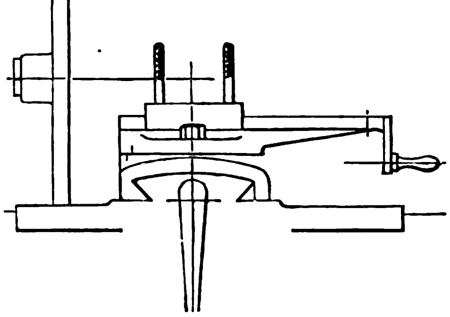


FIG. 5.

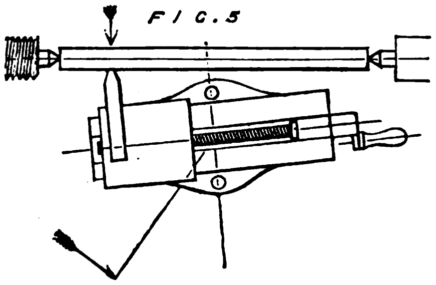


FIG. 6.

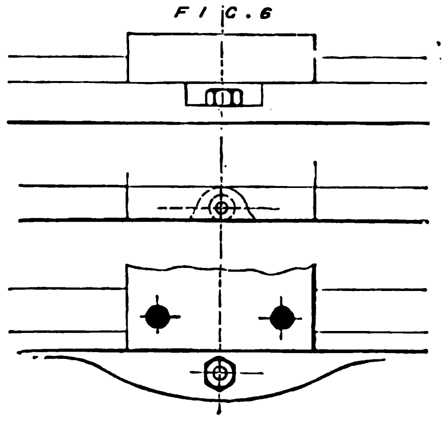


FIG. 7.

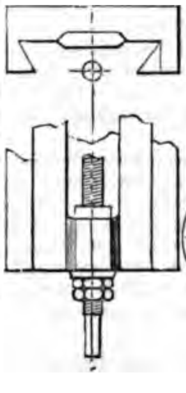


FIG. 8.

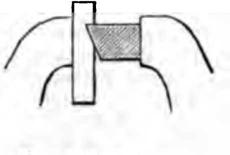


FIG. 9.

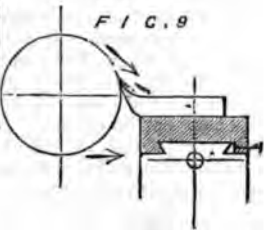
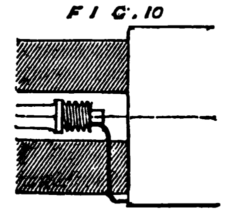


FIG. 10.



A variety of different slips may be used in a lathe, they must all of them be able to be tightened one way, and it is better to use those that are tightened both ways. If any set-screws used for this purpose come to the top of the lathe, they must be arranged, if possible, so that they can be tightened or slackened when the tool is set for turning. Slips or strips may be cast iron or wrought; wrought is the best, as it will not break. There is always some little difficulty in planing or filing and chipping these strips. They may, however, be easily gripped in the vice, thus (Fig. 8) by nicking two pieces of wrought iron to the same shape as the forging of the strip. As the action of the lathe tends to push the slides outways, it is better, if possible, to have the slips arranged so that the solid part of the rest takes the pressure. It may also be noticed (Fig. 9) that the accuracy desired in turning long spindles parallel is derived from the edge of the lathe bed, which should, for that reason, be touched as little as possible with the file, and should have the planing marks left in. In screw-cutting lathes the slip must in most arrangements be on the far side. It is a great advantage, especially in gap lathes, to have a good length of saddle, as in some classes of work, say large pulleys, fly-wheels, &c., the saddle must come as close as possible to the faceplate. The saddle is hollowed out at the back, so that it can go back as far as possible, as it is always bad to have to screw out the movable centre, especially in turning anything of small diameter, when the work is apt to "ride" over the tool. It is usual to provide the saddle with a locking nut for holding the saddle firm in cross traversing. There are such a large number of different arrangements of gearing made for feeding the slides, for turning with two tools (in which case the cross traverse screw is right and left handed), and for surfacing, &c., that it would be beyond the scope of these remarks to describe their individual action. Nor are the difficulties in turning generally found in these different gears, but generally in the simple operations of chucking work, setting and grinding, and packing the tool, arranging the speeds, getting the belt to its proper tension, staying long spindles or screwed shafts, and in screw-cutting, putting on the change wheels properly. No matter how true the lathe is, if some simple principles are not attended to it is impossible to turn out accurate work. To begin with, in sliding shafts slide them both ways up and down, and in facing up anything, say a faceplate, take a cut in, and then a cut out, for if the cut is taken all one way the result will be either a round or hollow faceplate, through no fault of the lathe. To see if the saddle is square to the bed and faceplate take out the centre and put in a bent scriber tight, then turn the lathe spindle from one side to the other (Fig. 10).

To be continued.)

THE ORGAN: A COMPREHENSIVE TREATISE ON ITS MANUFACTURE, PROCURAL, AND LODGMENT.*

By JOHN WATSON WARMAN,

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PART I.—GENERAL TREATMENT IN MANUFACTURE.

p. *Four Manuals.* 45, Heavies, to Tubas; Middle to Pneumatic, and remainder of Solo, and whole of Swell, and Ped. Reed-and-Chorus portion. 46 (see also Nos. 4 and 11 *a.*), Heaviest to Tubas; Middle to Pneumatic, and remainder of Solo, and Swell Reed-and-Chorus, and Pedale Reed-and-Chorus portions. 47 (see also Nos. 4 and 11 *a.*) like No. 46, except that Middle wind includes Great Reeds. For Nos. 48 and 49 see Nos. 19 and 20. See also at end of these INSTANCES (11, z.); also BORROWINGS (26 e. to end).

q. No. 45 is considered by author the best arrangement here. It will be seen that the division of the Swell for the purpose of supplementing the Pedale is not given in this, but in Nos. 46 and 47; the reason being that, although the presence of the Choir provides as before for the Pedale, and it is now more than ever necessary that the Swell be able to hold its own (for not only are there three other Manuals present, but Pneumatic action—which here is of course necessary,—will or ought to enable them all to be united), yet at same time this very circumstance renders it necessary that Pedale be commensurate: therefore when Ped. *small*, or part of Solo in *box*, or whole of it *small*, or Swell *well* able to take care of itself, or Choir-to-Great absent (this last here ought never to be, *see* SPECIFICATIONS), then under one or more of these it becomes a consideration whether No. 46 (*see* also Nos. 4 and 11, *a.*) should not be used instead. No. 47 (*see* also Nos. 4 and 11 *a.*) should not be used unless the Organ is under-reeded or great Reed-power is desired.

r. It will be seen that no arrangement is given for one pressure throughout entire Pedale; the reason being that more than one pressure on that department may be now looked on as essential (*see* reasons, 10, e.), and the necessary space for the two Front-boards *must* now be allowed. The Ped. has to provide Bass for delicate Choir as well as Tubas (which now with three pressures ought not to be restricted in their power by wind considerations), and it is obvious it cannot do this thoroughly with only one pressure. In consequence of this the difficulty with the 16ft. Reeds before-mentioned (*see* 11, n.) will not exist here, for the Swell Reeds will be powerful in any case, and even if 16ft. Swell Reed is absent (which, as a rule, it certainly ought *not* to be) a *Sub-oct. to Swell* on itself is generally practicable, and, if there be no 16ft. Reed either in Swell or Great, ought to be insisted on.

s. In larger Instruments the Great will have a 16ft. Reed as a matter of course, but a preferable method (where it is not advisable to have more than one 16ft. Manual Reed) will be to put a second 16ft. Reed of soft tone—a free reed will be here excellent—on the lighter-pressure portion of the Pedale; the Register running, as do the Flues of this portion, to G G G, and of course, like them, included in the "Part Sub-octave to Ped." The performer will thus have not only an alternative 16ft. Reed on his Pedale, but a soft useful 32ft. Reed down to G G G; the break being covered by the continuity of the loud Ped. Reeds as that of the Flues is by the Flue Chorus of the same Section. Here it is that the apportionment of two pressures to the Pedale is so valuable.

t. The new Organ in Manchester Cathedral, by Hill, has its heaviest Pressure for *Tuba* and *Harmonic Flute*, its middle for *Pneumatic*, and the *whole of remainder* on the lightest, this latter being 2¾ inches only.

u. The Organ built by Hook and Hastings, of Boston, for the Philadelphia Centennial, had heaviest for *Tubas*; middle for *Pedale*, *Motors*, and *part of Great*. This Instrument received the prize medal.

v. MORE THAN THREE PRESSURES. It will not be necessary to go at length here into particular instances; the Heaviest wind will generally take as before the Tubas, with perhaps the Pneumatic to Draw or Composition Action, if there be such; the next-to-Heav. will take Touch, Pneumatic, and remainder of Solo (or portion of it), and perhaps a portion of Pedale; the remaining two pressures will be apportioned on same rules as in the Instances already given. As pressures increase to even more than four it will be very easy to apportion with regard to due effect; in very large Instruments very powerful pressures will be required as Motors for the Composition Action, as at the Albert Hall; but Organs of this magnitude will as a rule be undertaken only by those who are well experienced in every part of the Instrument, and it would be, in fact, an impertinence in the present writer to lay down rules for their guidance. The aim has been in this portion of the work to point out how the smallest numbers of pressures may be best economised.

w. It must have been observed that the keeping the Ped. wind distinct from the Manual merely for avoidance of assumed chance of disturbance of latter has been totally ignored, and it will be as clearly seen how vexatious and mischievous a restriction such a procedure would have become. This is fully gone into in CHOICE OF NUMBER OF PRESSURES (next *Sub-division* 12, q. to 13, a.).

x. The large Instrument built by Bryceson for Mr. Holmes, of Regent's Park, has—Echo, *one half inch*; Choir, 2in.; Great entire and Swell Flue, 4in.; Swell Reeds, Pedale, and Solo, 6in.

y. The Organ built by Mr. W. Hill for the Panopticon, Leicester-square, London, had six distinct pressures.

z. It is necessary to bear in mind that all preceding arrangements are as supposing Bellows of usual or regular form—that is, an ordinary Horizontal Receiver with two or more hinged single-action Feeders of *total area* not exceeding (or not *much* exceeding) the total area of Receiver: the lighter pressure either with a Reservoir without any Feeders, or its own Feeders of form as just said, and with a disconnecting valve.

[12, a.] But, as already seen (7, f.), where space is limited it is sometimes necessary either to forego the two pressures or obtain them with but one—a *Combination*—Bellows (7, g.); in such event the Apportionment should be so managed either that the lighter supplies a very *small* portion of the Pipe-work, or else a *considerable* portion of it, or else that every Register *partakes* of the two pressures: it will be seen that the object in all three cases is to prevent the Bellows being at any time practically converted into one in which the *Feeder area* palpably exceeds the *area of Receiver*, that is—with Combined Bellows—the area of the Upper-board giving the *heavier* pressure.

b. The first method would be attained by (No. 48) placing Choir on lighter and everything else on heavier, or (No. 49) bottoms of Swell Reeds and of Swell Chorus on lighter, and everything else on heavier.

c. The second admits of more variety, thus:—No. 50; All Manuals on lighter, Pedale only on heavier. 51, Great, Ped., and Choir on lighter, and Swell only on heavier. 52, Reeds only (or) a portion of them on the heavier. 53, Pneumatic only on the heavier. 54, Pneumatic and Reeds (or portion of them) on the heavier. 55, Pneumatic and Pedale on the heavier.

d. The third method would be:—

No. 56, Trebles on heavier, and Basses on lighter.

See also Borrowings (26 e. to end).

No. 48 will be very useful for small 3-Man. Organ—in fact, with this number of Mans. be regarded as the normal arrangement with Combined Bellows.

No. 49 is inferior.

No. 50 is only recommended when Pedale incommensurate.

No. 51 is excellent when Swell incommensurate.

No. 52 will be excellent in a not very la Organ, where yet some powerful stops desired.

No. 53, not of much use, as Organs w Pneumatic generally want two blowists.

No. 54. Preceding holds good.

No. 55 is a simple and handy arrangem particularly with small Pedale.

No. 56 not (in author's opinion) worth ting two pressures for in so small an Organ.

e. Other arrangements may occur to any telligent Builder.

f. It will be understood that these all h equally good when Organ has a distinct Re voir for the lighter pressure, but Feeders, thou attached only to the heavier Receiver, are eit Whole-drop or Double-acting. And it will also borne in mind that both this lat arrangement and the Combined Bellows only recommended (and, in fact, intended) wl room is scarce. Still, with observance of foregoing arrangements, a satisfactory res may so be obtained. It is assumed through that Organ will not be larger than one blow —at all events, an adult—can supply.

g. *See* further in RESERVOIRS (15, e.).

** DETERMINATION.

h. It will be apparent that the Determi tion of the actual pressure to be employed i matter of very great importance; it is, h ever, not fully gone into here for reasons wh are given a little farther on. Choice of Num of distinct pressures is for obvious reasons m fully treated at this stage.

i. *See* also carefully in BORROWINGS, p ticularly from one Clavier to another.

* CHOICE OF NUMBER OF PRESSURES.

j. The Determination of the number of tinct pressures that shall be employed is trea at this stage more fully than the choice of ex pressure; and for this reason, that while latter can within wide limits be varied at pl sure after the entire Instrument has been l out, it will be obvious that such laying out m be inevitably much affected by the number different pressures selected, for although square content of the wind supply may rem the same, yet the shape and arrangement Bellows, and the Framing necessary for th support will require modification accordin *See* fully in GENERAL ARRANGEMENT.

k. We may, I think, with confidence down these three chief rules (to a cert extent antagonistic to each other):—

1. That more pressure than one will ine ably add to the *elaboration* of the Instrume

2. That, setting aside Mechanical Motors Solo Organ, very excellent results can be tained with *but one* pressure.

3. That a properly complete and devel Instrument even though not large, dem *more than one* pressure.

To apply these we may observe the fol ing:—

l. *One Manual.* With but one Manual author would strongly reprehend any divi of pressure, one being sufficient in all but exceptional cases (*see* INSTANCES, 10, x.).

m. *Two Mans.* With not more than Mans. the author would dissuade from than one pressure almost as strongly as but one Man., *unless* either the Organ be large for one person to blow, or there Pneumatic. And both these last are undesi in this case; however large and compl two Man. may be, still it can never be com surate for really classical performances even for effective accompaniment, witho third Man.; and in point of fact the large finer the Instrument the more unsatisfa will it be here, for the want of the Manual will seem more exasperating there be present so many Registers that suitably have been placed on it. See also BOWINGS (26, e. to end).

n. *Three Mans., one a Choir.* When are Great Swell and *Choir* a second pre may be viewed as highly *desirable*, alth not absolutely *necessary* unless the touc Swell and Great united will be too hea allow Pneumatic to be dispensed with, in w case a second pressure follows as a matt course; so also does it when the entire In too large for one person to blow, for it ›bviously be unwise to provide a second without availing oneself of the oppor- 'or change of pressure. More than two es are not, as a rule, here advocated, ry really complete Instrument must ur Manuals, and it may be said that all :ntial effects of which *these* three Mans. able are producible with no more than essures; when the third manual is a gan the case is, of course, different—see See also BORROWINGS (26, e. to end).

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(*To be continued.*)

GUNPOWDER.—I.

3Y JOHN JOSEPH LAKE, F.M.S.

Formerly of the Ordnance Department.

date of the invention of gunpowder is st in the mists of antiquity, and it is le that the material we know as such ıdually discovered, for we find mention ɜral combustibles that do not accord with it.

ed gives a translation from the Gentoo follows:—"The magistrate shall not ar with any deceitful machine, nor with d weapons, nor with cannons and guns, · kind of firearms." Assuming this re- as first written, unimproved by later or copyists, it gives the invention a very .tiquity.

ɜrning the above law Halhed says:— ll no doubt strike the reader with to find a prohibition of firearms in re- ' such unfathomable antiquity, and will y hence renew the suspicion, which has en deemed absurd, that Alexander the :id absolutely meet with some weapon kind in India, as a passage in Quintus seems to ascertain. Gunpowder has ıown in China as well as in Hindostan, ond all periods of investigation. The irearms' is literally, Sanscrit, *agneeaster*, ɔn of fire; they describe the first species ɔ have been a kind of dart, or arrow, with fire, and discharged upon the enemy bamboo. Among several extraordinary ies of this weapon one was that, after aken its flight, it divided into several e streams of flame—each of which took .nd which, when once kindled, could not nguished; but this kind of agneeaster lost. Cannon, in the Sanscrit idiom is *shet-agnee*, or the weapon that kills a ɪ men at once—from *shete*, a hundred, *ɜneh*, to kill; and the Pooran Shasters ›ries ascribe the invention of these de- 'e engines to *Beeshookerma*, the artist who ɜd to have forged all the weapons for · which was maintained between Dewta soor (Devata and Assura), or the good l spirit for the space of 100 years."*

great wall of China, built B.C. 221, has ures concerning which it is said, "the f the embrasures are pierced with small imilar to those used in Europe for the ɔn of the swivels or wall-pieces. The ppear to be part of the original construc- the wall, and it seems difficult to assign ı any other purpose than that of resis- ɔ the recoil of fire-arms."†

ns carries the antiquity of powder very ınd refers to Virgil, where the latter to Salmoneus' attempt to imitate r.‡ To come to more recent times. It is :hat the Arabs used gunpowder at the f Mecca, A.D. 690, and it is highly prob- ıt Roger Bacon obtained his knowledge of the enlightened and polished Saracens of during his travels in that country, a : concerning it, written in the year 1249, ; in the collection at the Escurial.§ The ıs no doubt acquired their knowledge of India or China. Bacon made the secret :nown in Latin, according to the custom ime, concealing one of the ingredients .he words *lura nope cum umbre*, which ince been shown to be the letters of *carbonum pulvere*, powder of charcoal, transposed, and this with sulphur and saltpetre, named by him distinctly, completes the ingredients of gunpowder. Bartholdus Schwartz (1336), Constantine Anelzen, and Polydore Vergil amongst moderns, have respectively had the honour of the invention assigned to them; but Bacon knew of it previously, and did not even claim it as his own, as is proved by his description of the cracker—"the childish amusement which exists in many parts of the world."

Firearms were known in Florence in 1325, and they appear in the public accounts of France in 1335—1345. Chased, a Hindu poet (A.D. 1200), speaks of their loud report.

The awkwardness of the matchlock, and rude character of the cannon at first constructed, were serious impediments in the way of the general use of gunpowder in war—in addition to the pertinacity with which mankind adhere to old habits and associations. To use his matchlock the soldier required a powder-flask, touch-box, leathern bag of bullets, and burning match. Further, he had to carry a sword for defence when his piece was discharged, bayonets not having been invented until a later period, and a rest for his matchlock as high as his shoulder. Bows and arrows long maintained their ascendency in consequence of these defects, and were preferred so late as the time of Queen Elizabeth. Shakespeare alludes to the prejudice against firearms and villainous saltpetre, in Hotspur's description of a dandy, who told him

> "That it was a great pity, so it was,
> That villainous saltpetre should be digg'd
> Out of the bowels of the harmless earth,
> Which many a good tall fellow had destroy'd
> So cowardly; and, but for these vile guns,
> He would himself have been a soldier.
> —King Henry IV., Pt. 1.

For the manufacture of gunpowder it is necessary that the ingredients should be of the greatest possible purity. Government charcoal is prepared from alder, willow or dogwood. Braddock in a *Memoir on Gunpowder*, says that the grambuth plant (*Cytisus cajan*) and milk-hedge (*Euphorbia tiraculli*), and the *Parkinsonia*, are suitable for it; as are also poplar, lime, horse chestnut, chestnut, hazel, and others. When the wood has been selected it is cleared of bark, cut into pieces of convenient size, and distilled in iron retorts. It is more suitably prepared in this way, and the products, such as pyroligneous acid, lost in the old way, are preserved. The charcoal having been powdered, and all imperfect pieces removed, it is now passed through lawn sieves, ground, and then passed through a bolting sieve of brass wire until its particles are reduced, as near as possible, to the same size as those of the saltpetre and sulphur, so as to enable them all to mix together in the most intimate manner. The powder made from charcoal, prepared in iron cylinders, is known as "cylinder powder." that from pit charcoal is called "pit powder,"

Saltpetre, or as otherwise named nitre, nitrate of potash, or potassic nitrate (NO_2Ko) is a compound of nitric acid and potash. The commercial saltpetre of this country comes from India, where it is obtained from the soil. Its production is aided by art. The grass of the country is burnt and left exposed all the winter in this state; the salts released by the fire are washed into the valleys during the rainy season, where, exposed to the heat of the sun, the moisture is evaporated, and the salt is left mixed with the soil, or is found in a state of efflorescence upon it. There are many contrivances to collect the saltpetre; the streams, for instance, are led into reservoirs or tanks, where the solution becomes concentrated by solar evaporation, and is afterwards reduced to a solid state artificially. The salt is also procured from the soil by digging large pits, and the nitrous earth, which is commonly of a whitish, black, or red colour, is deposited in them with water and kept well stirred. When the solid matter has subsided the water is drawn off into another smaller pit, the clear part collected from the top and evaporated, leaving the solid salt. In warm climates the earth becomes extensively impregnated with this salt, which is washed out, and the soil, in about a year, becomes again impregnated, if spread out and exposed to the atmosphere. By the charter of the East India Company of 1693 they were bound to supply Government with 500 tons of saltpetre at £38 10s. per ton in time of peace, and £45 during war.

During the war of the French revolution France was in difficulties about this preparation, and Napoleon appealed to the men of science. A commission was appointed, and "nitre beds" were established. Old walls were appropriated, demolished, and the débris placed in these beds, with lime, wood ashes, and all kinds of refuse, and they were hence rendered independent of foreign supply. Glauber had previously given a description of this process.

The saltpetre of commerce requires purification before it is fit for the manufacture of gunpowder, to remove the foreign salts and other impurities that are always more or less mixed with it. When it is dissolved, earthy matters sink to the bottom, and lighter float on the top, and are skimmed off. Chlorides of calcium and magnesium are separated by the nitrate of potash being less soluble in water and forming itself into crystals, whilst the others remain in solution. Other salts are removed by analogous processes.

Saltpetre crystallises in rhombic prisms; the solution in water does not act on litmus; it has a cooling, saline taste; it fuses at about 616° Fahr., and this operation requires care, as it undergoes partial decomposition at a high temperature.

Saltpetre, in the Government powder mills, after having been trebly refined, is melted into cakes. When required these are well brushed, and then broken into pieces by a wooden mallet, and ground in the saltpetre mill until sufficiently reduced for the pieces to pass through a fine wire sieve, worked in a covered hopper, or large funnel, formed of wood, a tub to receive the saltpetre being placed below. A cushion is placed between the tub and hopper, to keep the lighter particles of the salt from flying off. The French prevent their nitre from forming into cakes by evaporating it under ebullition, which dries it in a disintegrated state.

The sulphur is purified by sublimation or melting. By sublimation, sulphur vapourising at 170° Fahr., all impurities are left behind. In melting the heavier impurities sink to the bottom, the lighter ones rise to the top, so that the intermediate portion is pure. The sulphur is not employed as being essential to gunpowder, its use being purely utilitarian. It gives solidity to the mass, and any other ingredient that would answer the purpose without affecting the relations of carbon and saltpetre would, unless vitiated by some other circumstances, answer the same purpose. The best sulphur for these purposes is procured from Sicily and other volcanic districts.

Proper proportions of the ingredients being placed in a charge tub in alternate layers—the greater the number of the layers the better—they are mixed by means of a pronged wooden instrument worked by a handle at top. When this mixture has been satisfactorily accomplished they are passed through a fine brass-wire sieve and wooden hopper or funnel into another tub and stirred as before. This is one method amongst others. The ingredients are then carried to the powder-mill, in which is fixed a stone bed,* and on this two millstones, weighing between three and four tons each, revolve. The mixture is equally and carefully spread on the bed, all dust that may have arisen being carefully swept off the apparatus. The charge is levelled by several revolutions of the stones and then sprinkled with a little cold water from a copper watering pot. The quantity of water supplied depends on the state of the stones and the hygrometrical condition of the atmosphere at the time, according to the judgment of the attendant. Not more than 42lb. are allowed as a charge. The strength of the powder depends much on the rapidity of the revolution of the millstones as well as the length of time of trituration, for with a velocity of 7¼ revolutions a minute for three hours, powder of equal strength has been obtained to that of other charges worked for five hours with a velocity of 4½ revolutions per minute. Three hours are an average time for this operation, but it has to be left to the judgment of the millman, for when a charge may be thought to be nearly completed an unexpected change may occur which may render further working necessary, owing to an alteration in the state of the atmosphere, which materially affects the process. When it has arrived at the condition technically known as alive, it glides from beneath the stones without attaching itself to them, and is then conveyed to the press-room. At this stage a sample is taken and granulated by a hand-engine for proof. In the press-room the mill-cake, as it is now called, is laid in the press in layers 3in. thick, a copper plate being laid between each layer, until the press is full, and submitted to pressure.

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* 's Translation of the Gentoo Laws, p. 1., Ed. 1781.

† Staunton's Embassy to China, ii., 198.

‡ i et crudeles dantem Salmonea pœnas,
a flammas Jovis et sonitus imitatur Olympi.
—Æn. vi., 585.

§ iry into the Origin of Discoveries Attributed to :rns, p. 262, Ed. Eng. 1769.

* Sandstone is not fit for the purpose on account of the quartz in it.

Pressure was not used in the early manufacture of gunpowder, but it is necessary to enable the grain to resist deterioration from moisture and transport. The duration of the pressure depends much on the state of the atmosphere. When the cake is in a proper condition it is removed from the press and broken with a wooden maul, placed in a breaking trough, and then further broken into pieces about the size of a pea, and put into corning or graining sieves. Each of these has two discs of lignum vitæ, which, by a circular motion, further reduce the pieces until the grains pass through the meshes of the sieve into another one, which only permits the dust to pass through it into a trough below. The grains thus reduced are placed in separating sieves, the holes in which act as gauges and prevent the passage of all irregular or improper pieces.

The drying process which follows is usually conducted in small rooms, called stoves, heated by steam so that they can never be raised to the explosive point, but the proper temperature for the operation is about 100° Fahr. Small quantities of the powder are placed in wooden trays which are laid on racks in the stove and so exposed for about 36 hours. It is then passed through a sieve, consisting of two inclined planes covered with fine brass wire. By this means the powder is cooled, and any lumps that may have been formed during the operation of drying are removed.

The next operation, glazing, is performed in what are called reels, covered with lawn or canvas of a kind that will admit of dust and very small grains passing through. These reels are cylinders, and being revolved with considerable velocity, the powder is glazed by the friction to which it is thus exposed for about half an hour.

The different-sized grains are now separated from each other by sieves of different gauges. In the Government works these are known as large-grain and fine-grain powder. The large kind is used for ordnance, the other for small arms. The grain of powder for fowling pieces is still finer than that used by Government for small arms. Since the introduction of the 38-ton and other large guns, pebble powder has been introduced, the size of the grains giving the name to the preparation. The object of the enlargement of the grain is to reduce the rapidity of ignition. The powder used for priming the ancient matchlocks was merely dust. It was called *serpentine* powder from the part of the lock that held the match.

Blasting powder is inferior in strength to Government and good sporting powder; the disruption is not so violent, and it gives in consequence what miners call a *heave*.

The French, in their thirst for new things during the first revolution, introduced spherical or round-grain powder. I have seen some in the Mediterranean, and the barrel being marked "Turin, 1790," it was evidently a capture. This form was given to it by a rotatory motion in sieves. The first trial in the fourth year of the Republic was in its favour, but it did not afterwards answer better than ordinary powder, and, when used in small arms, was found not readily to inflame in the pan of the musket.

The method our ancestors pursued in manufacturing gunpowder on its first introduction was singular. They used charcoal from the softest woods, sometimes mixing with it the ashes of linen, rags, and straw. The sulphur was reduced by sublimation. The ingredients being prepared the saltpetre was dissolved in water, the sulphur and charcoal powder added, and the whole well mixed by constant stirring. Under the notion of giving additional force to the powder they added wine, brandy, vinegar, and the like. The mixture was not submitted to pressure, but when dry was granulated much in the way we now adopt.

As already noticed a solid grain is not absolutely necessary to produce explosive effects; which the French, during the long war of the revolution, occasionally took advantage of, when, from want of powder, they were in difficulties and at the same time able to procure the necessary ingredients. These they pulverised, and mixing them in proper proportions added a little moisture to give them sufficient consistency. When shaken sufficiently a tolerable rough kind of powder resulted to meet the emergency fairly.

(*To be concluded.*)

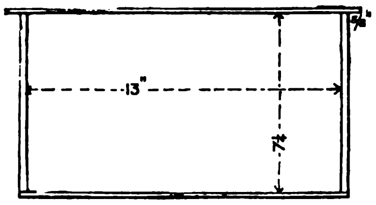
BEE MANAGEMENT.

SECTION II.

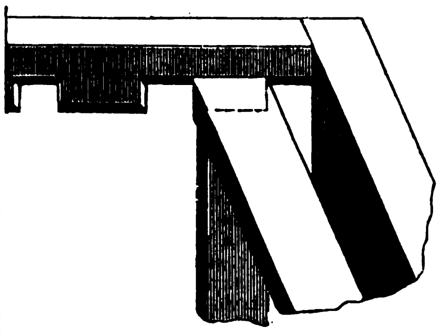
Bar-Frame Hives.

Introduction.

Any person who has kept bees for any length of time in straw skeps, must have often desired to possess a greater knowledge of the interior of his hives than an inspection of his hives, when inverted, would ever give him. This want has been gradually overcome, and in the present bar-frame we have a hive which admits of an inspection of any part of its interior at any time without damaging or destroying the combs or their contents.



Woodbury Bar-frame.



Interior of Woodbury hive, showing position of "distance notches" and end of bars.

The principle is exactly the same in all bar-frames, though the inventor of each hive has gone a different way to obtain the same result. The advantages of the bar-frame over the skep are numerous, as will be shown in describing the details of each hive; and, though perfection is not yet arrived at, the spirit of improvement is making rapid strides in that direction, and the bar-frames of the present day are such as to call forth admiration at the amount of ingenuity that has been bestowed upon them.

The principle of the bar-frame may be briefly described as follows:—A number of frames are fixed in the interior of the hive, means being taken to make the bees build their combs inside the frame, so that each comb may be easily removed (in its inclosing frame) at any time for inspection or manipulation, and returned to its place as easily.

In a bar-frame hive the size of frame is of great importance, and should be regulated by the situation of the apiary.

I find that a large frame is not so good as a moderate-sized one, for the following reasons: Firstly, it is much more difficult to get bees to take to supers in a hive with deep frames; secondly, the impressed sheets, which are of great use to the bees in reducing their labours, cannot be fixed in large frames without fear
of the weight of the bees on so large a s
breaking the sheet from the bar. I the
prefer a hive in which capacity is gain
increasing, not the *size*, but the *number*
bars.

The Woodbury bar has been taken
standard by many hive-makers, and fr
moderate size is perhaps more likely
adopted as a universal standard—shoul
an agreement ever occur—than a larger

The objections I have already given
latter, of course, apply to their use in an a
in a favourable as well as an unfavo
situation.

The most generally used hives are
bury's, Cheshire's, Abbott's, and the Stew
A more recently introduced hive, the
sional, differs from all the preceding.

The Woodbury Hive.

The Woodbury hive consists of an oute
of wood or straw 14½in. square inside, an
deep, on one side of which there is a w
7½ by 4. The door of the hive is cut i
floor board, but is not large enough for
strong hive at the height of the honey s
The crown board is in one piece, and h
hole in the centre for feeding, and two
nearer the sides for supering purposes.

The hive contains 10 bars of the dime
shown in the sketch, and are construct
top and sides of ⅜in., and the bottom
wood, being ¼in. wide.

The projections at the top of bar, techn
termed "ears," are ⅜in. long, each of
falling into a notch cut in the hive si
that the right distance between the b
maintained. The bars are not level wi
top of the hive, but fall ¼in. below, s
there is a ¼ space between the crown
and top of the bars. This space sho
kept filled with carpet or felt to preve
bees reaching the bar ends, or crown boar
propolising them fast.

It will be evident to any one that su
provements as have been made in bar-
hives, more recently introduced, may ea
adapted to the Woodbury with advanta
above description being that of the hive
original form. The objections to thi
will be evident when describing other im
hives, without pointing out such obje
here.

W. S. Tra

NOTES ON SOME POINTS IN BO MAKING.*

By Robert Briggs, C.E.

The recent inspection, by the writer, of a p
standard drawing of a common extern
tubular boiler, such as now has so general u
this country, brought to notice two errors
struction in general, almost universal, p
which it may be of some avail to discuss.
example referred to, there was shown a flat
steam dome, with stays to strengthen it,
down to the sides of the dome diagonall
steam pipe was taken off from the middle
flat dome sheet. Now it may be admitted
staying of sheet, which was three feet in d
was ample for the pressure proposed to be
so that the conditions for *use* of the boil
abundantly fulfilled; but it is contended th
strength could have been had, by giving th
form to the head sheet without staying at all
it is perfectly well known that the streng
spherical shell or of any portion of a spheric
is twice as great as that of the shell of a cy
the same diameter; or on the other hand
spherical shell, or part of a spherical shell, p
the same strength as a cylindric shell of t
thickness, when the radius of the spherical s
equal to the diameter of the cylindric one.
last case, when the rule stated is applied
head of the dome or end of the boiler, which
formed to a part of a spherical surface who
is the diameter of the dome or boiler, the
end is "dished" out 0·134 times the diamet
head or end. A three-foot head requir
dished only 0·4 of a foot (about 4 13-16 i
order to give the same strength to resist
pressure, for both head and shell, of the sa
ness of iron. A little allowance is needed
thinning of the sheet iron in *dishing* in s
as it may be thought proper, that the thic
preserved to an equality with that of t
This allowance is easily computed. The s
the flat circular plate is, to that of the dish
as 1 to 1·072. That is, the thickness of th

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* From the *Polytechnic Review*.

ıing, should be about 7 per cent. greater ıf the iron of the shell. This extra thick- ver, is a refinement to the boiler-maker ıo would sell or buy, the cheapest boiler with full requirements for strength; as ıg of the head will inevitably upset the f to a thickness much above the original ıt a dished head, as above described, of ırdinary shell thickness, will be much ıan the shell sheets at the joints, where they ıed by the rivet holes, even with the ıted longitudinal seams,

onsiderations apply more particularly to ıing in America, where it would be diffi- cure iron so poor that it would not dish thout impairment of strength, such iron ıble of flanging at any heat; yet the same applies to English boiler work, although, nt use of egg-end boilers seems to indicate ıgument here advanced has not been en- ır appreciated. In this country, certainly, waste of money to make a flat stayed head, ıhed one will answer, The next point to . is the use of cast iron bonnet manhole ıhe cylindric portion of a boiler when a ı wanted on such a surface. First, within ınable limit of curvature, it can be affirmed t manhole is just as good for service as a For shells of 3½ feet in diameter and above, ısolutely true. Double clips are always a one; but with one clip, it is practicable s good a joint as any steam engineer may h such bent manholes, and a rubber, or efer, a hemp-plait gasket filled with red lead (with a little litharge if in a hurry).

for all places, both curved and flat, a ron manhole ring is better than a cast-iron s safer, easier to make up to the boiler, the difference of weight is considered, it ıf not quite as cheap as a cast-iron ring ıre should be taken to make the wrought- ı heavy enough. Most of the failures to have been occasioned by *saving* in but material enough to give strength to , where it has been weakened by the man- ıple for all purposes, and the dimensions this strength are easily computed. Suppose ıle be 10 × 14, and imagine a shell 7-16in. he weak place of such a hole is the 14-inch is longitudinal to the cylinder. There has . removed from the shell 14 × 7-16 or 6⅛ ıhes of material, whence, for bare strength 16 square inches of iron should be found ıd of the manhole. 2½ × 1¼ give 3⅛ square section, and adding to the width ¾ for the s in the ring, this ring becomes 3¼ × 1¼. ınsion is the least that should be used in and it will be found ample for the jointing anhole plate. Little deduction should be case the hole is made transverse to the ere the curvature of the shell begins to tell ength of the ring, and in such case double ld be used for the plate.

ht-iron manhole rings should always be ı the inside of the boiler.

ıt-iron bonnet, manhole ring, or flange boss riveted to a boiler, it is very desirable to ry flanges; quite twice as heavy as usual joints with bolts, and then it is advisable ı thin plate ⅛ or 3-16 thick between the nd the shell of the boiler, so as to form a strip to drive against; but in these days of rought iron, cast iron attachments to ither nozzles, bonnets, or rings, have be- most inexcusable cheapenings. Boiler- ill also find out, at some time, that wrought- doors, and even fire and ashpit doors, pro- ade on formers, are handsomer, more and nearly as cheap as the ponderous cast- ıh have heretofore disfigured fire-fronts.

ATER LENS MICROSCOPE.*

irst microscope in existence consisted of rop of water. Water lenses, as formerly e unstable and tremulous, and almost if not rthless. This difficulty may be overcome, ırop of water may be rendered available as ope lens by confining it in a cell consisting t tube having a glass bottom. The simplest pest of all microscopes consists of a thin glass, having attached to it one or two per tubes, which are coated with black vax, and cemented to the glass with the terial. By aid of a small stick water is rop by drop, in the cells until the lenses he desired convexity. Objects held below will be more or less magnified, according ımeter and convexity of the drop. An easily d convenient stand for the water lens is Fig. 1, and Fig. 2 is a vertical section of showing the screw for adjusting the con- the drop. The stand is made of wood. re that supports the table slides freely upon ıal standard. A wire having a milled head, it may be turned, passes through the upper e standard, and has wound upon it a strong silk thread, one end of which is tied to a pin projecting from the table-supporting sleeve. An elastic rubber band is attached to the lower end of the sleeve, and to a pin projecting from the standard near the base, to draw the table downward. By this device the focus may be nicely adjusted. Two standards project from the bed piece for receiving the corners of a rectangular piece of silvered glass which forms the reflector. The best form of water cell consists of a brass tube about ⅜in. long, and ⅛ to 3-16in. internal diameter, having in one side a screw for displacing the water to render the lens more or less convex. A thin piece of glass is cemented to the lower end of the tube, and the inside of the tube is blackened. Several bushings may be fitted to the upper end of the tube to reduce the diameter of the drop, and thus increase the magnifying power of the lens. Water containing animalculæ may be placed on the under surface of the glass, and the lens may be focused by turning the adjusting screw. The lens may also be adjusted to magnify objects placed on the movable table. If air bubbles form on the upper surface of the glass they may be readily displaced by means of a cambric needle.

FIG. 1.

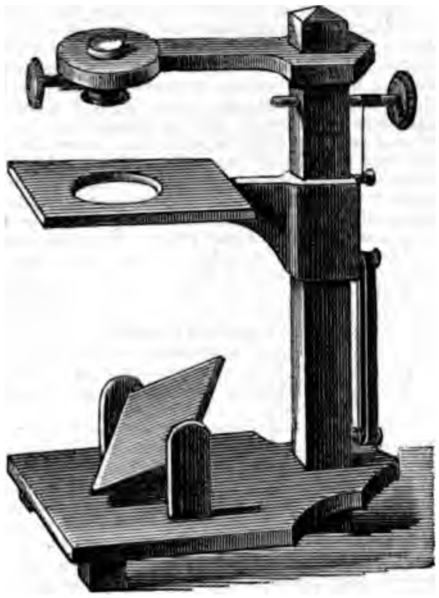
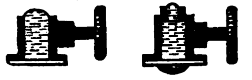


FIG. 2.



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[*] By G. M. Hopkins, in *Scientific American*.

IMPROVED PLANE IRONS.

IMPROVEMENTS in planes and plane irons have been recently patented by Mr. H. Baecker, of Remscheid, Germany, which are claimed to avoid the defects of the more common forms. According to the patentee, ordinary planes have many disadvantages—first, because they are expensive by reason of the forging and steeling the plane irons must undergo; of many a plane iron being ruined during the process of forging and steeling the same; of their becoming worthless as soon as the layer of steel is ground off. Second, they are unhandy, because it is but with difficulty that the irons can be adjusted and ground. Third, their quality of steel can never be relied upon.

FIG. 1

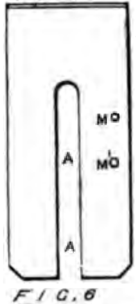


FIG. 7

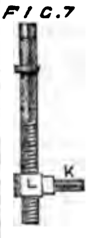


FIG. 2

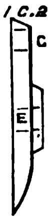


FIG. 3

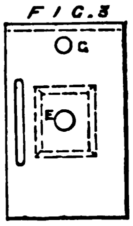


FIG. 6

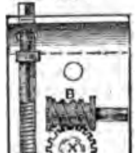


FIG. 4

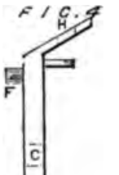
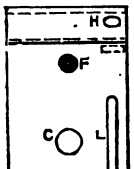


FIG. 5



The improved plane iron or blade is made entirely of steel; it consists of a thin sheet of steel of equal thickness, sharpened at its bottom edge. Its shape is shown in Fig. 1 in a front view. When it is to be used it is brought between two plates—that is to say, an upper plate, shown in Figs. 2 and 3, and a lower plate, as illustrated in Figs. 4 and 5; these plates are connected by means of a screw passing through the slot in the plane iron, so as to allow the latter to move up and down, but to prevent its assuming any side motion. This screw can be turned by different means. In Fig. 6 it is turned by means of a toothed wheel and a worm. When the worm is turned to the right, the drawing screw passing through the hole, C, in the lower plate, the slot in the plane iron, and the hole, E, in the upper plate will bring the two plates together; these will bear upon both sides of the plane iron, holding it fast and keeping it in a steady position. In order to keep the plane iron entirely steady a pin is united with the lower plate, by passing through the slot in the plane iron, and catching in the hole, G, in the upper plate.

Fig. 7 shows an adjusting screw which passes through a hole, H, in the bent top part of the lower plate (Fig. 4) and catches in a nut, I. A pin, K, is connected to this nut, I, said pin passing through a slot, L, in the lower plate, Fig. 5, and catching in one of the two holes in the plane iron, Fig. 1. The adjusting screw is turned by means of the key. If this screw is screwed up or down the plane iron is forced to follow its movements in consequence of the pin, K, catching in one of the holes. The adjusting screw and means for connecting the same with the plane iron or blade may be dispensed with in some cases, and the invention including planes of every description, the plane iron need not necessarily be provided with a slot, as divers other arrangements may be made for fastening the same between the two plates.

THE JANSSEN SOLAR PHOTOGRAPH AND OPTICAL STUDIES.*

By S. B. Langley, Director of the Allegheny Observatory, Pennsylvania.

M. JANSSEN, in papers lately presented to the French Institute,† has given an account of recent results in solar photography, obtained by him at the observatory of Meudon, and from the comments of Messrs. Huggins, Lockyer, De la Rue, and other competent judges, it has been understood that remarkable advances have been made over any other produced. A copy has been published in the *Annuaire du Bureau des Longitudes*, but details cannot well be studied from such a print on paper, and details are here all-important. As the writer has received, through the courtesy of M. Janssen, a fine positive on glass, the only one he knows of as having yet reached this country, and as it not only bears important testimony to facts which have rested hitherto in part on statements in previous numbers of this journal, but is in every way so remarkable as to constitute an important step in the history of solar phyics, an account will be given of it here.

The means used by M. Janssen for producing the photograph are understood to be a telescope of about five or six inches aperture, and twelve feet focal length, embodying the improvements introduced by Mr. Rutherfurd, and others of M. Janssen's own, the most important change being a shortening the time of exposure to 1-3000 of a second, and at the same time an enlargement of the image. This involves a modification of the time of development, &c., and has evidently cost study and labour, the arduousness of which may be inferred from the perfection of the result.

As the photograph can only be made generally intelligible by some sort of illustration, the reader is referred to two papers in this journal, the first in the number for February, 1874, where an article on the minute structure of the photosphere is illustrated by an Albertype plate; the second in March, 1875, accompanied by a steel engraving.‡ The reader must also be detained briefly over a question of nomenclature, which possibly has caused a misapprehension on M. Janssen's part, for the first paper undertook among other things, to specifically show that the elements of the photosphere were *not* "willow-leaf," or "rice-grain" like forms as had been commonly supposed. The term "rice-grain," it was carefully explained, was incorrect, and as an illustration imperfect. The name "rice-grain," for want of a generally-accepted word, was used in the article, but under protest; especially as I had myself resolved these into minuter components, and carefully drawn specific instances of the foliate form and subdivision, specially calling attention to them in the plate, where they are found in two squares surrounded by a heavy outline. It is necessary to insist on the fact that purely optical methods had informed us of the nature of the constituents of the surface with a minuteness which photography has not even now attained. It was also stated in the first of these articles that the estimated mean distances between the centres of these composite objects ranged from 2·57″ to 1·42″ according to the degree of disintegration introduced by magnifying power, and the very important conclusion was reached that the light of the sun comes to us chiefly from an extremely small part of its surface—an indefinitely small part, but which is at any rate *less than one fifth* of the whole. M. Janssen's impression that the true form and relative area of these has first been shown by the photograph is a misapprehension, though arising most naturally in part from the vicious nomenclature of the subject.

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* From the *American Journal of Science and Arts.*

† *Comptes Rendus*, Oct. 29th and Dec. 31st, 1877.

‡ See English Mechanic, Vol. XIX., p. 398, and Vol. XXI., p. 321.

Until lately photography has been useful, chiefly in fixing the positions and sizes of spots on the sun, rather than in studies of detail, which have hitherto been carried on with success only by the eye. The remarkable photograph before us begins a new order of things, for, though as we have said, it does not reach absolutely all that the eye has yet caught, yet only those who have watched the sun with powerful instruments for years, can have enjoyed (and that rarely) the opportunity of seeing more than is here fixed for leisure study. It need hardly be said how immense is the gain of this opportunity for all to examine and verify deliberately; and it should be stated further that the photograph not only confirms previous results which have rested on the testimony of one or two individuals, but adds at least one important one of its own.

The plate before us is, as has been said, a positive, the solar image being 303mm, or nearly twelve inches in diameter. The image viewed at a distance shows the usual darkening towards the edge, though not quite uniformly all round, a circumstance probably not in the present case significant of any solar irregularity. Upon a closer view we see the coarse vague maculations or marblings* (formed, as it seems to me, by waves in the solar atmosphere, causing regions of great thickness, and consequently greater absorption by the heaping of the "rice-grains."† and in some degree by their unequal distribution).

On a close approach we see the granular structure of the photosphere as it has never before been rendered in photography.

To give an idea of the precision of the photograph without the plate is hardly possible, but as the individual "grains" may be here counted, I have placed on the positive a Rogers' reticule, consisting of very small squares, engine-divided on glass, which had been actually used on the sun for a similar purpose, and with its aid counted the "grains" in different parts of the plate not far from the centre of the image, and taking the average I find a mean of about 5,200 "grains" to the square inch, whence it appears that at this rate the plate actually exhibits within its circumference over half a million of these objects. From this measurement and the solar angular semidiameter, it also appears that their mean distance in centres is 2·2″, which is in close agreement with optical determinations made with corresponding powers. As these objects are rather complex than simple, I venture the opinion that, should M. Janssen succeed in future in enlarging his photograph while retaining his present wonderful definition, their mean distance will tend to appear still less.

We are now brought to what is perhaps the most remarkable feature of the plate, for a continued examination shows what undoubtedly has not been established by optical studies—that there are extensive regions where the "grains" are distinctly seen, and others adjacent where they are confused and blurred as if by bad definition. There are numerous alternations of these areas of disturbance, which are themselves of varying sizes; perhaps it would be more correct to say that the general surface presents this blurry character with small regions where the definition is as sharp and clear as we have described it. Now—a question evidently to be asked—is this bad definition something in the solar atmosphere or our own? Does it mean a tremendous disturbance over hundreds of millions of square leagues, or a quivering of the air a few yards from the camera?

First we may ask—how far has there been any anticipation of such local disturbance on the sun, away from the spots and away from the faculæ as seen on the edge? I believe there has been, from telescopic study, a somewhat uncertain recognition that the photospheric structure differed at different times, but nothing like the variations shown here was anticipated. Doubtless these alternations of structure in adjacent regions, if once recognised, would be visible to the telescope if sought, and it has, in fact, often been asserted that the aspect of the granulations varied at different times from solar causes; but with the telescope we lack the facility for deliberate comparison of one part of the disc with another we obtain here, since, owing to the undulations which we do know without doubt are in our own atmosphere, our best vision is but momentary, and before we can turn from one part of the sun to compare it with another the opportunity is gone. The photograph, obtained as it is in less than a thousandth of a second, may be taken many times in succession, and reproduce more or less indefinite images, yet the thousandth exposure may fall in the brief instant of definition the observer patiently watches for, and then the results of this rare moment are made permanent by the camera.

Curiously enough these disturbances of the solar atmosphere have been more distinctly *felt* by the thermopile, perhaps, than seen by the telescope. In 1874, after summing the results of thermal measurements carried on at Allegheny, to determine the heat of different parts of the surface, and after eliminating the effects of increasing absorption towards the limb, of spots, &c., there remained irregularities of a small order, which showed either a hitherto unrecognised solar phenomenon, or (what might conceivably be the case) some undetected causes of minute instrumental error. The difficulty of determining which was great, for it was a characteristic of these minute fluctuations, that they were neither both fixed in position or magnitude, but incessantly changed place and degree. Only after a year's further study I felt confident that I had so far eliminated the smaller instrumental errors, that I was in presence of residual phenomena, which, however minute, were real, and which corresponded to continual fluctuations in the depth of the solar atmosphere all over the surface, in the nature of local disturbances caused by its currents, and I felt justified in announcing the existence of these—which I had never seen—in positive terms.*

Nothing could be more unexpected than the confirmation of these statements which the photograph offers, but it would be most unjust to M. Janssen's eminently original and valuable work not to state that such anticipations, however positive, are obscure compared with the light thrown on this part of the subject by his methods. We say this, under the reserves already hinted, as to the difficulty of distinguishing by a single plate the exact limits between the effects of solar and telluric disturbance; but so much at least appears to be solar, that we have here something very like evidence of great waves in the solar atmosphere, obscuring the photospheric structure, and not only obscuring but changing it, for the currents appear to have altered the shapes of the grains, and their disposition. M. Janssen seems to consider the ultimate form of these grains as literal spheres, but it appears to me that his own admirable photograph bears other evidence. The components of these "grains" when undisturbed do indeed tend to dome-like forms, but these have always appeared to me to be but the extremities of filaments; extremities which aggregated cause the "grains," and which lifted higher than their fellows cause the faculæ; the filaments themselves being seen a little here and there on the surface where bent over, and seen at all their length in the spots. In other words, we may compare the photosphere to a field of grain in which, from a bird's-eye view, we see, in a calm, only the rounded summits of the wheat. Let a wind blow fitfully over the surface, bending the crests here and there, and showing more of the form of the straws. This is, it seems to me, the suggested explanation of the elongated form of the "grains," shown in such an interesting manner in M. Janssen's photograph, where the action of solar currents is indicated, and accompanied with partial obscuration. Let a whirlwind beat down the grain, showing the stalks lying every way exposed throughout their length—these are the filaments in a spot.

Of course the simile is imperfect, and is not to be carried further. I can only venture conjecture as to what these "grains" really are, but I have always believed and still believe that they are not mere globular or bubble-like forms, but are associated with something beneath the surface most probably connected with ascending and descending gaseous currents which in some way bring to that surface the heat from the interior, and carry back to it the gases which have been cooled by radiation, perhaps even to the point where precipitation occurs.

As to the question of the real solar origin of certain of the less definite forms on the plate we may say, then, that it is known that certain peculiarities in our own atmosphere tend to impress themselves on the photographic plate, along with the solar phenomena, and it would be doubtless desirable, if possible, that two such photographs as we have here should be taken at intervals of five or ten minutes apart to eliminate this. It has been frequently asked why this is not done. But those who ask such a question are not familiar with the rarity of the instants in which *such* photographs can be taken. Two indeed can be taken at any interval, but those like the one before us demand not only the finest mechanical and chemical methods, and still more the highest skill, but atmospheric conditions so brief as to rarely or never last during even the short time mentioned.

Finally, then, though without two photographs of equal excellence taken within a few minutes of each other, it is perhaps impracticable to say *exactly* how much of the inequality of the plate is solar, it seems possible to state from the intrinsic evidence of the plate itself, that on the main features of its most interesting evidence as to the action of solar storms we may rely, and in this statement the writer, distrustful of his own knowledge of photographic processes, has sought the opinion of the most competent judge in these matters before expressing his own.

Our conclusion is, that M. Janssen has accomplished a remarkable, indeed, a wonderful advance in solar photography, and that his success is not only a brilliant, but a useful one, for which he should have the thanks of every student of solar physics.

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[*] This is seen in the Albertype on removing it five or six yards from the eye where details are lost. The vagueness of the aggregations is in the original (i.e., in the sun itself).

[†] Indicated all over the Albertype plate, and shown in specific details in the two designated squares.

[*] *Comptes Rendus*, Sept. 6th, 1875, p. 135.

ACTION OF LIGHT ON A SELENIUM (GALVANIC) ELEMENT.

By Robert Sabine.

IN the course of a series of experiments on the electrical behaviour of selenium, undertaken with a view to remove, if possible, the difficulties in the way of constructing constant resistances of this material, I have had occasion recently to investigate the effects of surface tension due to light. I find that the action of light on crystalline selenium (annealed at 200°C.) is much more striking when the selenium forms one element of a galvanic couple than when it acts as a resistance. The most convenient arrangement which I have found for observing this, is to make up a couple, consisting of (1) a plate of selenium hanging suspended by means of a platinum wire, and (2) a strip of platinum foil in distilled water. The potentials of the two poles are not very different, and any change in the electro-positiveness of the selenium is at once very apparent.

The first selenium-platinum element which I constructed behaved as follows:—In the dark the element gave a steady electromotive force of about 0·1 volt., the selenium being *positive* to the platinum. On admitting daylight to the selenium plate it instantly became *electro-negative* to the platinum, showing an electromotive force of 0·05 volt. in that direction. That is to say, the selenium had become 0·15 volt. more than electro-negative by the action of the light than it was in the dark. After the first impulse this extreme electro-negativeness of the selenium, due partly to polarisation, gave way, and it gradually passed again to the electro-positive side, where, after a few minutes, it settled to a constant value, but still electro-negative to its condition in the dark. I found that the slightest shadow or other variation in the intensity of the light caused a considerable variation in the electromotive force of the couple and a consequent indication. On excluding the light the selenium instantly increased in electro-positiveness, and soon settled to its original position. A couple in which two plates of selenium were opposed to each other, light being excluded from one and admitted to the other, gave identical results, only the resistance of the element was much greater.

The effect of light, therefore, in modifying the surface tension of selenium is evidently to render it more electro-negative, and presumably not more metallic, as has been suggested in explanation of its increased conductivity. I am endeavouring to construct a combination of selenium elements, which, with a mirror galvanometer and photographic arrangement, may be used to give a trustworthy record of the intensity of daylight. The practical difficulties in the way at present I have hopes will not be insurmountable.—*Nature.*

THE ANALOGY BETWEEN LIGHT AND SOUND.—IV.

By Prof. W. F. Barrett.

THE relationship between colour and music, if any exist, must be found by comparing the wave-length corresponding to each note of the gamut with the wave-length corresponding to each colour of the spectrum. First let us find what range of wave-lengths is embraced by our organs of vision and hearing respectively. By proper means a good observer can see from the fixed line, A, in the solar spectrum, which has a wave-length of 760 millionths of a millimetre, to the line, L, which has a wave-of 381 millionths of a millimetre. The latter st exactly one-half the former, so that the ion is two to one, corresponding to an octave ic. Ordinarily the visible spectrum extends n interval corresponding to a seventh in The range of hearing is far greater, em- about eleven octaves.* But there are rays each end of the spectrum our eyes cannot which can be made evident by means that take me too far from my subject to allude to nd there are vibrations beyond the limits of which can be made evident by means of a re flame. Let us, however, take one octave ic out of the eleven which are audible, and e it (in the manner previously stated) with tave of colour, the limits of which are just This we may fairly do, as the notes in musical octave are proportional repetitions of other.

difficulty we meet at the outset is that there ne of demarcation between the colours of the m, but careful attempts have been made to limits of the colours. The most recent and determination of these limits is one made by nent German physicist, Prof. Listing;† a de- ation accurately expressed by taking the ength that forms the boundary of the colours er side. Employing pure spectra, and using recaution, Listing experimentally determined nsition places and the central region of each the so-called "Fraunhofer lines" being used marks. The observations were then repeated he normal spectrum obtained by diffraction, e checked by the independent observations of and by repetitions at different times. In y the remarkable fact was disclosed that the s of vibrations at the transition spots form *hmetical progression* throughout the entire f colours; every succeeding colour towards et being due to 48¼ billions more vibrations ond than the preceding one. The number ions expresses therefore the range of a single sensation in human vision. For reasons isting adopts the following scale of colours—red, orange, yellow, green, cyanogen, indigo, ender, and states as a law that this series physically expressed by an arithmetical pro- of eight numbers, in which the last is the of the first.‡

number of vibrations corresponding to the limit of colour at the red end, he fixes, upon ltz's and Angström's authority, at 363 9 per second, or a wave-length of 819·8 ths of a millimetre. By adding to the former half the colour interval—namely, 24⅛ —the normal centre of the first colour is ob- 48¼ billions added to that gives the centre next colour, and so on. These, and also the f each colour, are here tabulated along with responding wave-length.

howing the wave-length λ, in millionths of llimetre; and the vibration number *n*, in ns per second, of the limits of the colours of pectrum.

	λ	*n*
e lower limit of vision ...	819·8	363·9
... ...	768·6	388·2
ion limit	723·4	412·5
... ...	683·2	436·7
ion limit	647·2	461·0
... ...	614.9	485·2
ion limit	585·6	509·5
... ...	559·0	533·8
ion limit	534·7	558·0
... ...	512·4	582·3
ion limit	491·9	606·6
en	473·0	639·8
ion limit	455·5	655·1
... ...	439·2	679·3
ion limit	424·0	703·6
... ...	409·9	727·9
ion limit	396·7	752·1
er	381·3	776·4
ion limit	372·6	800·6

wave-lengths of any colour or note is inversely vibration number giving rise to it. So that if the vibration numbers are expressed by the series 2, 3, 4, and so on in arithmetical progression, the wave-lengths would be expressed by the reciprocals ½, ⅓, ¼, &c. This latter is called an *harmonic* series, and according to the eminent authority of Prof. Listing, it expresses the order of the wave-lengths in the successive colours of a rainbow. Now the so-called chromatic scale in music is arranged in equal musical steps; and some may be inclined to jump to the conclusion that therefore the vibration number of its tones must form an arithmetical series like our spectrum, and that the analogy between colours and tones is indubitable! The terms harmonic series in one case and chromatic scale in the other foster this delusion. Let me, therefore, beg you to remember that there is no necessary connection whatever with music in the one case, or with colour in the other; a series of notes arranged with their vibration numbers in arithmetical progression would form simply intolerable musical intervals, and therefore no such series is to be found in any musical scale. But if, instead of arranging the vibration number of our notes in an arithmetical series as 1, 2, 3, 4, &c., we arrange them in a geometrical series as 1, 2, 4, 8, &c., then we have the well-known chromatic scale, or scale of equal temperament, as it is sometimes termed. Here, then, is a vital difference between the analogy of colour and tone: the vibration numbers of one form an arithmetical series, of the other a geometrical series. Mathematicians seeking to establish an hypothesis would not, however, be deterred by such a discrepancy. The pliability of figures under such circumstances is proverbially wonderful.

I do not pretend to be a mathematician, but it is well known that the *logarithms* of a geometrical series give one an arithmetical series of numbers. Hence, as Professor Listing points out, if we take the logarithms of the vibration numbers expressing the chromatic scale in music we have a series of numbers corresponding to the vibration numbers of the colours in the solar spectrum. Physiologically and psychologically there may be wide differences between music and colour, but here we seem to reach some sort of physical basis for this analogy.* †

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not the wider range in the organ of hearing have y a process of evolution? Among the early races greater advantage would be afforded by the quick n of various sounds—both for the purpose of pro- food and preservation from attack—than would om an increase in the range of colour sensation. relihood of all mankind were in future dependent ing or skill in spectrum analysis, we might expect slow but steady refinement and extension of our vision; the growth of civilisation is doubtless the former.

gendorff's Annalen, vol. cxxxi., p. 564.

he *Phil. Mag.* for 1848, p. 281, Brücke pointed out ra should be added to the colours of the spectrum lementary to the tint lavender-grey noticed by l at the extreme violet end of the spectrum. arrived at this conclusion from the fact, that when s of selenite are viewed by polarised light, brown d to succeed colourless light, and on crossing the as to yield the complementary colour the brown ed by lavender-grey, the intensity of which is pro- l to the depth of the tint of brown previously

* Curiously enough this numerical relationship, or as some would prefer to call it coincidence, between music and colour has been examined from another point of view. In a paper published so long since as 1845, a translation of which appeared in "Taylor's Scientific Memoirs," an Italian physicist, Mosotti, found an extraordinary correspondence between the ratios of the wave-length of the so-called Fraunhofer's lines in the spectrum and the wave-lengths of the notes of the diatonic scale or gamut. Mosotti used a "diffraction" spectrum, wherein the colour spaces are arranged according to their wave-lengths, and to the Fraunhofer landmarks he added the longest and shortest wave-lengths at the two extremes of the spectrum, and also the wave-length of the brightest or central part of the spectrum. These three points, added to the fixed Fraunhofer lines B, C, D, E, F, G, H, formed a series of ten wave-lengths, which he thus compared with the notes of the diatonic scale:—

Music.	C	D flat	D	E	F	F sharp	G	A	B	C
	1	$\frac{27}{25}$	$\frac{9}{8}$	$\frac{5}{4}$	$\frac{4}{3}$	$\frac{25}{18}$	$\frac{3}{2}$	$\frac{5}{3}$	$\frac{15}{8}$	2
	$\frac{1}{738}$	$\frac{1}{683\cdot3}$	$\frac{1}{656}$	$\frac{1}{590}$	$\frac{1}{553\cdot5}$	$\frac{1}{531}$	$\frac{1}{492}$	$\frac{1}{443}$	$\frac{1}{393\cdot5}$	$\frac{1}{36}$
Colour.	Ex.	B	C	D	Mid.	E	F	G	H	Ex.
	738	688	656	589	553·5	526	484	429	393	36

The first horizontal row of figures represents the proportional number of vibrations necessary to produce the notes of the diatonic scale, the names of which are given overhead. The numbers in the second row have the same ratio as the numbers in the first, and the denominators of these fractions represent the ratio of the wave-lengths of the respective notes. The bottom row gives the lengths in millionths of a millimetre of the luminous waves corresponding to the Fraunhofer lines named above them, and also to the two extremes or darkest parts of the spectrum marked Ex. Ex. and the central or highest portion marked Mid. It is curious to note the fair agreement between these figures. But after all this can only be regarded as a *coincidence* and nothing more. In fact such a coincidence, where no physical relationships exist, furnishes a warning to speculative minds. For since Mosotti's time the wave-lengths of the Fraunhofer lines have been determined with far greater precision by Angström, and the following numbers show the corrections necessary: the coincidence now nearly disappears, but another starts up, if we take the line A as 100, and compare the ratios of the other lines with the ratio of the wave-lengths of the notes in the ordinary diatonic scale or gamut.

WAVE-LENGTHS OF THE PRINCIPAL FRAUNHOFER LINES ACCORDING TO ANGSTRÖM.

Lines.	Wave-length in Millionths of a Millimetre.
A	760
B	687
C	656
D	589
E	527
F	486
G	431
H	397

† In *Nature* for January 13, 1870, I drew attention to the analogy in the wave-lengths in the spectrum and the gamut, and though Listing's figures were the basis of my observations, I had not at the time read his paper, and was therefore unaware of his conclusions, which are summarised in the latter part of this lecture. The appearance of my note in *Nature* led to several interesting letters in that journal on the general question of analogy of colour and music, and the arguments on both sides of this oft disputed subject will be found ably discussed in that valuable periodical for the first half of the year 1870. Mr. James Stuart's letter (which brought Mosotti's observations under my notice) in *Nature* for February, 1870, and Mr. Sedley Taylor's letter in the following number are especially worthy of careful perusal. Mr. Sedley Taylor points out that whereas to get a good concord exact tuning is requisite—the least deviation from the right pitch being sufficient to turn a concord into a discord—to obtain harmonious colour-intervals considerable latitude is possible, any part of one colour-division producing an equally pleasant or disagreeable effect on the eye, when compared with any part of another colour-division. That is to say, there is no range of wave-length possible in musical concords, whereas there is considerable range of wave-length possible in colour-concords. Mr. Taylor thereupon shows that if instead of taking the *central* part of each band of colour (*i.e.*, its mean wave-length), as is done by Professor Listing in the table quoted on p. 454, we take into consideration the limits of each colour, that is to say, the whole range of the colour-space in the spectrum, and compare the result with the corresponding positions on the gamut, it will be found that each colour on the whole corresponds to very discordant intervals in the scale of pitch; and that only at one point (*i.e.*, one wave-length) in each colour band does it answer to a concord in music. Mr. Sedley Taylor, therefore, rejects the idea of any real analogy, and believes the correspondence to be simply numerical coincidences. To such an authority as Mr. Sedley Taylor I listen with pleasure and respect, but though I have no wish, nor ability, to be a special pleader on behalf of this subject, it seems to me the analogy cannot be got rid of quite so readily as Mr. Taylor suggests. As we depart from any one point in each colour-space of the spectrum, a sensible difference in tint ensues, and though the whole spectrum forms a lovely gradation of colour, yet if we remove and juxtapose the two extreme tints of any one colour-space, the effect on the eye is extremely unpleasant. Take, for example the first instance in the table given by Mr. Sedley Taylor, as opposed to the analogy, one limit of the red would correspond to the note B, the other limit to the note C (taking the central red as C). But dark red and orange red are as unpleasant colour-intervals as the notes B and C are dissonant musical intervals, and so on with every colour-space. In fact, just as Helmholtz has shown—in the diagram whereby Mr. Taylor demolishes the analogy—that the sounds which produce the most discordant effects with the key-note lie in the immediate neighbourhood of the unison, octave, and fifth, so too the tints which are most disagreeable to juxtapose with the key-note, say the colour red, lie in the immediate neighbourhood of the unison, red; the octave, lavender; and the fifth, blue. Moreover, we must bear in mind that the ear is a far more delicate instrument for the detection of intervals depending on periodic time than the eye, and we should therefore expect a more subtle appreciation of such intervals by one organ than the other. The great difference that exists in this analogy is, as remarked in the lecture, that in the case of musical concords we are dealing with a resultant sound, but which the ear, as Helmholtz has shown, analyses into its constituents; and in the case of colour-concords we are dealing with blended or juxtaposed lights. But if the eye were as highly trained as the ear, it is possible that an analysis of a compound colour would be effected by the appendages of the retina as readily as the analysis of a compound tone is effected by the appendages of the auditory nerve. Broadly viewed, there appears to be enough general agreement among the facts to justify indulgence in speculation on this analogy, and at the same time not sufficient exactitude to allow of any dogmatising on the subject. In addition to what has been brought forward, there are some valuable remarks on the analogy in one of Dr. Thomas Young's memoirs, "Philosophical Transactions," 1802; in Chevreul's work on the "Principles of Harmony of Colour"; in a brochure by Dr. Macdonald on "Sound and Colour"; and, lastly and chiefly in Section 19 of Helmholtz's "Physiological Optics." In this last a list is given of authorities who have written on the subject since the time of Newton.

SCIENTIFIC SOCIETIES.

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ROYAL MICROSCOPICAL SOCIETY.

AT the meeting held May 1st, 1878, H. J. Slack, Esq., president, in the chair, four new Fellows were elected, and Professor Abbé, of Jena, was elected an honorary fellow of the society. A paper, by Mr. Michael, "On a New British Cheyletus," was read by the secretary. It minutely described the structure and habits of the insect and was illustrated by drawings. The name proposed by its discoverer was *Cheyletus flabellifer*. Mr. Charles Stewart gave a résumé of a paper which had been received from Dr. Oscar Schmidt, of New Orleans, in continuation of a former communication, "On the Blood Corpuscles of Amphiuma, Frog, and Man." The President suggested to the meeting a series of experiments, which he thought might be of value in the interpretation of optical images by the examination of microscopic drawings of Lissajous' curves under various powers. He also brought before the notice of the fellows a species of fungus which he had found infesting the leaves of the Bay, but which did not appear to derive its nutriment from the leaf itself. After some discussion, the fungus was identified by Dr. M. C. Cooke, as *Capnodium Footii*, which was stated to live upon the honeydew found upon the surface of the leaves of a large number of trees, particularly in the autumn months.

SCIENTIFIC NEWS.

SOME months ago the Woodruff Scientific Voyage Round the World scheme managed to get itself talked about in a few English papers, but it was not long before the bubble burst in the United States, where the promoters have been quietly laughed at. It seems, however, that the French scheme of a similar nature is progressing so far satisfactorily that the passenger list will be closed at an early date. The vessel, the Picardie, a steamer of 1,000 horse-power and 1,560 tons measurement, is announced to leave Marseilles on June 30, under the command of Lieut. M. G. Biard. The staff is complete, but it may be doubted whether the passenger list will fill as well as the promoters expected. And yet a "voyage round the world," combining instruction with pleasure, would probably be of more benefit to students of science than many courses of lectures delivered in the usual routine of a college.

Among the letters will be found communications from several readers who witnessed the transit of Mercury on Monday. We also learn, just before going to press, that the transit was observed at Aberdeen, by Lord Lindsay, Mr. Ranyard, Dr. Copeland, Mr. Carpenter, and Herr Lohse, and photographed by Mr. Davis. A thin cloud covered the sun at the time of first contact. No ring of light was seen round the part of the planet off the sun's disc. External contact was observed spectroscopically by Lord Lindsay, who detected the approach of the planet by the eclipse of the C line 13 seconds before its limb encroached upon the continuous spectrum of the photosphere. Mr. Ranyard observed the continuous spectrum below C line, but saw no trace of the planet until it was on the sun's disc. No change in the solar spectrum was observed at the limb of the planet. Dr. Copeland, Mr. Carpenter, and Herr Lohse obtained both contacts and measures of diameter. Mr. G. Talmage, at Leyton, failed, "owing to the prevalence of clouds, to observe the times of external and internal contact at ingress. The first view he obtained was at 3.43, when Mercury had advanced some considerable distance on the sun's disc. The duration of clear sky was then so short that there was not sufficient time to obtain micrometrical measures of distance from the sun's limb. For about 8 or 10 seconds the sky was absolutely clear, and then he noticed that Mercury was surrounded by a bright ring, darkening off to the periphery, which was exceedingly well defined. The distance between the limb of Mercury and periphery of ring was about two-thirds of the planet's diameter. He used the full aperture of 10in., with a diagonal and power of 80."

It seems that the Chinese can lay claim to the invention of the telephone, for Chin-Hoo, writing in the *Peking Gazette*, says that Kung-Fo-Whing invented the telephone, or Thunthsien, in the year 978. Probably the string telephone, which is certainly very old, but is also certainly very different to Prof. Bell's.

Col. Yule, writing to the *Athenæum*, asks whether a passage in the "Lives of the Lindsays" (Vol. III., page 219) does not foreshadow the phonograph. Mr. Robert Lindsay once surprised a friend, a Mr. David B., busily engaged in constructing some piece of machinery, and after a promise of secrecy, was told that "those bungling rascals, by their defective shorthand writing, annihilate and destroy the effect of Mr. Pitt's and Mr. Fox's best speeches. . . . Now, my friend, my object is to place this same instrument in the House, and play the speech off with the same volubility as it is spoken, and not one syllable will be lost." Mr. Lindsay says the machine was still in embryo, but he noticed that it was furnished with keys and types, a statement which suggests the typograph rather than the phonograph.

Mr. Worthington G. Smith gives, in the *Gardeners' Chronicle*, an explanation of the salmon disease which is just now puzzling the commissioners and the fishery owners. It is nothing less or more than the fungus (Saprolignea ferox) familiar to aquarium keepers. Many other fish besides salmon are attacked by the pest, which is this year excessively virulent, but the loss of salmon is by far the most serious. An attempt to attribute the cause to the pollution of rivers by woollen mills is useless, because the salmon are dying by hundreds in rivers which are quite guiltless of any pollution of the kind. It would seem that a favourable opportunity presents itself for trying the effects of hydrochloric acid. Mr. Smith furnishes illustrations of the fungus, and finds a reason for the unprecedented severity of the visitation in the mildness of the past winter.

It is said that Professor Hughes, the inventor of the type-printing telegraph, has discovered that some bodies are as sensitive to sound as selenium is to light. According to *Nature*, if such a body be placed in the circuit of a small battery it will be so affected by the sonorous vibrations when spoken to as to replace entirely the transmitter of a Bell telephone. A mere scratch with the finger-nail, or a touch with the soft part of a feather, is distinctly transmitted. No information is, however, published as to the names of the bodies so remarkably sensitive to sounds.

The torpedo defences of the Thames are now complete. The station is at Shornemead Battery, and in the operating room there are a number of bells, each in electrical connection with a torpedo, which can only be fired by completing the circuit. When a ship touches a torpedo the bell belonging to the latter will ring, and the officer in charge can either explode the machine or allow the vessel to pass on her course uninjured. Of course the torpedoes are not in position, but they are ready, with all appliances, for being moored when required.

The new torpedo boat, which was recently inspected by the Lords of the Admiralty, draws only 8in. forward and 12in. aft. It is 50ft. long × 7ft. 6in. beam, and is expected to steam 20 knots an hour.

At the annual meeting of the Royal Institution, held last week, it was stated that during the last 25 years the number of members paying 5 guineas annually had increased from 344 to 544, while the real and funded property of the Institution now amounted to upwards of £84,500. Sixty-two lectures and nineteen Friday evening discourses were delivered in 1877.

The Russian Government have concluded a contract with an American company for the deepening of the Neva between Cronstadt and St. Petersburg. The quantity of mud, &c., to be excavated is estimated at 15,000,000 cubic yards, as there is to be a channel with a uniform depth of 20ft. The work is to be completed in four years.

An "invention," not proceeded with, for preventing priming and corrosion of steam boilers, consists of any oil or mixture of oils with tannic or gallic acid, or with both of them.

The principal food of herrings caught in the German Ocean and the Baltic consists, according to M. Mobins, of some kinds of very small crustaceans of the order of Copepoda. In February, 1872, a great many herrings were caught in Kiel Bay. Nearly all that M. Mobins opened had their stomachs full of Copepoda, belonging almost exclusively to one species (*Temora longicornis*). In the full stomach of one large herring the number of these crustaceans present was, after careful counting, found to be 60,895. Another herring contained 19,170. For three weeks continuously there were taken daily in Kiel Bay about 240,000 herrings. Supposing that each of these devoured every day only 10,000 copepoda (which is putting the number very low), this would give, for one day, a consumption of 2,400 millions, and in three weeks 43,000 millions. The upper surface of the water swarmed with these minute animals, so that with fine-meshed nets they could easily be caught in thousands. These facts show that the German coasts, though they are poor in species, have enormous quantities of individual animals.

In a recent letter to the French Academy M. Tacchini gives the results of his solar observations during the first quarter of 1878. The spots have been very rare and small. Between 10th February and 2nd March neither spots nor pores were observable; on the other hand, the granulation was splendid. It would appear that the minimum of spots really comes th year, not last; their frequency has been steadi diminishing up till now. The number of pr tuberances, also, has been very small during th quarter, on an average 2·1 per day, with height of half a minute. They have extend over a large zone, with two maxima beyond th principal zone of spots, and the nebulous stru ture has predominated. There have been isolated metallic eruptions.

A method recently recommended by M. Vo Bibra, for restoring old writing that has becon illegible, consists in painting the piece wit sulphide of ammonium, which brings out th lines distinctly. The excess of sulphide washed off, and the piece is dried betwee filtering paper. Another means recommende is a moderately concentrated solution of tanni which is similarly applied. The MS. is drie at 50° to 60° C. Both methods are, of cours only applicable to gallic inks. For cleanin of oil-paintings, the same author advises th use of nitrobenzol. The painting, taken ou of its frame, is first cleared of dust with brush, then washed with a wet sponge; a thic layer of soapsuds is next applied for 8 to 1 minutes, then cleared off with a strong brush The painting is now washed with water an dried, after which it is rubbed with a line cloth saturated with nitrobenzol, frequentl changed till the picture becomes clean.

There is now being bored at Pesth a Artesian well, which will be deeper than an made hitherto. The work has been unde taken by MM. Zsigmond, Bros. A grant o 1,000,000fr. has been made them by the tow on condition of furnishing an unlimited suppl of hot water for the municipal establishment and public baths. The depth of the well is present about 951 metres, and the temperatu of the water is about 161° F. The work will b continued till the temperature is 178° F. Th well furnishes daily 790,000 litres of hot wate rising to a height of 10·50m. This quantity water will not only suffice for all the wants the town, but will transform the environs int a sort of tropical garden. Since June last th boring has traversed 60 metres of dolomit The upper layers have furnished some interes ing data to geology. Among the mechanic inventions to which this undertaking has give rise may be specially noted an apparatus which the water escaping from the well utilised as a motor force imparting to the bor a velocity twice that which it had before.

A curious phenomenon has been observed a property at Vernon, in France. Five or years ago lightning struck a garden plant with gooseberry bushes and cherry tre making a very deep hole, the orifice of whi was not 10 ctm. in diameter. Subsequent everything died round about. The dea circle enlarged year by year. It is now sev metres in diameter, and has just reached cherry tree planted twelve years ago, whi has died like the rest. The goosebe bushes which were replanted died in two yea The cause of the evil, says *Science pour To* which records the phenomenon, was eviden the lightning, but how comes it that its mor action has persisted, and that the sterility ga ground? Did the lightning generate in soil chemical compounds injurious to plant Did it burn the humus? This is a point which we remain ignorant.

From observations recently made by Abich, and communicated to the St. Petersbu Academy, it appears that the western part the Caucasus, which is subject to the influe of moist winds from the Black Sea, is nea under the same conditions as the Alps and Pyrenees, and its limit of perpetual snow nearly at the same height as that of the li in those ranges; whereas in the eastern p subject as it is to a continental climate, phenomena of this order greatly resemble th observed on the northern slopes of the Hi layas. In this, also, the Caucasus serves transition between Europe and Asia, but most remarkable fact is that the glaci of the Caucasus are at present in a period diminution and retreat similar to that obser for fifteen years in the glaciers of the Alps a the Pyrenees, especially on the sides of M Blanc.

LETTERS TO THE EDITOR.

[We do not hold ourselves responsible for the opinions of our correspondents. The Editor respectfully requests that all communications should be drawn up as briefly as possible.]

All communications should be addressed to the Editor of the English Mechanic, 31, *Tavistock-street, Covent-garden, W.C.*

All Cheques and Post-office Orders to be made Payable to J. Passmore Edwards.

**** In order to facilitate reference, Correspondents, when speaking of any Letter previously inserted, will oblige by mentioning the number of the Letter, as well as the page on which it appears.*

> "I would have everyone write what he knows, and as much as he knows, but no more; and that not in this only, but in all other subjects: For such a person may have some particular knowledge and experience of the nature of such a person or such a fountain, that as to other things, knows no more than what everybody does, and yet, to keep a clutter with this little pittance of his, will undertake to write the whole body of physicks: a vice from whence great inconveniences derive their original."—*Montaigne's Essays.*

THE LUNAR CRATER THEBIT—BUILDING AN OBSERVATORY—GLOBES—A £5 TELESCOPE—ELEMENTARY HANDBOOK OF ASTRONOMY—VISIBILITY OF THE MOON'S DARK LIMB—"THE DAWN OF HISTORY"—A NOVEL MODE OF "ENDOWMENT"—CHAMBERS'S "DESCRIPTIVE ASTRONOMY"—TELESCOPIC APERTURE—OLBER'S THEORY OF THE PLANETOIDS—STELLAR PHOTOMETRY, &c.—STAR IN HYDRA—REFLECTOR OR REFRACTOR?—STUDY OF NAUTICAL ASTRONOMY.

[14296.]—My acquaintance with the minute detail of the Lunar Crater Thebit is not sufficiently intimate to enable me to answer Mr. Mawe-Smith (letter 14248, p. 165) definitely, without a further examination of that formation. I will, however, take the earliest opportunity of looking at it. I am afraid that I shall be away from home on the night of the 10th inst., when, though, the sun will not have risen so high as at the epoch of Mr. Smith's sketch; while on the 11th Thebit will have got further into sunlight than it was at the date of your correspondent's drawing. If he will turn back to p. 632 of Vol. XXV. of the English Mechanic he will find a sketch of this crater under evening illumination, which confirms some of the features seen by him on the 11th ult.

With reference to the queries put to me in letter 14250 (p. 166), by Mr. Richards, I would say: 1st. That there can be no possible objection to brick for the walls of his observatory; but that, on the contrary, if he be indifferent about the extra cost, he had better employ that material for them. Wood is used from motives of economy. He must be especially careful, however, to have very wide shutter-openings in his dome, so as to rapidly equalise external and internal temperature. 2nd. Though, should he decide to construct the entire building of wood, he need be under no apprehension that any difficulty will arise in doing so, so as to carry well a 12½ft. dome, running on iron (or lignum-vitæ) balls. I know of two domes of larger diameter than Mr. Richards's, which have worked efficiently for years upon wooden observatories without any "sag" whatever in the wall-plates. They were of course well and strongly built originally. 3rd. With regard to the finder. Nothing forms so useful and available a pointer as two *thick* wires, crossing in the middle of the field of view, and each forming an angle of 45° with the Meridian. Possibly Mr. Lancaster wrote in a hurry, or was thinking of something else, when he recommended fine cross hairs; which would be utterly useless after dark. Lastly, an iron pillar is neater, handier, and much more compact for an Equatoreal than a stone one. Cooke's form of pillar leaves nothing to be desired. Of course it must have a massive stone or brick foundation.

The personal appeal made to me in reply 32382, p. 172, by "Cornishman," has sent me back to his original query on p. 24. Having read it, I will answer it as far as I can, leaving to Mr. Lancaster, or some other expert, the task of replying to the mere mechanical part of the question put. In the outset, then, the globes undoubtedly are of practical use; as, although precession has changed the coordinates of Right ascension and Declination to some extent, the positions of the Stars, inter se, remain the same, so that your correspondent may learn the face of the heavens from them, trace fairly well the paths of the Sun, Moon, and planets through the sky, and perform all the usual "problems on the globe." In the case of the terrestrial globe, it is good for all time; its deficiencies lying mainly in its delineation of a then unexplored Africa, and its North Polar details being but imperfect. In the next place, the "British Catalogue" originally appeared in Flamsteed's "Historia Cœlestis" in 1725, and contains 3,310 stars observed at Greenwich. There is an enlarged edition of it in the "Account of Flamsteed," by Baily, published some forty years ago or more. As for the rising of the globe above its wooden horizon, it is impossible to say anything as to the cause of this, or its remedy, without seeing it. The question about cementing the axis is wholly beyond my power to answer.

"Telescope Tele" (query 32742, p. 175) has got an uncommonly hard bargain. In fact, I do not mind telling him, in strict confidence, that he has unhappily thrown his money away upon some mere rubbish. The two diaphragms should, of course, be tightly fixed in their places in the tube. I do hope that your correspondent will not dream of going to the cost of a Barlow lens and an additional astronomical eyepiece for his precious instrument. The four lenses in his terrestrial eyepiece are all right; but there should be two in the astronomical one. Possibly the "lens along with the dark glass for the sun" may be the missing one, as no lens belongs to an eye-shade proper. On no account whatever would I advise "Telescope Tele" to spend another farthing on his telescope beyond the sum necessary to complete his present astronomical eyepiece and fix his diaphragms. By far the best thing, though, that he can do is to sell it again to anybody who will be weak-minded enough to pay him what he gave for it.

I could answer query 32743 (p. 175) better had "A Poor Cornishman" said in what branch of Astronomy he is particularly interested. Should his object be to get a general view of the Science, he can scarcely do better than purchase that most excellent little shilling volume on "Astronomy," by Mr W. H. M. Christie, published by the Society for Promoting Christian Knowledge. If he will say whether he proposes to devote himself to Stellar, Solar, Lunar, or Planetary Astronomy, to study the Science mathematically, or devote himself to it in its instrumental aspect, I will try and help him in the selection of books to suit his particular purpose.

If Mr. Robinson (query 32783, p. 176) will consider that the dark limb of the Moon is rendered visible to us by Earth shine, and that when it is New Moon to the Earth it is Full Earth to the Moon, and vice versâ, he will see that the dark limb must be at its brightest when the Moon's illuminated crescent is at its thinnest. In addition, however, to this constant cause of variation in the brightness of the dark limb, the transparency or opacity of our own very variable atmosphere most perceptibly affects its visibility.

I may tell "Float," in reply to his query (32793, p. 176), that the *Dawn of History* is by C. F. Keary, and is published by Moseley and Co. I must, however reiterate what I said in letter 14087 (p. 13)—viz, that I have only seen an advertisement of this work. With the other one which I recommended to your correspondent, Sir John Lubbock's *Prehistoric Times*, I am most thoroughly familiar, and can speak very confidently of it indeed.

In a charming little piece of penny-a-lining which appeared in the *Times* some fortnight ago, I find the most liberal offer of the owners of the White Star Line of Steamers, to convey observers of the approaching Solar Eclipse to America and back for £20, described as "a noble instance of the private endowment of an unremunerative branch of scientific inquiry." If this be "endowment," then I suppose that if I give a lift in my carriage along a country road to a doctor who is in a hurry to get to a patient, and do not charge him for it, I "endow" medicine; but I am afraid that commonplace people would be disposed to accuse me of employing a solecism if I claimed to do so. However, as the proverb says, "Any stick will do to beat a dog with," and I suppose that so eligible an opportunity of familiarising the public with the idea of "endowment of scientific research" was too tempting to be passed over.

If Mr. Chambers (letter 14287, p. 195) will turn to letter 14190, p. 117, he will find that I not only admit there that I was wrong, but indicate also the way in which my mistake arose. If, however, it will afford your correspondent any gratification to have such admission reiterated in another form, I will say at once that the table in his *Descriptive Astronomy* is perfectly correct (as I, of course, originally believed it to be); and at the same time very cheerfully testify to the remarkable general accuracy of the immense mass of astronomical information contained between the two covers of his very excellent and valuable book.

I need only say here that "W. G. P." quite correctly interprets my meaning, in the concluding paragraph of his letter (14288) on p. 195.

The reply to query 32804, p. 201, is a very simple one indeed. Olber's theory is *not* held by astronomers now. As projected on the plane of the ecliptic a good many of the orbits of the planetoids intersect, but the orbit of Flora nowhere approaches that of Hilda for example, within 100,000,000 of miles. Moreover none of these numerous bodies pass through a common point in space; and their nodes are scattered all over the Ecliptic in a manner following no recognisable law. What in Olber's time was a mere dream, is now a demonstrable impossibility; and the theory of the minor planets being the fragments resulting from the explosion of a large one is as extinct as the Ptolemaic one of the Solar system. I must caution "Tyro" against accepting Dr. Lardner as an astronomical authority. He was simply a plausible popular scientific expositor, with but little depth of knowledge of the subjects on which he treated.

With regard to query 32822 (p. 201), I may inform "Mac," that the Report of the Harvard Observatory to which I referred in letter 14245, gives merely information as to the methods of celestial photometry there employed; the results (save in the case of the Satellites of Mars) being reserved for future publication. I should think that Sampson Low and Co., the American publishers in London, would be very likely people through whom to obtain this—or any future—publication of the observatory referred to, assuming them, of course, to be sold. The copy I saw was a presentation one.

I cannot answer query 32837 (p. 202) off-hand, as I do not possess a copy of the B. A. C. myself; but will avail myself of the earliest opportunity of consulting it, and will then give Mr. Gore the result of my examination. ε Hydræ itself neither appears in the "Greenwich Seven-year Catalogue" nor in the Cape one.

The only reply that I can give to query 32840 (p. 202) is, that I suppose that Mr. Browning must have raised his price for 4¼in. reflectors since 1867. With regard to the concluding question, I would say that personally I should prefer a first-class 4in. refractor to a 4¼in. reflector; but "Permian" must bear in mind that the achromatic would be very nearly double the price of the reflector, which is a serious consideration. My querist could hardly get a 4in. refractor on the most moderate equatorial stand under some £45, while for £3 or £4 more he might obtain an 8½in. reflector mounted on an altazimuth. If your correspondent is hesitating between two instruments of the same aperture, let him select the achromatic. On the other hand, should he wish to decide between two telescopes of the same price, let him by all means adopt the reflecting form.

If "Doshre" (query 32844, p. 202), intends, as he says, to study *nautical* astronomy, he will require, not a £10 or £15 telescope at all, but a good sextant. The mathematics necessary for an intelligent appreciation of the problems which he will have to solve, will extend to spherical trigonometry, while the most perfect familiarity with the nature and use of logarithms is also essential. I think that if my querist will get Young's *Navigation and Nautical Astronomy* in "Weale's Series," and its accompanying volume of *Tables*, he will obtain an excellent idea of the chief subjects to which his attention will have to be directed. Of course, when he is once au fait in the use of logarithmic tables he may solve all the leading questions in navigation by mere rule of thumb, but I understand him to signify that he wishes to know something of the theory of the operations he will have to perform, and of the reasons for performing them. By the bye, he will require a good naked eye acquaintance with the stars, and for acquiring this nothing can surpass Proctor's small *Star Atlas*, which he will do well to procure.

A Fellow of the Royal Astronomical Society.

SELENOGRAPHICAL.

[14297.]—Craterlets E. of Lexell. Lohrmann only shows one (I think the most northerly one) of the four craterlets alluded to by Mr. Gaudibert (English Mechanic, No. 682, p. 138, letter 14219). He also shows a craterlet and a cleft in Lexell itself, which are not on B. and M. Lohrmann and Beer and Mädler frequently delineate the same objects very differently. Some of these discrepancies may be due to the fact that "L." used a telescope having an aperture more than an inch larger than the one employed by B. and M. (Lohrmann employing a 4·8in. Fraunhofer and a small achromatic of 3¼in. aperture, while the B. M. telescope, by the aid of which the first edition of the "Mappa Selenographica" was constructed, was only 3·7in. in diameter); but all of them cannot be imputed to this cause, and, as far as I can judge, Lohrmann has drawn minute details much more accurately than his more celebrated contemporaries. In the neighbouring formation, Sasserides, B. and M. show a little row of four well-marked craterlets, while L. draws two rings in their place, the larger of the two—the N. one—being very slightly smaller than B. and M.'s Sasserides "*e*."

Hansteen.—Mr. Gaudibert's rill is probably a new discovery, as it does not agree with Schmidt's description of his No. 217 in the "Rillen," or with Neison's map. It seems to correspond very closely with some ridges shown by B. and M. in the second edition of their map, and may possibly be a very narrow valley between some of these ridges, resembling in this respect I A a 7, for instance

Aristarchus.—Having been engaged lately on a comparison of several maps and sketches of this crater and its surroundings, perhaps a few brief extracts from my notes, chiefly with reference to markings on the floor of Aristarchus, may be of interest to Mr. Gaudibert and others. The first representation of Browning's mountain, with which I am acquainted, occurs on a very fine drawing of Aristarchus, Herodotus, and the region north of these two craters, by Mr. Hunter, the drawing being constructed from some ten sketches made from March, 1860, to January, 1862, with 12in. aperture of Lord Rosse's 3ft. reflector, a power of about 400 being usually employed. On both Mr. Hunter's and Mr. Browning's drawings (*c. f.* "Student," April, 1869), the central peak and "Browning's" mountain are shown connected with one another by a low ridge, and on Mr. Hunter's the central (*i.e.*, the southern) peak is elongated exactly as depicted by Mr. Gaudibert (English Mechanic, No. 380, July 5, 1872). Phillips' drawing of the floor is not a very satisfactory one, and even his delineation of the great serpentine valley must, I think, yield the "pass" to that of Mr. Hunter. Mr. Hunter shows a white marking as bright or brighter than the central mountain, very slightly east of the spot where Schmidt draws his craterlet, and this marking may possibly be identical with Mr. Gaudibert's new hillock (letter 14219), and Schmidt's little crater. It is well known that Schmidt is very fond of drawing small craterlets (he shows an amazing quantity of them on the floor of Mersenius), and it frequently happens that on drawings of the same formation by different hands mounds appear as craterlets and craterlets as mounds. For instance, on Mr. Gaudibert's drawing in the English Mechanic for July 5th, 1872, his No. 59 appears as a craterlet flanked by two mounds, No. 58 and 60, but Schmidt draws all three as craterlets; 53 and 54, are shown by Hunter as craterlets, exactly as on Mr. Gaudibert's drawing, but by Schmidt as two mounds. No. 64 is a craterlet on Schmidt and Hunter, and a mound on Gaudibert; No. 66 is a mound on Gaudibert, a craterlet on Hunter—in fact, any one might give hundreds of such instances.

Lohrmann, on his map (but not on Sec. XVIII.), shows a minute craterlet about as far S E. of the central mountain as Schmidt's craterlet is N.W., and there are faint traces on his map of Schmidt's two hillocks at the S. border of the floor. It may be as well perhaps, also, to mention here that Mr. Hunter shows a mound on the S.E. of craterlet 41 (= B. and M. and Schmidt's "A.," "ζ" of Schröter, Lohrmann 49 [Sec. XVIII.]), and also one in the same position on the outside slope of 38, and that Gruithuisen draws ("Astron. Jahrbuch," Vol. X., Plate VI., figure 33) two mounds just where No. 46 stands, while Browning shows a white patch there.

Fontenelle, Formation III. ξ^6 W. of.—I think that Mr. Gaudibert's craterlet No. 9 is the one which I saw on June 23rd, 1874. Lohrmann shows two hillocks on the floor of Fontenelle, B. and M. only one. (In letter 14096, page 16, No. 677. *Lambert* for "crater, now" read "crater-row," and in the last line of the letter for "sketches" read "sketch.")

Timaeus —On the Melbourne photogram, date Sept. 1, 1873, this crater is shown with a small central mountain, probably the one mentioned by Mr. Gaudibert, the crater being nearly half full of shadow when western portion of the mountain is not apparent. I forgot to mention above that on this photogram the three northern craterlets of the eastern row E. of Lexell appear broken down, exactly as Mr. Gaudibert describes them, and that the two rings in Sasserides appear as delineated by Lohrmann, and *not* as on the "Mappa Selenographica."

Crater N.W. of Hygenus.—I do not think that the craterlet alluded to by Mr. Gaudibert is at all connected with Dr. Klein's "Nova." Mr. Gaudibert's sketch was carefully examined along with all other obtainable ones when Dr. Klein's discovery was announced, and the little craterlet was noticed; but we came to the conclusion that it had nothing to do with the new crater. There are several little ones scattered up and down the region N. of Hygenus, with one of which Mr. Gaudibert's is probably identical. It must be remembered that Dr. Klein has seen his "new" crater several times since he first discovered it, under various illuminations, and that it has been also seen by Schmidt. The weather was very unfavourable here on the 9th and 10th, and, as far as I am aware, the crater was only seen by Mr. Ward, of Belfast, on the evening of the 9th instant. He writes to me that he got a glimpse of the Moon through a break in the clouds of about five minutes' duration, when the Moon was from two to three hours past the meridian, and that on looking at the region with a power of 175 on his 4·3in. Wray, he "at once saw the black crater, and also the cleft (?) 'B.,' but the latter had a bent or crooked appearance near the middle." Dr. Klein's article in the "Wochenschrift" is reproduced in the current No. of "Sirius," and the May number of the "Selenographical Journal" will contain a large diagram of the "new" crater and its surroundings, and an article on the subject by Mr. Neison.

Gruithuisen draws a surprising number of clefts in the Triesnecker system, and also at the end of the Hygenus cleft, and he gives several drawings of the junction between the clefts Amadæus and Hygenus, delineating the connecting cleft 'A' exactly as it is shown by Mr. Gaudibert (English Mechanic, Sept. 22nd, 1871, No. 339, letter 2605). He must have been a most indefatigable observer (for instance, he gives no less than 28 different observations of the clefts of Triesnecker alone between the years 1814 and 1826!), and the acuteness of his sight must have been something marvellous, though his imagination frequently ran away with him in his interpretation of what he saw:—I am not aware, though, that he ever went so far as to assert that he could see the Moon's Zodiacal Light with the naked eye, as has been asserted in the pages of a scientific journal.

Posidonius.—There is a drawing of this formation by Gruithuisen in Bode's "Jahrbuch" for 1824, to which there is no allusion in the text on which 'B' (*c. f.* English Mechanic, Nos. 308, 346, 349, 357, 362, &c.) appears as a crater about the size of '17.' It does not appear in Schröter, and Gruithuisen's drawing is evidently intended to call attention to this. It is also shown as a crater, slightly smaller in size than 17, on a drawing in my possession by Flammarion. On Schmidt it appears as three or four low ridges, not very unlike Mr. Gaudibert's drawing and description of it in English Mechanic for March 1, 1872, No. 362, letter 3698. I have never seen it as a crater myself.

Fracastorius.—As this object is again attracting some attention at the hands of lunar observers, it may be useful to direct attention to three drawings of it which are, I believe, not very generally known. The first is one by Gruithuisen (executed under the evening illumination), which is to be found on plate V., figure 5, of his "Jahrbuch" for 1848; the second is a drawing by Mitchel with the 11in. Merz achromatic which he erected in the Cincinnati observatory, and is engraved, together with a view of Gassendi, on the plate facing page 93 of his "Popular Astronomy;" the third was executed by Müller with the aid of the Dorpat refractor, and is on Tag. IX. of the plates accompanying his "Populäre Astronomie" (Edition of 1861). **Herbert Sadler.**

April 27th.

THE LUNAR CRATER PLATO.

[14298.]—Letters 14032, Vol. XXVI., p. 601, 14061, Vol. XXVI., p. 625, 14191, Vol. XXVII., p. 117, and 14221, Vol. XXVII., p. 139, contain records of observations of the successive illumination of the Walled Plain Plato from 7·64 days of the Moon's age to 18·89 days also of the Moon's age in the years 1860 and 1861. With the hope that some of the features then observed have been seen during the last two lunations I am desirous of soliciting attention during May and June to some of the intermediate phases of illumination, so as to present a regular series of appearances of Plato as the sun rises, culminates, and sets upon it.

1878, May 10, 6.0, moon's age 8·25 days.

1861, March 19, 9.0, moon's age, 8·27 days.

On the evening of May 10, should the sky be clear, an interesting observation of the ruined Walled Plain, "Newton" of Schröter may be obtained, when the situations of the remaining fragments of its wall may be determined and the localities of the minute craterlets on its floor ascertained; the best time for this work is during the eighth and ninth days of the moon's age. The isolated rock "Sico" is situated on the southern boundary or wall of Newton, the Teneriffe Mountains being situated to the east.

The record of the observations in 1861 is as follows:—"Terminator grazing the eastern edges of Newton and Plato."

Floor.—The *eastern* part of the floor of Plato *slightly rough*, the summits of the irregularities just catching the rays of the morning sun. *Note.*—An important observation, especially in connection with after appearances in this part of the crater. At 8·11 days of the moon's age, 1860, May 28, 8.15 to 10.10, no *definite* indications of roughness were obtained. I apprehend it is a feature difficult to catch.

1878, May 11, 8.0, moon's age 9·33 days.

1861, March 20, 10.25 to 11.0, moon's age 9·34 days.

Terminator a little eastward of the eastern edge of Copernicus, which is a very magnificent object, and grazing the eastern edge of Clavius.

North interior brightly illuminated from the lateral mountain chain on the north-west rim.

East, the rock ζ very brilliant, its shadow eastward of the crater being exceedingly well marked.

South interior exceedingly well illuminated.

South-west exterior, the ruggedness of the exterior slope well seen, with the ravine running nearly parallel with the summit.

[This ravine was observed between March 13 and 24, 1878, by Miss Ashley, of Bath, who says:—"There is a sort of ridge or double line of the wall of Plato, beginning just south of the crater G, and going to a point north-east of B. and M.'s λ."—W. R. B.]

The rock λ south-west of Plato very distinct.

[This rock is the principal object of a group just south-west of Plato. Miss Ashley, between March 13 and 24, observed three objects near it, two on the west and one on the north-east, which she describes as a crater, the other two as mountains. On April 11 and 15, 1878, the Rev. R. S. Hutchings, of Salisbury, records that B. and M.'s λ was seen plainly to consist of three peaks in an equilateral triangle, the easternmost λ the largest and brightest. He also noticed a small crater on the exterior of the south ridge of Plato, about the middle, which he considered to be Miss Ashley's crater, but the positions are not accordant. It would be well if observers using different apertures were to specify the number of objects seen in the group and the aperture employed.—W. R. B.]

North-west, the ruggedness of the exterior slope very distinct, also the rock ν north-west of Plato.

S W., W., and N.W. interiors in shadow, the shadows short.

Floor, a nearly uniform tint, bluish grey, the dash of blue faint but decided; the colour was darker than that of the Mare Imbrium. Occasionally faint specks of light appear on the eastern part of the floor where the slight irregularities were seen March 19, 9.0.

On p. 503, Vol. XXVI., No. 671, M. Gaudibert has published a sketch of objects east of Plato. I have received several sketches of objects both east and west of Plato, the latest by Mr. Hutchings, as noted above. He appears to have a difficulty in identifying Schröter's χ, for he says:—"I think there must be some mistake in the printing of his (Gaudibert's) sketch in the English Mechanic of Feb. 1, 1878. It is unintelligible to me, and what I take to be χ is certainly not in the position of Gaudibert's 1, 2, 3, 4, but much further distant, both from the rim of Plato and from I.G." It would greatly facilitate the settlement of the positions of objects in this locality if observers were to give sketches of a few objects, with their positions well aligned and triangulated.

Buckhurst-hill, May 2. **W. R. Birt.**

SOLAR SPECTRUM.

[14299.]—By careful manipulation with a spectroscope of considerable dispersive power, a great many of the absorption lines in the solar spectrum, marked in Angström's map, as somewhat broad single ones, are proved to be close double, triple, and even quadruple lines. The irresoluble broad lines are mostly those caused by the "vapours," which are in the solar "atmosphere," and are furthest from the body of the sun. Thus the broadest lines are the C and F lines of hydrogen, the outside limit of the atmosphere being hydrogen; the magnesium lines (the little B's) are the next broadest, magnesium vapour being that below the hydrogen in the solar atmosphere; the sodium, D lines, rank next below the magnesium, sodium being the next vapour in order. The iron lines are broader than the nickel and barium lines, and come next to sodium, but in the solar atmosphere the nickel and barium vapours seem generally to be above the iron, but on this point more evidence is required.

In great solar disturbances, such as cyclones and storms, where there is rapid motion, increased pressure and absorption, the vapour mostly affected seems to be hydrogen, then magnesium, then sodium, then nickel, barium, and iron. These disturbances would tend, locally, to widen the respective absorption lines, and make them appear "nebulous." If this were effected over a considerable area of the sun, the absorption lines of hydrogen, magnesium, sodium, barium, nickel, and iron in the solar spectrum would no longer be as thin as the spectroscope would otherwise make them, but they would be, as in fact we now see them, their width depending on the extent and nature of the solar disturbance. I shall be glad to hear what others, who have given more study to this branch of solar physics than I have, have to say on the subject, it being one of very great interest. **Spectrum.**

THE METEOR, APRIL 2nd.

[14300.]—Adverting to letter 14249, p. 166, I certainly thought the meteor referred to by the *Times* correspondent was identical with the one observed by me. I arrived at this conclusion by the coincidence of the time at which we both observed it, and, further, because it did not occur to me that there may possibly have been two fine meteors visible at or about the same time. I know several persons who saw the meteor observed by me, but I have not heard of any one who saw a second meteor the same evening, nor have I seen an account of one in any of the papers. Having, therefore, concluded that the *Times* correspondent and myself had observed the same meteor, it naturally followed that I also concluded his description of it was inaccurate when I found it disagreed with my own observations, which I know to be correct so far as I have described them. With regard to the difference of position in the heavens assigned by us to this meteor, having read "F.R.A.S.'s" letter 14245, p. 165, I quite perceive that our respective points of observation may have rated by a distance which would have for that difference; but there are other in his description, when compared with could not be so explained. He says "it ike in shape." I noted that it was per- ular in shape. Again, he says "its colour om a silvery white to a pale red." I did any change of colour. It appeared to me bluish white of great brilliancy, which tained until the moment of its disappear- also says "it disappeared, leaving a long ight behind it." I particularly noticed id not. It vanished instantly, and the nsition from intense light to total dark- o my mind one of the most remarkable onnected with it.

rusing Mr. Cornish's letter I am inclined that the meteors are not identical. I there must have been two meteors, one of observed by the *Times* correspondent, her by myself. I, of course, do not know as to his point of observation. Mine was N., long. 1° 30′ W.

E. Mawe Smith.

CANCRI.—To Mr. Webb.

—The most recent measures of ζ Cancri ne across are those of Dembowski in the umber of the *Astr. Nach.* He gives, as 7 evenings' measures at the end of 1876 ning of 1877: P = 108 69°, D = 0·682″, distance on March 9th coming out 0 81″, rch 30th 0 68″. The present distance is ± 0·85″, and the angle cannot be very rom 98·0°.

Herbert Sadler.

RANSIT OF MERCURY.

—The weather here was on the whole for those observers who wished to see the Mercury. The air was rather unsteady, and hazy clouds about, but these did not materially with distinct vision. I caught the planet immediately after external d was much interested in watching the as it gradually widened and deepened to e, and then narrowed again as the sun's in behind the planet. I was not able to rtion of the planet that was still outside the sun, but I saw that its form became kite-shaped before losing its connection black sky. When it had entered well disc of the sun it appeared intensely sharply circular, but I was not able to see bra or any bright ring surrounding it or spot on its surface. I also looked for a ut could not see one. The sun's surface arly free from spots, but the marbling or f the disc was very plain. I used my rtonian reflector, and examined the of ingress with a diagonal eyepiece of glass with a light sun-shade. The later ns were made partly with the same and partly by projection of the image on fine white cardboard.

A. Woolsey Blacklock, M.D.

d, May 6th.

—A cloudy sky with an occasional f sunshine through a hazy atmosphere ttle hopes of satisfactorily observing the my neighbourhood, and the sudden of the clouds an hour before the time pparently hopeless; but at 3.25 p.m. a e clouds revealed the sun with Mercury about ten times its own breadth on to the e sun, much farther than I expected to r only ten minutes' transit, according to time. From that time up to four o'clock s frequently to be seen at short intervals, not quite free from clouds more than d then only for half a minute at a time; se intervals I managed to see the bright l the planet, which made the sun appear eper in colour by comparison. Also a e in the centre of the planet. I also hat there was no mistaking it for a small he order of the shading being reversed, a-mercurial planet hunters may make a

o'clock the sun was invisible. The wind blowing steadily from the east up to 3 d at 4 o'clock it had got round to the which way it travelled I did not observe. ls also broke up and travelled more My dark glass was a microscopic glass ked over a night light; telescope, 3ft. er about 40; the eye-lens being 5-6ths of

I. V. V.

—The weather is splendid here, and I gress of the planet well with a 2¼in. Bor- r 80. Owing to a light breeze the air was and the rippling on the sun's limb con- so that a notch seemed to be struck into ere at a blow. The planet was not pre- sible to me. It assumed for a few seconds after internal contact, and before there was a clear line of light between it and the sun's limb, a drawn-out pear-shape (somewhat like a peg-top). Fairly on the sun's disc an aureola was quite apparent. I tried a power of 200, but found, owing to haziness, it was not so good as the lower powers. 100 worked well. The circlet surrounding Mercury gave me the impression of a faint penumbra at the margin of a sunspot.

Newcastle-upon-Tyne. **M. H. B.**

THE ESTIMATION OF THE ORIGINAL GRAVITIES OF BEERS.

[14305.]—The most important and general reason for estimating the original gravity of beers is that when beer is exported a drawback is allowed in proportion to the gravity of the wort from which the beer has been prepared; and as the materials from which beer is made are very heavily taxed, it would be impossible for English brewed beer to compete with that of other countries, unless the duty paid on the malt was refunded on exportation, the amount of duty so refunded being in proportion to the original gravity of the beer. The process is also of great use when we desire to know the gravity which any brewer may make his beer, so that we may compete with our neighbours in strength and other characteristics.

Of course it cannot be expected that the Excise will accept the simple statement of a brewer desirous of exporting beer, that such beer was brewed at a particular gravity, and therefore the brewer has to furnish samples of the beer, so that they may determine the original gravity for themselves. Now this gravity which, with reference to the beer, is called its "original gravity," is determined for revenue purposes, under the authority of an Act of Parliament, by a process originally devised by Messrs. Dobson and Phillips, and subsequently investigated under the direction of Professors Graham, Hoffman, and Redwood, by Messrs. Young and Forsey.

The nature of the data upon which the process is founded is based on the fact that when yeast is added to a wort its specific gravity diminishes as fermentation progresses, and this "attenuation," as it is called, results in 180 parts of sugar by weight yielding 92 parts of alcohol, and 88 parts of carbonic acid gas, which latter escapes; this may be demonstrated by the following reaction:—

Sugar.		Alcohol.		Carbonic Acid.
$C_6H_{12}O_6$	=	$2C_2H_6O$	+	$2CO_2$

Therefore, nearly half of the weight of the decomposed sugar disappears from the wort during fermentation, such abstraction of solid matter consequently lowering its density. Now, as the specific gravity of a solution of sugar is greater than water, while the specific gravity of alcohol is lower in proportion to its strength, it follows that the lowness of specific gravity caused by the presence of the alcohol in a fermented wort, will counterbalance and conceal a portion of the density of the sugar remaining undecomposed in the solution, so that before the true specific gravity due to solid matter in such a wort can be determined, the alcohol must be removed, and the wort made up to its original bulk by the addition of distilled water. The true specific gravity being ascertained, if we add to it the number of degrees of gravity lost in the wort through the decomposition of the sugar in the production of the amount of alcohol which it may contain, we shall arrive at the original gravity of the wort.

Now, the data upon which the method of estimation is based are of four kinds. 1st. The specific gravity of the unfermented wort, which corresponds to the "original gravity" of the wort. 2nd. The specific gravity of the fermented wort, or matured beer, or the "beer gravity." 3rd. The specific gravity of the alcohol obtained by the distillation of a given bulk of the fermented wort, after such alcohol has been increased to an equal bulk, by addition of water, which shows the alcoholic strength of the beer, 1000 minus the specific gravity, being termed the "spirit indication." And 4th. The specific gravity of the residue after distillation, and increased by the addition of water to the original bulk of the beer subjected to distillation, which indicates the "extract gravity" or what the specific gravity of the beer would be if uninfluenced by the presence of alcohol; and the last in conjunction with the third, shows the number of degrees of gravity lost in the formation of the alcohol.

Now, as the matter which is decomposed during fermentation does not wholly consist of sugar, and as a certain loss of alcohol takes place, due partly to evaporation, and partly to oxidation of the alcohol to acetic acid, the inventors of the process had to arrange their results so as to counterbalance these incidental influences, and were also obliged to draw up a table of corrections for the amount of acetic acid present in any sample of beer under examination. Of course it can easily be understood that the older are the beers under examination, the more necessary will be the careful estimation of the acetic acid they contain, and at any time also it is very important in practical brewing to know how to determine the percentage of acidity in any given beer so that we may judge as to the keeping qualities of any particular brewing. We may likewise by calculation from the data we obtain in the process, work out not only the percentage of alcohol and acetic acid, but also the percentage of extractive matter and water, and we can also analyse the dry extract, and determine the relative amounts of its constituents, maltose, dextrin, and albuminoids.

In estimating the amount of acetic acid present in beer we must bear in mind that a certain amount of acid is always present in all healthy fermentations (succinic acid and glycerine being constant products of alcoholic fermentation), and which must not be taken into account in correcting the spirit indication. For this reason also it is quite useless to endeavour to judge as to the more or less acidity of worts, by the employment of litmus paper. The quantity of acid normally found in worts is equal to one part of absolute acetic acid in one thousand parts of wort, or one-tenth per cent. It is, therefore, only the excess above this which is taken into account in arriving at the true number of degrees of gravity lost.

The process is as follows, and I must impress upon you the extreme necessity for all the weighings and measurings being made at a temperature of 60° F., and with the greatest accuracy and care:—

The amount of acetic acid is first estimated, and for the purpose we require a solution of ammonia, of specific gravity of ·9986, a given bulk of which will exactly neutralise one per cent. of absolute acetic acid in an equivalent bulk of beer; 100 grammes therefore will neutralise 1 gramme of absolute, and each cubic centimetre of the ammonia solution will neutralise 01 per cent. of acetic acid. This solution is generally known as standard excise ammonia, and may be purchased of the saccharometer-makers, Messrs. Long and Son, Little Tower-street, London, or of Messrs. Sutton, chemists, Norwich.

We proceed first to carefully measure 100cc. of the beer into a beaker, and then having filled a burette (divided into cubic centimetres) with the ammonia solution, we let it drop very carefully into the beer in the beaker, stirring well with a glass rod, until all the acidity of the beer is neutralised. This point is ascertained by testing with litmus paper, making short streaks on the test paper with the moistened glass rod, until neutral reaction results, or, in other words, until the litmus paper ceases to change from blue to red, or from red to blue.

This plan is far preferable to adding litmus solution to the beer to be tested, as the colour of the beer prevents the end of the reaction from being quickly recognised.

Now, it is very easy to calculate the percentage of acidity after reading off the number of cc. of ammonia solution used, for, as each cc. of ammonia neutralises ·01 per cent. of acetic acid, if we multiply the number of cc. of ammonia used by ·01, the result will give us the percentage of acid in the sample of beer under examination; and consequently if we have employed, say, 26cc. of ammonia solution for our purpose, the beer will contain (26 × ·01) = ·26 per cent. of acid, ·1 per cent. of this being actual normal acidity, consisting chiefly of lactic acid formed naturally during the malting, and of a small amount of succinic acid formed in the process of fermentation, leaving ·16 per cent. due to acetic acid present in the beer, and upon reference to the following table we shall find opposite the net percentage that our beer contains—viz., ·16, the spirit indication which has been partly hidden by the acid in the beer.

Per cent. of acetic acid	Corresponding Degrees of Spirit Indication.									
	·00	·01	·02	·03	·04	·05	·06	·07	·08	·09
0	—	·02	·04	·06	·07	·08	·09	·11	·12	·13
·1	·14	·15	·17	·18	·19	·21	·22	·23	·24	·26
·2	·27	·28	·29	·31	·32	·33	·34	·35	·37	·38
·3	·39	·40	·42	·43	·44	·46	·47	·48	·49	·51
·4	·52	·53	·55	·56	·57	·59	·60	·61	·62	·64
·5	·65	·66	·67	·69	·70	·71	·72	·73	·75	·76
·6	·77	·78	·80	·81	·82	·84	·85	·86	·87	·89
·7	·90	·91	·93	·94	·95	·97	·98	·99	1·00	1·02
·8	1·03	1·04	1·05	1·07	1·08	1·09	1·10	1·11	1·13	1·14
·9	1·15	1·16	1·18	1·19	1·21	1·22	1·23	1·25	1·26	1·28
1·0	1·29	1·31	1·33	1·35	·36	1·37	1·38	1·40	1·41	1·42

We next proceed to separate the spirit from the beer by means of distillation, and the most convenient and inexpensive still for the purpose is a glass Liebig's condenser, which costs only 2 or 3 shillings. 100 cc. of the beer at 60°F. is poured into a measuring flask having a mark on the neck, and then it s transferred to another flask holding about half a litre, the measuring flask being carefully rinsed out with distilled water, and the washings added to the beer. The half-litre flask is then connected in an air-tight manner, by means of a cork, bent glass tube, and indiarubber joint to the tube of the condenser, and the perfectly clean measuring flask is placed to receive the spirit as it distils over. About two-thirds of the bulk of the beer used are then distilled off, and received in the measuring flask; the distillate, which will contain the whole of the alcohol, is then increased by the addition of distilled water to the 100cc. mark on flask (or the same bulk as the beer operated upon), then well agitated, cooled to exactly 60° F., and its specific gravity ascertained by the weighing bottle, and an accurate balance—1000 minus this specific gravity being the "spirit indication." The extract remaining in the distilling flask is likewise treated in the same manner, being transferred to the 100cc. measuring flask made up to the mark with distilled water, well agitated, cooled to 60° F., and weighed in the balance. Its density is termed the "extract gravity."

Having found the "spirit indication," as above, or 1000 minus the specific gravity of the spirit, if we refer to the following table we shall find the degrees of gravity that have been lost, or the number of pounds of extractive matter per barrel that must have undergone decomposition in order to produce the alcohol found.

Degrees of spirit indication	Corresponding Degrees of Gravity Lost.									
	·0	·1	.2	·3	·4	·5	·6	·7	·8	·9
0	—	·3	·6	·9	1·2	1·5	1·8	2·1	2 4	2·7
1	3·0	3 3	3·7	4·1	4·4	4 8	5·1	5·5	5·9	6·2
2	6·6	7·0	7·4	7·8	8·2	8·6	9·0	9·4	9·8	10·2
3	10·7	11·1	11·5	12·0	12·4	12·9	13·3	13·8	14·2	14·7
4	15·1	15·5	16·0	16·4	16·8	17·3	17·7	18·2	18·6	19 1
5	19·5	19·9	20·4	20·9	21·3	21·8	22·2	22·7	23·1	23·6
6	24·1	24·6	25·0	25·5	26·0	26·4	26·9	27·4	27·8	28·3
7	28·8	29·2	29·7	30·2	30·7	31·2	31·7	32·2	32·7	33·2
8	33·7	34·3	34·8	35·4	35·9	36·5	37·0	37·5	38·0	38·6
9	39·1	39·7	40·2	40·7	41·2	41·7	42·2	42·7	43·2	43·7
10	44·2	44·7	45·1	45·6	46·0	46·5	47·0	47·5	48·0	48·5
11	49·0	49·6	50·1	50·6	51·2	51·7	52·2	52·5	53·3	53·8
12	54·3	54·9	55·4	55·9	56·4	56·9	57·4	57·9	58·4	58·9
13	59·4	60·0	60·5	61·1	61·6	62·2	62·7	63·3	63·8	64·3
14	64·8	65·4	65·9	66·5	67·1	67·6	68·2	68·7	69·3	69·9
15	70·5	71·1	71·7	72·3	72·9	73·5	74·1	74·7	75·3	75·9
16	76·5									

We have then the "spirit indication" represented by the specific gravity of the alcohol distilled, and the spirit indication represented by the net percentage of acidity. Adding the two together gives the true spirit indication.

As an example, the following particulars of an experiment made upon a beer brewed at a gravity of 1064·58, will illustrate the method pursued:—

Specific gravity of beer 1012·42=4·47lb. per barrel.
Specific gravity of spirit 990 56
Specific gravity of extract 1022·08

In estimating the acid, 26 cc. of the ammonia solution were required to neutralise the acidity of the beer, which was thus shown to contain ·26 per cent. of total acidity (26 + ·01) then—

Total acid present in beer	0 26 per cent	
Deduct, as being already allowed for in the formation of table No. 1 ...	0·10 ,,	
Acetic acid to be taken account of...	0·16 ,,	
Observed degrees of "spirit indication," or 1000 minus the specific gravity of the distillate		9·44
Add spirit indication corresponding to 0·16 per cent. of acid, as per table No. 1 ...		0·22
True spirit indication		9 66

Then, by table no 2, 9·66 of spirit indication corresponds to 42 5 of gravity lost, or—

Spirit indication 9·66, corresponding to ...	42 50
Add extract gravity	1022·08
Original specific gravity	1064·58

And to bring the specific gravity found to pounds per barrel, deduct 1000 multiply by 36, and divide by 100, or—

Original specific gravity	1064·58
	1000
	64·58
	36
	-
100)'	88
Pounds per barrel, original gravity	23·25

Two other methods exist for estimating the original gravity of beers, but both are only rough approximations, and not reliable.

The alcoholic percentage in beer is found by looking at Drinkwater's alcoholic percentage table in any encyclopoedia, under the heading alcohol. When opposite the number corresponding to our specific gravity of alcohol, we shall see the percentage of absolute alcohol it represents.

Rotherham. **H. P. Harris.**

ROLLER BEARINGS.

[14306.]—Now that bicycling, with the rest of spring's delights, is reviving, and as one or two queries, &c., about bicycles have appeared in this paper lately, I send the following theory relative to roller bearings, which, I think, puts the matter in a new light. I was till lately a firm believer in the superiority of cone bearings, and, like many others, pooh-poohed rollers altogether. Fig. 1 represents the rollers and axle as they work theoretically, not practically. This is where, I suggest, other writers err, as a very little consideration would have shown them.

Let the rollers fit as accurately as they can be made practically; then, as soon as the rider mounts, his weight will cause them to take the position shown in Fig. 2, more or less, which is a very different thing from Fig. 1. The machine moving in the direction of the arrow, the axle grips roller No. 1, and carries it round, as shown in Fig. 3. It will thus be seen that in Fig. 3, at the points A and B, where the friction would be greatest in a cone bearing, with rollers you have for the moment a practically frictionless one. The motion being continued, No. 1 takes the place of No. 8, and 2 that of No. 1, and so on through the series.

FIG. 1

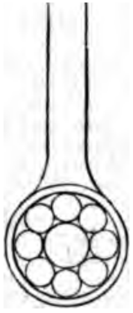


FIG. 2

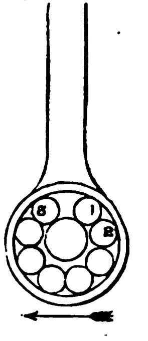
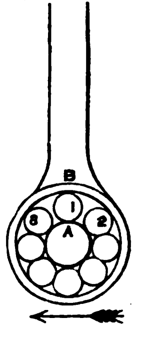


FIG. 3



Of course, in the drawing I have greatly exaggerated the play, but I have done so to render my meaning clearer. From the foregoing I think it will be seen that roller bearings lessen the friction, and that those gentlemen who have advocated them have had more than fancy on their side. **Ajax.**

BICYCLING MATTERS.

[14307.]—I THINK that if the best improvements of each bicycle-maker could be manufactured into one we should have a very good machine for the season. There is Carver's patent hollow spokes, Singer obtains the sole use of cycle bearings, Grout (I believe) obtains a patent for his "Indestructible tire," which I have heard well recommended, and other makers have specialities which they alone can use. But perhaps some of your correspondents do not consider the above "patents" any improvements at all upon other makers. If so, I should like to hear their opinions upon them.

I quite agree with Mr. Brown in his letter (1305, p. 335 of last vol.) upon roller bearings. Mr. Striffler (letter 13526, last vol.) gives a diagram of the adjustable crank, showing that the stroke can be adjusted at pleasure, &c, and without diminishing speed. Is this fitted to any bicycle, and if not, can it be fitted by any maker if desired? **G. L. P.**

A FEW WORDS ON BICYCLES: THEIR CONSTRUCTION AND BRAKES.

[14308.]—On reading Mr. Striffler's article on cheap bicycles I saw that if he countersank the clamps for wire a little on the top side he would get a much stronger spoke-head.

Backbones are made much stronger at present than necessary. If I were having a machine made for myself I should order one with a racer backbone, but with roadster forks, so saving several pounds in
weight. Any rider knows that there is n
strain on a backbone, which he can soon
lifting up the back wheel when some one i
saddle; the hollowness, at the same time
them very strong.

Bearings.—A few days ago I rode down
about 4½ miles long, with two other frien
machines were by eminent makers, and
follows:—No. 1. Ball bearings, 54in.; w
rider, about 150lb. No. 2. Roller bearings
weight of rider, about the same as No. 1.
Roller bearings, 52in.; weight of rider, abo
The weights of machines did not differ 5lb.
started together at the top of the hill, and v
No. 1 began to lead the way, our legs over the
all the time. Ere long Nos. 2 and 3 had to
to catch up a little to No. 1, which they
repeat several times, and we found on reac
bottom that No. 1, ball bearings, would b
there about three minutes before the other
they not treadled part way. We did the 4½
about 18 minutes against a head wind.

Brakes.—The most powerful brake I hav
Stassen's eccentric, but it is rather ex
Trailing brakes are not any good in tow
paved streets. Roller brakes on back whee
much good; sometimes scotching the wl
rubber soon getting worn through them. A
is not much weight on the back wheel, so it
brake. I never use one, preferring to ride
If, however, the machine runs away, t
simple dodge is to put one leg over the han
brake with the instep, taking care to do it g
else there is a spill if done suddenly, leani
well at the same time. With very little pra
machine can be thus stopped in a very short
on going down almost any hill.

ON THE MEASUREMENT OF APERTURE OF MICROSCOPE C TIVES.

[14309.]—Drs. Nickols and Bull say
their experiments they have not found that
ing lenses," or concaves associated with
piece, are apt to elongate the focus. This i
I have a set of amplifiers for my microsco
sisting of single concave lenses, by whi
demonstrate this at once.

But this assertion pales before one cont
the succeeding paragraph, so surprising i
accuracy that it appears to me to give qu
ferent tone to the spirit of the discussion.
that "if half the front lens of the obj
obscured by a screen touching it, half the l
in some cases but little of the apparent
lost." To this Drs. Nickols and Bull repl
our observations, when the screen *is in clos*
with the object-glass, and a biconcave len
stop to keep the eye central, is used as an e
lens, half the angle, as well as half the
always cut off." To save time and usele
ment I have taken the apertures by th
sector measurement of the series of object-g
below. The examining lens had a cap wi
¼in. in diameter, set 1½in. behind, so as to kee
central, and in each measurement the half
stop of the thinnest platinum foil was br
close contact with the front lens.

Object-glass.		Full aperture.		Apertur half-se
2-3	...	28°	...	19°
1-2	...	78°	...	58°
1-5	...	125°	...	86°
1-10	...	150°	...	100°
1-12	...	152°	...	90°

I state that in an object-glass with
obscured front, by the usual measurement
apparent angle, or half the field, is not cut
Nickols and Bull say that "it is." T
coming to a mere contradiction, must put
argument. This experiment is very easy t
I give a caution against an apparent cause
When the front of the object-glass is lowe
upon the half-screen of foil, this seems t
placed and slip away to the side, but this
deception. When the object-glass is foc
the distant light instead of half, a smaller
only of the field is obscured, an appearan
from rays extending from the open half be
beyond the screen.

Drs. Nickols and Bull are perhaps not a
upwards of four years ago this aperture
was a subject of rather warm controvers
again drifting into the same groove, antag
then seeking refuge in the collar adjus
pointed out cases wherein correct dimensi
be taken from the focal distance up to the
of a limiting stop, close to the front le
must represent and include a definite angle
ture; yet under certain conditions such a
measurement is no longer practicable. Fo
a thickness of glass might be added to the f
so as to bring its focal plane on to the
leaving the correction perfect; this illust
condition of an immersion lens with objects

covering glass, the under surface represent- front of a lens of extra thickness. There ı this case no focal distance, no matter what le of the cone of rays or the diameter of the ght be, either large or small, the estimated aperture must come out as 180°.

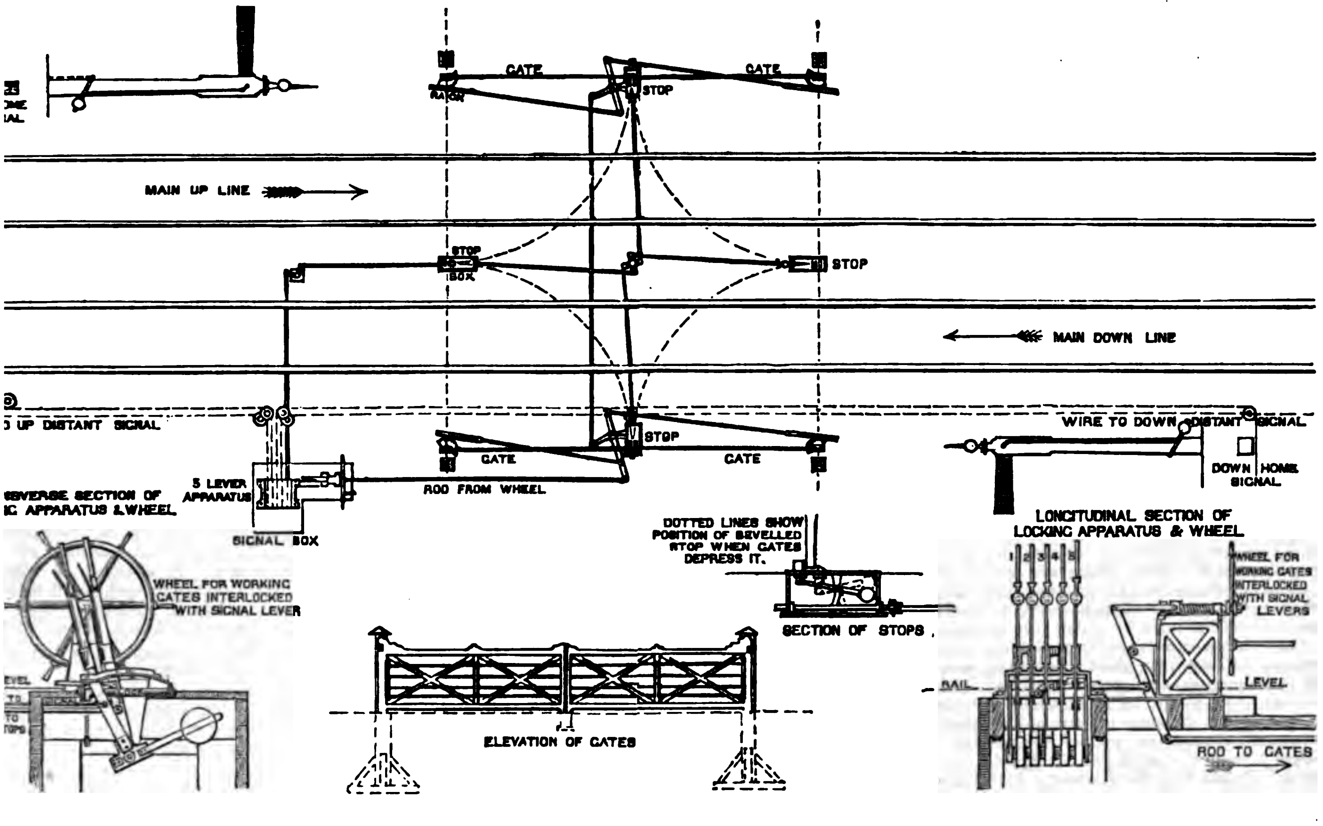
nit that a measurement of the light spot or r of transmission of the front lens, as inter- by a film of dried milk, is not very definite, h an adjustable slit it is easy to ascertain e edges encroach on the field, by means of mining lens; this method I prefer.

Nickols and Bull have done service in point- inaccuracies arising from the use of pinhole bove the examining lens, but do not appear to to perceive that pencils of rays bounding the view, and extending beyond the central ones, ause false indications of aperture. This is nt of the argument which, as it cannot be d, is rather evaded. I cannot see the use of ing a discussion that is getting wearisome. I aintain that all methods hitherto used for ing apertures give exceedingly erroneous and I shall be glad if Drs. Nickols and Bull ise any more accurate system.

F. H. Wenham.

RAILWAY CROSSING GATES.

0.]—At all places where a public road crosses ay on the level, there is a source of danger onvenience, and such crossings should be as much as possible by the use of bridges.


MAIN UP LINE
MAIN DOWN LINE
GATE
GATE
STOP
STOP
STOP
STOP
BOX
GATE
GATE
UP DISTANT SIGNAL
WIRE TO DOWN DISTANT SIGNAL
DOWN HOME SIGNAL
5 LEVER APPARATUS
SIGNAL BOX
ROD FROM WHEEL
TRANSVERSE SECTION OF APPARATUS & WHEEL
WHEEL FOR WORKING GATES INTERLOCKED WITH SIGNAL LEVER
DOTTED LINES SHOW POSITION OF BEVELLED STOP WHEN GATES DEPRESS IT.
SECTION OF STOPS
ELEVATION OF GATES
LONGITUDINAL SECTION OF LOCKING APPARATUS & WHEEL
WHEEL FOR WORKING GATES INTERLOCKED WITH SIGNAL LEVERS
LEVEL
RAIL
ROD TO GATES

nd a diagram, showing the arrangement of g gates, as used by Messrs. Saxby and r. All the four gates are opened and closed aneously by a wheel placed inside the signal- combination, and interlocked with a frame of ers for working the home and distant signals direction, and the levelled stops for holding tes in position. The signals are upon the d system," and completely protect the gates hut across the railway, and also the road and, as the gate and signal levers are inter- it is impossible for any signal to be lowered train to proceed over the crossing until the re shut and secured across the public road.

re also seen at a few level crossings, where ck system is in operation, a "mechanical ation" of the levers and block instruments. arrangement the "be-ready" signal for an ching train cannot be accepted until the re properly shut and secured across the road. as the "be-ready" signal has been accepted es are locked, and cannot again be moved he train has passed, and the "line-clear" has been sent back to the signal-man in the This operation at once unlocks the gates he next "be-ready" signal is accepted.

system of signalling, as above described, is safe," but if the block signal-boxes are not nearer to each other than usual, great delay sed to the road traffic.

For a future number of the Mechanic I will prepare a diagram of signals on the "spread system," as used at the level crossings of two railways.

May 1st. **O. E. S.**

THE COMPOSITION AND FORM OF MINERALS CONTAINING IRON AND LIME.

[14311.]—In connection with a controversy, which has happily terminated in the pages of the English Mechanic, relating to mineralogy, it has occurred to me that the crystallographic form of minerals depends in a very great degree, if not altogether, on the chemical composition.

In accordance with this idea I have considered, however crudely, some of the leading minerals having iron and lime for their components, singly or combined, and have endeavoured, feeble though the effort may be, to show that the form depends on the composition. I am inclined to think that the composition and the form are merely the cause and effect, and that it opens up an extensive field of inquiry and research for scientific men who may be equally proficient in practical mineralogy and chemical analysis. Any difference in the composition, however slight, must, I think, of necessity produce a difference in the crystalline form to a greater or less extent. The following carbonates crystallise in the hexagonal system—viz., the carbonates of iron, calcium, magnesium, manganese, and zinc—but the carbonates of barium, strontium, lead and calcium, crystallise in the rhombic. This difference in crystallisation is, doubtless, due to the difference in chemical composition. Carbonate of lime crystallises in the hexagonal or rhombic forms, according as it is deposited from cold or warm solutions. Thus the warm solution produces a different molecular arrangement from the cold. And the addition of minute portions of other substances to the solution of the carbonate tends to produce the rhombic form in preference to the hexagonal.

Again, in natron $Na_2CO_3 + 10H_2O$, malachite $Cu_2CO_3(HO)_2$, and azurite $2CuCO_3Cu(HO)_2$, the monoclinic forms are assumed due to the molecular arrangement being modified by the hydration of the carbonates.

Again, minerals in which lime forms one of the constituents, crystallise in all the systems. Fluer spar (CaF_2) and garnet crystallise in most of the primary forms of the cubic system.

Scheelite, calcium tungstate ($CaWO_4$), crystallises in the tetragonal system in the pyramidal form.

Apatite, $3Ca_3P_2O_8$, CaF_2, dolomite $CaMg(CO_3)_2$, and calcite $CaCO_3$ crystallise in the hexagonal system but in different forms. The apatite assumes all the holohedral forms, the pyramid and prism hexagonal and dihexagonal, but does not appear to take any of the hemihedral forms. Dolomite occurs in rhombohedrons, while calcite takes the form of the hexagonal prism, and scalenohedron, besides its favourite form, the rhombohedron. These varieties of form are doubtless due to the difference in chemical composition.

Anhydride $CaSO_4$, arragonite $CaCO_3$, and okenite $(SiO)_2(HO)_4CaO$ crystallise in the same system, the rhombic, with difference of form due to composition.

Gypsum $CaSO_4 + 2OH_2$, wollastonite $CaSiO_3$, datholite $CaSiO_3$, $CaBOo_4 + OH_2$, pectolite NaHO $(CaO)_2(SiO_2)_3$, and sphene Ca_2SiO_3, TeO_3, crystallise in the monoclinic.

It is important to observe that all except the last are hydrous, and that the hydrous carbonates of sodium and copper crystallise in the same system. This is a coincidence. Again, the anhydride, $CaSO_4$, when it becomes hydrated gypsum, $CaSO_4 + 2OH_2$, changes from the rhombic to the monoclinic form. It thus appears that the composition determines the form.

Lastly, Schiller spar, a silicate of Fe, Ca, Mg, Al, &c., and axinite, a silicate of Fe, Ca, Mg, Mu, &c., crystallise in the triclinic system, the chemical composition being similar.

Iron, like calcium, is found in crystals in all the systems. We have iron, native, magnetic, and pyrites, crystallising in various forms of the octahedral system; and idocrase, a silicate of Fe, Ca, Mg, and Al, assumes the tetragonal form. Red hæmatite, Fe_2O_3; chalybite, $FeCO_3$; and pyrrhotine, the magnetic pyrites mentioned by "G.J.H.," crystallise in the hexagonal—the sulphur in the pyrites taking the place of the oxygen in the hæmatite without altering the form. In fact, in many cases, sulphur is chemically equivalent to oxygen—for instance, we have H_2O and H_2S, K_2O and K_2S, CO_2 and CS_2, KHO and KHS, C_2H_5HO and C_2H_5HS, &c.

Brown hæmatite, Fe_2HO_6, and mispickel, $Fe_2(SAs)_2$, crystallise in the rhombic system as prisms, the molecular arrangement and composition being similar. It may be remarked that brown hæmatite is simply the red hæmatite hydrated, inducing a different molecular arrangement. Copperas, $FeSO_4 + 7H_2O$, and vivianite, $Fe_3(PO_4)_2$, assume the monoclinic form; and, as stated above, Schiller spar and axinite, both containing iron, and having similar constituents, crystallise in the triclinic.

Augite, epidote, and hornblende silicates, having similar constituents, and all containing iron and calcium, crystallise in the same system—the monoclinic. Perhaps some may be convinced from the above references that chemical composition has something to do with the system and the forms of that system in which minerals crystallise. Perhaps they may also see that it has a great deal to do with the crystallisation, and perhaps they may feel disposed to go one step further and see that the molecular arrangement dependent on the chemical composition wholly determines the form assumed in each case.

Hugh Clements.

ORGANIC CHEMISTRY.

[14312.]—Mr. Clements (p. 123) will fir information as to the isomerism of ethylic hydride in the volume of "Researches" recently issued by Dr. Frankland.

Kolbe's system of nomenclature for alcohols is certainly open to the objection of employing a new word; but on the other hand it is much more systematic than the old method, and has the advantage of clearly indicating by the name, the composition and constitution of each alcohol. The nomenclature of organic chemistry may ultimately become, in every case, simply the name of a class and subdivision, with the number of the substance in that subdivision; but upon this subject I hope to write again shortly.

I cannot claim any special acquaintance with the dichlorbenzenes, and am simply quoting from "Fownes" (p. 436) when I inform my friend that orthodichlorbenzene (1 : 2) is a liquid at — 19° and boils at 179°; metadichlorbenzene (1 : 3) solidifies at — 18°, and boils at 172°; and paradichlorbenzene melts at 54° and boils at 173°.

Mr. Tervet, p. 171, is in error as regards the percentage composition of two of the alcohols mentioned in my reply to query 32103, p. 610. The examples I gave were propyl carbinol or primary butylic alcohol $CPrH_2Ho$; methyl ethyl carbinol or secondary butylic alcohol CMeEtHHo; and trimethyl carbinol or tertiary butylic alcohol CMe_3Ho. All these contain $C_4H_{10}O$, and have, therefore, the same percentage composition—namely,

Carbon	64·864
Oxygen	21·621
Hydrogen	13·513
	99·999

The method of distinguishing the different classes of C_nH_{2n+1} alcohols cited by my friend is very interesting. What is nitralic acid? I have not heard of it.

Wm. John Grey.

THE LAST LETTERS OF "THE HARMONIOUS BLACKSMITH."

III. Violins and Violin Strings.

[14313.]—MY mind is, unfortunately, so illogically constituted that I am quite unable to perceive the facts. That thick strings and comparatively high bridges are used with the violoncello and double bass prove the common hypothesis that the bridges of those instruments and most other viols do not act on their soundboards as cranked levers. In this world success is largely due to good proportions. We begin by making a double bass with a large *thick* soundboard, which may, or may not, be necessary for the production of sounds whose timbre is pleasing to us, and, as a mere matter of course, we are compelled to employ sufficiently powerful means to transmit to the said thick soundboard, the force with which the bow is moved, for, in the absence of such means—to wit, thick strings—that force would not be transmitted to the soundboard. It is also necessary that the transmitters of force, yclept strings, be *effectively* connected with that surface to which they are employed to transmit force—to wit, the soundboard. Now, there are several ways of doing this, but, probably from its obvious simplicity, deflecting the strings so as to cause a considerable proportion of the force by which they are strained to be resolved downwards, has been the means generally prepared in bow instruments (perhaps because its evil consequences are not so strikingly patent in them as they would be in instruments with many strings). This diversion of part of the tensile force downward *clamps or presses* the strings to the bridge. It also *clamps the bridge to the soundboard.* Unless this be effectively done the strings' vibrations cannot be effectually communicated to the belly, and the tone becomes imperfect. Now, the higher the bridge the greater the deflection of the string, and the greater the deflection of the string the more firmly it becomes connected with the bridge, also the more firmly the latter becomes connected with the belly. So, even without assuming that a high bridge has more power to move the belly than a low one has—which I believe to be the fact—we need not be very much surprised to find high bridges cause the best tones, and will probably continue to do so, even if a more scientific method of connecting the strings with the soundboard were substituted for the present—may I say *barbarous*—down pressure which *necessitates* a rigid belly to bear it.

The evils of the excessive rigidity of the soundboard become very patent, indeed, when we pluck fiddle strings; the audible vibrations soon cease, notwithstanding the supposed great elasticity of catgut. Fiddles answer tolerably for *bow* instruments, but are not of much account without horsehair, excepting the double bass, whose sounds, especially those produced from its *open* strings, are very fine and powerful when its strings are plucked. Fiddles are but poor lutes or guitars, not to say harps. They rather belong to the banjo family, but the shortness of their strings' vibrations is of little importance so long as the exciting force thereof is continuously applied to them. No doubt our most gracious king fiddle is a musical monarch, but, like all constitutional sovereigns he governs through—rather perhaps is governed by—his prime minister yclept ye bow. See my article in ENGLISH MECHANIC, No. —

You think the success of Tyndall's experiment was chiefly due to employing only one string. No doubt this had something to do with it. If a soundboard be rigid enough to resist the force of tension of only one string—say, 100lb.—it must be easier to induce in it vibrations of *given amplitude* than if it were rigid enough to resist the pull of four similar strings—say, 400lb. Something like this obtains when only a few strings are on a piano or harp, and I have no doubt such a fiddle as I suggested would be more powerful with only one string than with 4 or 6; but, however well it might render a solo, the performer on one string could hardly rival Paganini's duet entirely in harmonics. By the way, I have not heard any modern fiddles do this, although it is, of course, *very easy* with *long* fingers and *adequate practice.*

You seem to fear the difficulty of making an effective bow instrument with keys *lies* in the treble. I have not found it there, rather in the bass. Mott used to bring out E., 2 oct. above your 1st string, more like the sound of a pipe than any violinist I ever heard, unless he made an harmonic of it. We found the greatest difficulty in the lower octave, below C C (of the 'cello), but I firmly believe our difficulty resulted chiefly from want of weight and *tension* in the strings. Had the lower notes been strung with from No. 26 to No. 30 wire, and covered so heavily that the tension would have caused 22in. of the same wire (uncovered) to sound middle C., I honestly believe the tones would have rivalled the double bass in power. Perhaps they might have had more of the organ open diapason quality, and very little of the "rasp" character.

Monk Mason's mechanical double bass had mechanism for stopping almost identical with that employed in conjunction with the pedals in the harp for shortening the vibrating length of its strings. Of course, no fingerboard proper was needed. I strongly suspect the very best mechanical fiddle, or rather viol, must, like Monk Mason's, have fixed intervals, and like Hawkins' claviol, a string for each note. This enables any harmony, however close or *discordant*, to be performed.

When young and inexperienced I oft fell into the error of inventing and designing things which, although I knew it not, had been tried and found wanting before I was born. Experience soon taught me the advantages of ascertaining what had been done by others in the same line before attempting to invent: so perhaps I may take the liberty of advising you to render yourself familiar with some of the many attempts to construct mechanically-bowed instruments, especially the claviol of Hawkins. Rees' "Cyclopædia" is in the library of the London Institution, and I found the polite librarian willing to allow inspection when asked civilly.

Personally I prefer Mott's sostinente to any instrument in which the bow or rubber acts *directly* on the strings, unless indeed it be king fiddle himself with his (bow) prime minister held by a Paganini or a (late) John Alvey Turner. I have ceased to hope to hear the pure pipe-like tones of the sostinente from the strings of any instrument whose direct acting bow is moved by mechanism, whatever the bow may effect when held in the hand of a master. That makes *all the difference between* mind and mechanism.

Jan. 20, 1872. **A. Savage.**

KNAPSACK TOURS.

[14314.]—THE most pleasant of rambles is that with a knapsack. Procure one light and strong, put in it what is absolutely necessary; be careful not to overload yourself, or your first impression will be that it is drudgery instead of one of the most pleasant methods of journeying. You may carry a sponge, tooth, nail, and hair brushes, a piece of scented soap; you may smile. I have found brown Windsor agreeable after a dusty tramp. Do not load yourself with a heavy flask, a supply of acidulated lozenges will be grateful. If a smoker, do not forget a supply of your favourite weed and pipes. If fond of the naturalist or botanical pursuits, you will find room for a few boxes, &c. Specimens inconvenient to carry may be posted to your residence with instructions how to be dealt with until your return.

Clothing is an important item. They should be light and warm, a coat that will button across the chest. During the heat of the day you may take off your waistcoat and bag it. Trousers of the peg-top build, sufficiently loose to fold up to the knee to form knickerbockers when desirable. In that case you will wear stockings. A travelling cap will be useful for a change, also slippers. The shoes—there's the rub. Take a tried and trusty pair, light, strong, and broad in the soles, lacing up high. You will learn to be your own shoeblack, so take a small supply of castor oil and a piece of sponge. Your boots will come in for a good share of your interest if you desire them to do good service, and for a few days be above blacking. The linen collar is a miserable thing to wear when
walking, better a soft silk tie. Carry a fe
collars, mackintosh, and leggings, if very l
not be without. Get Crutchley's map of the
selected, and study it a little before starting.
correspondence may be carried on in bl
having a supply of postcards, paper, an
pencil. Write the address in lead, then g
lick over with your tongue. It will not b
obliterated.

Should you desire an economical trip
hotels. You will find the country inns mo
Have a good breakfast, carry a crust or bis
midday, and have a good dinner or meat t
your walking is done for the day. You
surprised how reasonably a trip after this
can be done. I am no great pedestrian, l
no difficulty in covering about twenty-fiv
a day.

May 1st. J.

ADULTERATION OF FOOD DETE
LARD.

[14315.]—LARD is prepared from the fa
pig. The best is usually made from the
surrounds the kidneys, and is known under t
of bladder lard. That called keg lard is
from fat of inferior quality. Pure lard sh
firm and white, and should have a sweet s
taste, and should not deposit when melte
melting point of good lard varies between
81·3; adulterated with mutton fat the melti
would be higher. The most probable adu
are: mutton fat, usually added in the summ
to make the lard firmer; water, to increase
chloride of calcium, to make it hold more
potato-starch, salt, and salicylic acid. Sa
not to be looked upon as an adulteration, u
undue proportions. Starch is detected by t
tion of a little tincture of iodine, and also u
microscope; for that purpose a little should b
upon a hot slip of glass, and examined wit
when the presence of starch will be plainly

For the determination of water in lard 10
should be taken, and gently warmed until
to lose weight; the loss will be the amount o
For the detection of chloride of calcium
quantity of lard should be boiled with wa
the water tested with oxalate of ammoniu
will throw down the calcium as oxalate of
the chlorine must be precipitated by nitrate
The water should also be tested for an all
red litmus paper; if, upon the addition o
chloride of iron, the water turns blue, salic
is present. **Albert S**

UNFERMENTED BREAD.

[14316.]—IN reply to "Daghbert" (lett
p. 170), I have to say that our bread never
moister with age. Can he or any one else
why carbonic acid gas is used in the manuf
"aërated bread." Would not common air
as well with heat? A chemist of so
cautioned me some years ago against eating
called, having found in it, he said, "the
potatoes, and the mould of beans, and alum.

There seems to be a misprint in the l
"Daghbert," as regards the quantity of
meal. It is more likely 2lb. than 13lb., for
uses 110 grains of bicarbonate of soda. I
that his relative proportions of soda and
each other are exactly the same as my own.

A Phy

CONTINUOUS BRAKES.

[14317.]—IN letter 14262, p. 169, of the
MECHANIC, "C. E. S." omits all mentio
hydraulic brake (E. D. Barker's patent
system is in daily use on the Midland a
Eastern Railways, and gives great sat
owing to its power and smoothness of actio
also capable of the nicest regulation. An
readers who have travelled by the 4·40 p.
from St. Pancras will be able to vouch as
facts.

As will be seen by reference to the
December 30th, 1876, at a trial held on the
Railway, Barker's brake stopped a train r
a speed of 50 miles in 15 seconds, and w
yards. This, I believe, is the quickest s
by any system.

I may add that the hydraulic brake has
made automatic, and that a trial of the new
ment will shortly be held on the Great
Railway.

April 27th. **F.**

FAST RUNS OF EARLY LOCOMO

[14318.]—IN answer to "E. H. E.," lett
I send a shortened account of some run
were carefully observed in the earliest day
ways. I select one on each of the lesser,
on each of the greater lines:—

Line.	Date.	Weight of train.	Distance run.	Engine.	Running time.	Stops.	Speed over a mile.	Speed over a mile.	Average.
		lb.	miles		min.		max.	min.	
:broath & Forfar.........	1839 Sep. 13	49,370	15	Victoria	45¼	6	31·25	8·95	19·88
rmingham & Derby Jn.	„ Dec. 5	62,312	23¼	Derwent	53¾	3	37·5	6·04	26·09
ındee & Arbroath	„ Sep. 12	47,664	12¾	Griffin	36 7/12	4	35·71	9·37	20·84
ırnkirk & Glasgow......	„ Sep. 3	15,000	8	Garnkirk	27 3/13	3	—	—	17·58
rand Junction	„ Oct. 14	61,504	34½	Clio	66¾	2	68·18	10·71	30·92
do.	„ Nov. 13	88,928	10¾	Lucifer	19¾	—	68·18	8·92	36·86
do.	„ Nov. 15	not stated	10½	Camilla	9 7/10	—	68·18	10·62	33·85
:eat Western................	„ July 20	85,760	30¾	Ajax Neptune	66 4/14	3	50	6·35	27·83
do.	„ Aug. 12	39,698	13	Vulcan	27½	3	50	9·20	28·32
do.	„ Dec. 13	76,482	17¼	Bacchus	37½	2	50	9·20	27·97
·eds & Selby	„ Oct. 31	59,168	20	Dart	50 7/15	4	44·11	9·20	23·66
verpool & Manchester	„ Nov. 11	50,563	11¼	Milo	28	1	50	10·30	30·55
ındon & Birmingham...	„ Oct. 12	83,925	103	No. 75	230¾	7	50	7·89	26·78
do.	„ Dec. 12	96,788	31¼	No. 39	73¼	3	46·87	10·41	25·60
do.	do.	107,736	20	No. 18	41⅔	1	41·66	12·29	28·95
ındon & Croydon.........	„ July 18	42,080	10·37	Surrey	25 14/15	4	50	7·97	24·10
ındon & South-Western	„ April 8	58,096	15	Sam Slick	38½	4	36·36	15·38	23·46
do.	do.	96,132	38	Jupiter	71¾	4	40	17·64	31·78
do.	„ Aug. 23	103,596	38	Renown	92¾	6	50	10·16	24·67
:wcastle & Carlisle......	„ Oct. 17	41,300	13	Wellington	30½	2	41·66	9·49	25·28
ırth Union	„ Nov. 28	55,800	6¼	No. 6	12	—	37·5	23·43	31·25
ockton & Darlington...	„ Sep. 25	17,496	18¼	Arrow	43⅗	4	42·85	4·28	25·32
ırk & N. Midland	„ Oct. 29	33,856	14	York	35½	2	35·71	15·46	23·66

se particulars are taken from Whishaw's on railways—a book now, I believe, not often with. More are added, for which there is not here. The steam pressure in all these cases is d not to have exceeded 55lb. per square inch. pe shortly to answer the other queries which lately been addressed to me. Itzaex.

ROUND v. SQUARE.

319.]—As "J. G.'s" letter in the Amateur anical Society's *Journal* has been copied into ENGLISH MECHANIC I may as well take this rtunity of replying to that part of it which rs addressed to me, instead of waiting for the number of the Journal.

ave not had sufficient experience in the contion of turning apparatus to know whether it d be much easier to make the various instrus that are carried in the slide-rest with round d of square stems. I should imagine, howthat the well in which they are carried can be readily made square than round, as in the r case it would probably be shaped by the ng machine, leaving little for the file to do. For tools as the eccentric cutter and drill I suppose orm would answer as well as the other, but for ertical and horizontal cutting frames I think quare form must be the best, as the instrument, dropped into the well and secured there, is in oper position for work without any adjustment; the whole, I am inclined to fancy that nothing d be gained by departing from the old forms.

G. C. C.

E WASTE OF NATIONAL MONEY.

320.]—IT would seem that waste of money with d to the late Scientific Loan Collection is not t an end. I have just received a sort of diploma anks for my contribution to it. This diploma n engraved framework, and my name printed. childishness go further? Next will be a diploma anks from the grocers to each buyer of 1lb. of A letter of thanks in a few instances would been all vary well, perhaps even a printed form ; but to make it a sort of certificate of merit, print the name to each, is simply the very onness of waste. Aliquando.

RATUM.—Letter 14266 (p. 170), for "13lb. and meal" read "1½lb."—DAGHBERT.

RATA.—Letter 14274.—For "lined" (lines 10 12) read "hind"; for "lighter" (line 23) read lier."—ALDERLEY EDGE.

The Oldest American Land Plant.—Relics of terrestrial vegetation of extreme antiquity have been found in Ohio by Professor Claypole, of Antioch College. During a geological excursion, one of his students called attention to a slab of fossiliferous limestone from the Clinton beds, which are of Upper Silurian age. This specimen is notable for presenting vegetable impressions, which are strikingly suggestive of a Lepidodendron stem. In studying the character of the plant Professor Claypole has had the benefit of Dr. Dawson's advice. Probably it belongs to a new genus, closely related to Lepidodendron, for which the name Glyptodendron is suggested—a name which refers to the sculpturing of the stem. The interest of the discovery lies in the fact that indisputable traces of land plants had not previously been found in America on so low a geological horizon. Nor, indeed, had remains of arborescent vegetation been found in strata of this age, either in the Old or in the New World.

The Best Form of Engine.—The economy of the best form of engine may be fairly judged from the following remarkable proposition received by the Philadelphia Water Committee recently:—"W. H. McFadden, Esq., Chief Engineer Water Department —Sir,—Referring to the recommendation in your last report, on page 38, we would respectfully submit for your consideration the following proposition:—We propose to furnish steam pumping machinery and foundations, boilers, and air vessels complete, with all valves and attachments inside of house, to the pumping mains proposed to connect with the distributing pipes of Belmont Waterworks, on the east side of the Schuylkill river, and operate the same, furnishing all coal, stores, and supplies, provide attendants, and maintain repairs free of all cost to the city in the first cost and operating expenses, for the same sum per million of gallons pumped as it now costs the Belmont Works, as exhibited in your last report, that being the lowest cost for steam pumpage in the list. At the expiration of five years from the time the machinery is started, it shall all become the property of the city of Philadelphia, without further cost or expense. Ground and houses to be furnished by the city, and located at Schuylkill Works, as named in your recommendation. The water department is to so arrange its pipes that any excess of pumping not required on the east side can flow into the Belmont basin, in order that continuous pumpage can be maintained. The machinery to be capable of pumping fourteen million gallons per twenty-four hours. The quantity of water pumped to be determined by the method now used by the department, and payment to be made quarterly on quantities certified by the chief of the department. Respectfully submitted by the W. Camp and Sons' Steam Engine and Boiler Company."

REPLIES TO QUERIES.

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⁂ In their answers, Correspondents are respectfully requested to mention, in each instance, the title and number of the query asked.

[31878.]—**Engines on the Somerset and Dorset Joint Railway.**—The existence of the engines upon the Somerset and Dorset Railway is most conclusively proved by your correspondent, "S. D. J. R. Loco.," page 97. I have, after making most careful inquiries, and also seeing the engines myself, three times asserted the existence of these engines. It was not my intention to have wasted any more time to prove that engines have been built by the South-Western and Midland Railways for the joint line, as it is a fact. "The New Clock," page 170, states that your correspondent, "S. D. J. R. Loco.," did not go to Nine Elms to test boilers. This is useless, as I know an engineer who was present at Derby and Nine Elms when the boilers were tested, and the representative of the Somerset and Dorset Locomotive Department was also present. "Nine Elms Works," page 145, makes the extraordinary statement that the "Locomotive department of the Somerset and Dorset Joint Railway is under the control of Mr. Johnson, of the Midland." This is not the case, as the locomotive and carriage superintendent of that railway is Mr. B. S. Fisher, and he has full control over the whole joint rolling stock. If your correspondent requires further proof of the existence of Mr. Fisher, will he take the trouble to look at "Bradshaw," page 43?—C. E. S.

[32040.]—**Scotch Expresses (U.Q.)**—The fastest Scotch trains are the 10 a.m. G. N. King's Cross to Edinburgh, and 10 a.m. N. B. Edinburgh to King's Cross, time 9 hours, which is well kept. The former has been timed to leave King's Cross at 10 a.m. for upwards of 20 years, and for a very long time has been known as the Flying Scotchman. The late Mr. William Nimmo (better known as the Scotch guard) made three journeys a week in charge of this train, from its commencement up to within a short time of his death.—AN OLD G. N.

[32269.]—**Systematic Memory.**—I used an artificial system of memory at one time to some extent, but in practice I never could be certain whether I remembered the mnemonic first, and the fact afterwards; or the fact first, and the mnemonic afterwards: and I am strongly inclined to think that the pith of the matter lies in this, that as soon as you have spent sufficient brain work over a fact as to devise a mnemonic for it, you remember it in the ordinary way.—WM. JOHN GREY.

[32405.]—**B. Sc. Examination (U.Q.).**—I do not know what the questions were that were given at the L.U. for the above examination, as I entered at Owen's College, Manchester. But the questions were very simple, and the substance and solutions given to analyse were very easy. The practical examination occupies two hours, during which time you will have to make an analysis of two solutions and one solid. The practical work could easily be got up from Jarman's "Qualitative Analysis," a most excellent book for any one getting up the subject alone. If there is anything in which I can be of any assistance to you, let me know through the ENGLISH MECHANIC queries.—D. A. N., 1st B. Sc., 1877.

[32482.]—**Narrow Gauge, Origin of.**—The reason assigned by "E. M. R." for the gauge being 4ft. 8½in. is correct as far as it goes; but he should go further back, and find out why the tram-rails were exactly 5ft. outside measure. It is commonly believed that the gauge was merely adapted from the wooden tramways which had been laid down to suit the carts in use in the North, without any thought of whether or not 5ft. or 4ft. 8½in. would be a suitable gauge for a railway. The fact is, rails were down before flanges were used, and as there was no reason to alter the gauge when flanges came into vogue, so there was none when the locomotive was introduced.—B. K. J.

[32485.]—**Boiler Flues.**—"A Junior" should read "Boiler and Factory Chimneys," by Robert Wilson, published by Lockwood & Co., or see p. 219, Vol. XXIII. of ENGLISH MECHANIC for a paper by Mr. Robert Briggs. Too many considerations enter into the question for any one to give a rule that will answer in all cases.—M. P.

[32507.]—**Joints in Pipes.**—"John" should get Warn's "Sheet-Metal Worker's Instructor," in which he would have the methods of planning out the metal for all kinds of forms. The way to cut metal sheets so as to be able to make up a good joint was illustrated in this journal some time back, but I forget when.—M. P.

[32515.]—**Priming.**—It may be that in some particular design of engine flush-topped fire-boxes prime more than those with crown tops, but the shape of the top can have little to do with the priming. About centre of length of boiler is the best place for dome.—J. M. T.

[32533.]—**Sulphuric Acid.**—The method of obtaining sulphuric acid (sp. gr. 1·845) given by "Arthur Alfred" is new and amusing.—WM. JOHN GREY.

[32547.]—**Railway Rates.**—"Corcyra" (p. 178) says I am very lame on this point, r think that because a railway company exists by virtue of an Act of Parliament the directors and shareholders are to serve the public for very little or no pay. The dividends paid by railway companies are not particularly high, and day by day their expenses become greater. It is not, in my opinion, the monopoly which causes a company to seek an Act of Parliament, but in order to obtain possession of the requisite premises and land, as any man can (supposing he owns the land and has the capital at command) construct a railway, subject to the general laws which control such matters; and there is in these laws a provision made against undue preference, and, all things being equal, a company cannot charge more to one firm than another for the same class of goods; but in this case all things are not equal, and the company has an undoubted right to make a contract for the conveyance of a large quantity of goods. Railway companies do not always own all the rolling stock they use; they can and do hire it as occasion may require, and it would be absurd to expect them to keep trucks waiting for goods which may or may not come without receiving remuneration in some shape or form. Take the case of a contract passenger ticket, say, for six months. You will get a certain discount, or for payment of one fare per day you may make three or four journeys. In this case they make a reduction upon being guaranteed a certain amount—the same with the other.—Os.

[32558.]—G.W.R. Broad-Gauge Engines.—I am extremely obliged to "Helios" for the information about the twelve engines, but I think he is hardly correct in saying only a few of them can run from London to Swindon without the aid of a water crane, as since "Helios's" letter I was at Paddington, and saw Tartar start with the Dutchman. I asked the driver whether he had any difficulty in making the run from London to Swindon without taking in water. He said no, not in the least—two of the engines do it every day, one up and the other down. He said only the other day he came from Bristol to London without taking in water, and could have run 30 miles further. As you will see by letter 32703 in last week's Mechanic a good many of the above class take the Dutchman in turn. Most of the tenders must be of very much the same size. By the bye, the longest run without a stop in England is made by these engines — viz., from Paddington to Bath by the 9 p.m. mail, and corresponding up train (distance being 106¾ miles). As to the G.W.R. narrow gauge taking 20 minutes longer to run the same distance (deducting the stop) than the G.N.R., the G.W.R. are not noted for quick running on the narrow gauge, although their engines are very good, the dimensions of which appeared in the English Mechanic of 8th of February, having a tractive force of about 96lb. to the square inch. Although hardly able to attain the 15 coach test they are very fair engines. There is no other railway runs so many really fast trains as the G.N.R. does from London to Peterborough, but if you compare their fastest—viz., the Scotchman—with the Dutchman (broad gauge) the latter's running is fastest. The Scotchman, running from King's-cross to Grantham, 105 miles, takes 2 hours and 10 minutes, or at about 48½ miles per hour, whereas the Dutchman travels from Paddington to Bath, 106¾ miles, in 2 hours and 12 minutes, or at about 48½ miles per hour. But it must be remembered that in the meantime it has been standing 10 minutes at Swindon. The speed to Bath is really 53 miles per hour, not taking into account the extra slowing and starting. It is evident which is the fastest. I came up last summer in the Dutchman from Swindon to London. We did it in exactly the allowed time, 1 hour 27 minutes. Owing to the slacking at Didcot on account of the curve the speed on other parts of the line is pretty fast. We did in one hour 56 miles, and during the quickest half we did 31 miles in 30 minutes, the greatest speed attained being about 68 miles per hour.—H.

[32559.]—Concrete Blocks.—To "Irishman."—If you would kindly give the modus operandi of erecting buildings, cottages, &c., with concrete, stating the materials best adapted, and the constituent proportions of the same, it would, I have no doubt, interest many readers of "ours." I have heard of a large block of houses, five stories high, being erected (I believe) in Birmingham. Can any one say if such is the case, and name the locality where situate?—Paul Pry.

[32578.]—Brakes.—In answer to "L. L.," p. 148, the Midland Company intend to fit ten more engines of 1,290 and 1,322 classes of express engines with a vacuum brake, as more engines are required with this brake at Liverpool and Manchester. It has not yet been decided whether the Smith's vacuum is to be fitted to these engines or the "Improved Smith's," now known as "Hardy's Vacuum Brake." "Helios" and "B. H., Solr.," page 148, state that "Barker's brake will shortly be made self-acting." I shall be glad if they will give further particulars upon this subject as soon as the train is really fitted. More than a year ago I saw the diagrams showing "Barker's automatic apparatus." Since that time rumours have at least ten times been in circulation that "a train was being fitted with Barker's automatic brake." Sometimes it was to be upon the Midland, or the Brighton, or Great Eastern, or Glasgow and South-Western Railways. These rumours no doubt took their rise from the fact that many people think that Barker's No. 2 brake, as used on the Midland engines Nos. 132 and 135, is "Barker's automatic." This is not the case. The Great Eastern Railway Company have 65 carriages and vans fitted with Barker's first or No. 1 brake. In this arrangement the brake is under the control of the guards only. This company intended to fit an engine and train with the No. 2 system, which is worked by the driver, but is not self-acting in case of accident. Is this the train to which "B. H., Solr.," and "Helios" refer?—C. E. S.

[32592.]—Surface Condensation.—I am sorry to say that I fail to understand "Beaver's" sketch and description, on p. 149, of what he believes to be the best way of disposing of exhaust steam; and, being myself interested in utilising the water condensed from steam that has already done its work in the cylinder of a steam-engine, I should feel obliged if he would enlighten me on various points connected with his surface-condenser, or, rather, feed-water heater, as an engine fitted with this apparatus could hardly be called a condensing engine, as no vacuum would be found in the condenser, and the pressure of the exhaust steam would not be less than that of the atmosphere. In my case this would not matter, and I should be very glad to adopt some simple arrangement (as I have no doubt the "Beaver's" plan is) for condensing the exhaust steam from a 20 h.-p. double horizontal cylinder high-pressure engine, as, during the summer months, the supply of water for the boiler is insufficient, and I should be very pleased if "Beaver" or any other correspondent would kindly give me any hints how to do this effectively. Now, with regard to the plan described in your last number, it appears to me to consist of a sheet of corrugated iron bolted to another flat plate; but neither A, B, nor C, gives any clue as to the manner in which the steam circulates between them. I fear corrugated iron would be more rapidly consumed than the 2in. gas barrel he mentions having seen in use. I cannot understand what is meant by D, one method of putting them together reversed; and the remaining letters do not give one any idea of what the general arrangements for emptying the condensed steam in the shape of water into cistern are like, or why Q, the outlet should be in the ashpit. Such an apparatus might be of service for stationary engines where the supply of water is insufficient; but I cannot imagine that it would meet the requirements of "A. W. E." in connection with tramway locomotives, as the advantages to be derived by its adoption would not compensate for the extra weight and space required for it.—Mongibello.

[32592.]—Surface Condensation.—I do not see how "Beaver's" condenser (p. 149) could be employed on a tramway engine, nor do I quite understand if it is an air or water surface condenser. Unless it is possible to burn the exhaust steam, or so to superheat it before or after its passage through the cylinder as to render it invisible, I think an air surface condenser would be preferable to water, whether used in the form of injection or surrounding or passing through tubes. The difficulty seems to be the providing of sufficient surface, which, if operated upon only by the natural current caused by the forward motion of the engine, and having to be estimated for the maximum summer temperature of the air, would have to be very large—probably 8 or 10 times the steam-generating surface of the boiler. A very large reduction of condensing surface might doubtless be permissible if an artificial current of air through the tubes or over the surfaces of the condenser could be produced, and this might doubtless be done by a fan (which, however, would have to be quite noiseless), when, perhaps, a surface of 5 times the heating surface of the boiler might suffice. A good deal of power would, however, be taken up by the fan; but, as the work to be done by a street tramway engine is only about the actual work of 4 horses at their best, it seems to me that there would be power enough disposable for this. There are trams existing where a couple of horses have to draw a weight of 8 tons behind them up gradients of 1 in 40, at 4 miles per hour. An engine, if to be a commercial success, ought to draw double this weight at 6 miles per hour up such gradients; but I scarcely think that any existing independent engines are capable of doing it. Such an amount of work would not be heavy for an ordinary locomotive of, say, 7 or 8 tons in weight: but this class of engine has the advantage of the steam blast, which the street tramway engine has not—at least, not at all times, as being inadmissible in the streets of a town or city. I do not think that combined engines and passenger cars will, as a rule, come into extended use. The present large stock of horse cars have to be taken account of, and, besides this, in the event of engine repairs (which is a thing of frequent occurrence), the car is rendered for the time useless. A very elaborate car of this kind was built at Winterthour, to seat 64 persons; gauge, 39 37in.; weight exclusive of passengers, 11¼ tons—with passengers, 16 tons; dead weight per passeneer seat, 396lb.; 4 axles; two bogie frames; maximum weight on each driving axle, 4½ tons—on each trailing axle, 3½ tons; greatest length, 42ft.; greatest width, 8ft. 4in.; greatest height, 14ft.; adapted to curves of 22 yards radius; tangential draught, 1,650lb., with a steam pressure of 12 atmospheres in the boiler, giving off at a speed of about 9½ miles per hour, 40 h.p.; but, in spite of its being in itself a very first-class thing, and having even been known to take as many as 120 persons over gradients varying from 36 to 40 per 1,000, it has nevertheless been discarded, and is offered for sale. I think, therefore, that an independent engine which can be coupled to any of the existing horse cars is the correct thing. An engine merely to run on level lines, and to replace only 1 or 2 horses in direct draught—or, say, 4 or 8 in total number—can be of no commercial value. On ordinary lines a single horse runs 18 miles per day, and draws a load of about 70cwt. at 6 miles per hour. I do not think that any engine can compete against this in point of cost, and at Paris I am given to understand that a horse tram parallel to one worked by steam is worked at a cost of 20 per cent. less than the steam one. The application of steam must, therefore, be for heavier lines and heavier traffic, so as to replace at least a total of 12 to 16 horses. The condensing arrangement with water is objectionable. There is always a difficulty in procuring, and frequent stoppages are necessary for taking, water, and if total and continous condensation is carried out, large quantities must be taken even for short runs. Air surface condensation, or a system of burning the steam or otherwise rendering it invisible, is, in my opinion, the only proper way, and I shall be very glad if "Beaver" or any other of our friends would give his or their opinions. The first cost of engine is also important, and ought not to exceed the price of the total number of horses it can effectively replace, as repairs and depreciation are likely to be very heavy items (I have heard of no less than 5 axle breakages, with only 3 or 4 engines in use, within a period of 9 months from starting). In considering the number of horses such an engine is to replace, we cannot calculate upon much increase of speed, as this is restricted to very nearly the ordinary rate of horse trams. This is particularly the case in the gradual introduction of steam traction on trams at present worked by horses, as the engine could only take its proper place amongst the courses, and therefore only run at same speed.—A. W. E.

[32666.]—Heart.—I am not a medical man, but will answer to the best of my ability. The symptoms, I should think, indicate a diseased heart. I should not try electricity nor any remedy until you know further. The failure of medical advice may have arisen from want of experience in auscultation. If you were to apply to a good physician he could, by an examination of your chest, judging by appearance, touch, sounds heard by means of the stethoscope, and the peculiar manner of beat of the pulse, very probably arrive at whether they arise from malformation, fatty degeneration, or a disordered state of the involuntary nervous system—*i.e.*, the sympathetic. This is very important for you to know, and will regulate all treatment. Physiology teaches that excitement of the involuntary nerves accelerates the action of the heart, and undoubtedly continued mental depression will have the very opposite effect. Should it be the latter no doubt a tonic course will be ordered, such as iron, quinine, an entire absence from all anxiety and worry being very essential; regular diet, and if you can bear it, a salt-water sponge-bath occasionally. As a parting word don't fail to get further advice.—Theo Izod.

[32674.] — Cornish Pumping Engine. — If "E. J." is interested in Cornish "pit-work" he would do well to read "An Essay on Cornish Mine Drainage," by S. Michell and J. T. Letcher, published by Lake and Co., Falmouth, which gives a good description of all the parts below the outer end of the engine beam. For double-beat valves and the Cornish engine he could not do better than read "Bourne on the Steam-Engine."—Mongibello.

[32675.]—Soap Making.—German soap:—1cwt. extra pale yellow, 2oz. oil of lavender, foreign, 4oz. oil of cloves, 4oz. cassia, 1½oz. wintergreen, 1oz. sassafras, ½oz. oil of aniseed, 1oz. oil of carraway, ½oz. citronelle, ½oz. peppermint, 7oz. vermilion colour dissolved in water. 12lb. marine soap included in weight. (As "Perfumer" addresses me I take it he has read what I have written before, and will remember what I said of these last two. I give the receipts as I find them. If there is anything not clear, I will help him all I can.) Sunflower oil soap:—10oz. oil of lavender extract, 5oz. oil of cassia, 1oz. oil of wintergreen, 2oz. oil of citronelle, ½oz. oil of verbena, 1cwt. extra pale yellow, 2lb. palm oil colour. 12lb. marine soap included in the weight. Milk of roses:—Sweet almonds, 1½oz., white oil soap 2 drachms, cold cream 12oz., spirits of wine 1oz., rose water 1 pint, otto de rose 4 drops. Blanch the almonds, beat till of a soft paste, add gradually the rose-water, and strain, beat also the soap with a little rose-water, and add the cold cream by degrees, mix the almond liquor, soap, and cold cream, and lastly the otto dissolved in the spirits of wine. Scent for Circassian cream: — Otto of roses 4 drachms, essence of bergamot 2oz., essence of lemon 2oz., oil of lavender 2oz., Circassian cream, lard ¾lb., olive oil 8oz., white wax 4oz., alkanet root, q.s. 1½oz. of above scent.—Pimpernel.

[32681.]—The Rhine.—I have just returned from a run up the Rhine. May and June are good months. The vine, a disappointing plant, is not ripe till August and September. Coblentz is a pleasant town at which to stay, and from it excursions by boat and rail can easily be made to all parts. I found the Anker Hotel comfortable and reasonable. There is an English Church service in the Augusta Palace, and the gardens are a pleasant promenade. Higher up, and 40 minutes from the Rhine by bus, is Schlangenbad, a delightful village in the hills, an English doctor, and good hotels. I went to the Victoria, good and cheap. English is spoken at both the houses, and is, in fact, at most hotels. I should ay do not stay at Wiesbaden; it is in a basin, and s enervating, though it has great attractions for pleasure-seekers. The best route is viâ Flushing to Cologne, then by boat. For Schlangenbad, Eltville is the point of debarkation. Eltville, Biebrich, or Boppard are fairly good places to stay at.—Ponto.

[32718.]—**The Knitting Machine.**—Lamb's machine is the only machine that will knit a stocking all complete, to any size or shape. I have one, and can knit anything with it from 180 stitches down to 2.—Chas. Langdon.

[32720.]—**Canvas Canoe.**—In my reply last week, for "good broad and deep keel" read, "broad beam and deep keel."—Eldnar.

[32723.]—**Camera Obscura.**—Your summer-house will do well for a camera obscura. The requisites will be a plano-convex lens, 5 to 6in. diameter, and 4ft. focus, a piece of thin patent plate mirror, 10in. by 6in., mounted in a chamber, so that it can be moved from 40 to 50 degrees, the convex surface of lens being downwards. The table should be made of a hoop 3ft. in diameter, fastened with stays to a central screw moving on another screw for adjustment; or, what is better, should be suspended by cords to pulleys in roof, and weights on other side, so that the ring can be adjusted with ease. A calico or canvas should be fastened loosely on to ring, so that it will form a concave hollow; then whitewash the whole several times, so as to obtain a good surface to receive the image on.—W. J. Lancaster.

[32724.]—**Canaries.**—If "Perplexed Photo" will take a piece of used linen or calico, let it be thin and a little used, as if new it would not adapt itself to the cage so well; let it be large enough to come down from the top the depth of 4in. or so round about the cage, let it be laid loosely on the top of the cage; put it on at bed-time. The bird will soon get used to it. Take it off the first thing in the morning when rising, examine the cloth, and kill the ticks that will be then on it. I find them on both sides of the cloth. The same cloth will be of use constantly, only when too dirty let it be washed. I have tried this for more than a year, and now I don't find one where before I killed a dozen. I also examine the door of the cage round about, and all the joints, as I have found them before now in the notch of the perches.—James M'Clenahan.

[32725.]—**Birds' Perches.**—I am a great admirer of the "Animal World," published by the Society for the Prevention of Cruelty to Animals, and I read an article in it which highly recommended the perches to be flat on the top and to have the edges rounded, about ¾in. broad, and full ½in. thick.—James M'Clenahan.

[32729.]—**Chemistry.**—In carbonic oxide there is no condensation, so that one volume contains half a volume of C, and half a volume of O, hence to convert the carbonic oxide into carbonic anhydride half a volume of oxygen is necessary. This, then, would form one volume of carbonic anhydride, and leave one and a half volumes of oxygen after ignition.—W. J. Lancaster.

[32736.] — **Batteries.** — The Léclanché is the battery generally used for electric bells, as there is little or no waste when out of action. Fuller's battery bids fair to be employed in future. Zinc is the positive and carbon the negative element. The zinc is placed in a porous cell with water and about 2oz. of mercury. The carbon is placed in a glass or earthenware cell, with a saturated solution of bichromate of potash, to which is added about a one-twentieth part of sulphuric acid. It is almost needless to say that the porous cell is placed inside the glass or earthenware cell. Both bells could be worked by one battery if you had three wires, but would require two batteries if you had only two wires. If "Teleph" requires a sketch of the connections or other information, I shall be happy to oblige him.—John Earl Clark, Liverpool.

[32737.]—**Welding Copper.**—Take 1 part of phosphate of soda, and 2 parts of boracic acid. This welding powder should be strewn on the surface of the copper at a red heat; the pieces should then be heated up to a full cherry red or yellow heat, and brought immediately under the hammer, when they may be as readily welded as iron itself. 1. Care must be taken that no charcoal or other solid carbon comes in contact with the points to be welded. 2. As copper is a much softer metal than iron they must, therefore, be so shaped as to be enabled to resist such blows as well as may be; and it is also well to use a wooden hammer, which does not exercise so great a force on account of its lightness.—John R. Eddy.

[32738.]—**Butterfly Catching.** — Peacocks and admirals are found almost anywhere in August and September, but swallowtails only in the Cambridgeshire fens. The middle of the day, from 12 till 2, is the best time for butterflies. The laurel or cyanide bottle used for killing the specimens will also destroy the parasites sometimes found on butterflies, especially on M. Galathea. "Young Entomologist" should provide himself with Stainton's or Newman's "Butterflies and Moths," where he will find all the information he requires.—Inquisitive.

[32738.]—**Butterfly Catching.** — Swallowtails (P. Machaon) are only to be obtained in the Cambridgeshire fens. The red admiral (Atalanta) and the peacock (Io) are best bred. The larvæ can be easily obtained at the beginning of August in any lane where the nettle grows freely. The insects that attack the perfect insects are mites, and in order to keep them out the cases should be as nearly airtight as possible, and a small piece of camphor should be kept in each drawer.—Wallasey.

[32742.]—**£5 Telescope.**—As to the apparent size of the planets you may be mistaken. Very few amateurs can determine how much larger a planet appears through a telescope than with the naked eye. But one thing you can easily find out—viz., whether the objects seen are surrounded by halos of colour; if there is little or no colour, and only a little misty appearance, it is not so bad as some of the £5 3in. telescopes I have had the pleasure of looking through. I should, some day, be so pleased to see the gentleman who saw the knitting needles and thread three miles off! The diaphragm should be tight, and should be so arranged as just to cut the end of telescope when looking through from eyepiece end. I should not advise you to have a Barlow lens fitted to this telescope. Better sell the telescope, and get a good one. You would only waste time and money by endeavouring to use it. The only part wanted for a Barlow is the sliding tube which takes the eyepieces. The day eyepiece should have four lenses, the astro two.—W. J. Lancaster.

[32743.]—**Handbook.**—I think "Popular Astronomy," by Sir George B. Airy, will be the sort of book you want. It is 2s. 6d.—H. P.

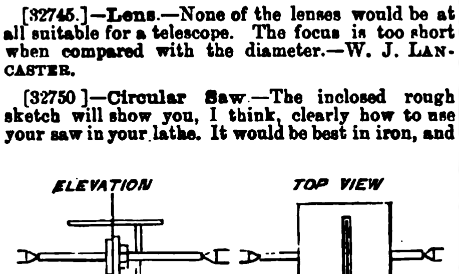
[32744.]—**Photographic Lenses.**—The lenses are much better when mounted rigidly, for two reasons—first, and most important, because they are always in centre; and, secondly, because they cannot be misplaced. You will at once see from these remarks that the lenses must be firm, and not loose in any way.—W. J. Lancaster.

[32744.]—**Photographic Lenses.**—The only evil attending the eccentricity of your pairs of lenses would be the throwing of the picture on the ground-glass out of centre by the same amount as the eccentricity of the lenses. It could not deteriorate the picture in any way. I should say the loose lenses are preferable, because they may be cleaned easier.—Perdu.

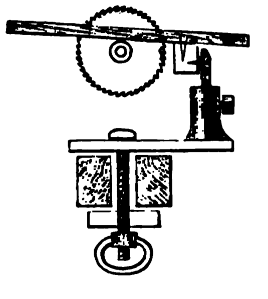
[32745.]—**Lens.**—The objection to the use of your photo lenses as astronomical lenses would be their short focus. When this is so short that the lines drawn from the edges of the lens to the focal point inclose an angle greater than 10° or 12° spherical aberration ensues—that is, all the rays do not meet at the focal point, and consequently all that part of the picture passing near the edge of the glass appears misty. This in the camera, where short focus is necessary, is obviated by the use of stops; in the astronomical telescope by using lenses of long focus. By using stops in a telescope you would diminish the field too much. You might try it as a land telescope, however, but first take out your stops and see what sort of an image you get on the ground-glass.—Perdu.

[32745.]—**Lens.**—None of the lenses would be at all suitable for a telescope. The focus is too short when compared with the diameter.—W. J. Lancaster.

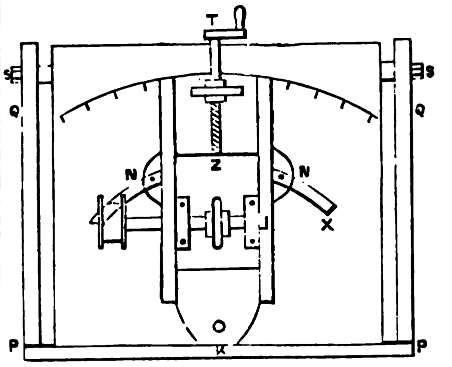
[32750.]—**Circular Saw.**—The inclosed rough sketch will show you, I think, clearly how to use your saw in your lathe. It would be best in iron, and could be made very light. The dotted line is to remind you to make the bottom side like that of your loose headstock.—X. X.

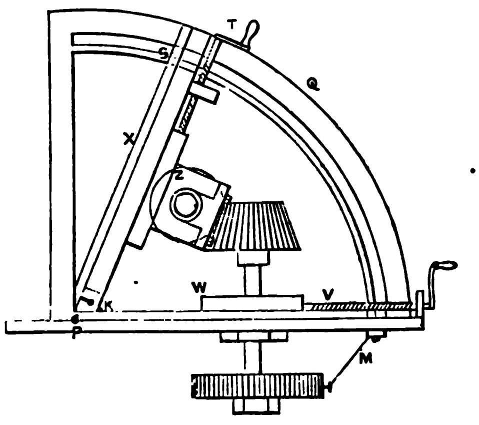


[32750.]—**Circular Saw.**—The following description of a makeshift fixing of a small circular saw as executed by myself, and which answers for rough purposes, may help the querist to what he requires. A 1ft. ¾in. screw bolt, two nuts, and washers, the bolt centred for lathe centres and driven by ordinary driver off mandrel served to mount the saw on. To the T-rest, by means of wood screws through holes drilled in rest, was secured a stout cross piece of wood, and on to that a wooden bench, the section of the whole appearing as in figure. This arrangement is easily and expeditiously disconnected. I leave out sundry details which are self-suggestive.—C. O.



[32751.]—**Wheel-Cutting Machine.**—The inclosed sketch is an idea of mine, taken from 2 or 3 sorts of wheel-cutting machines. I think you will easily see it will cut any wheel. Q, quadrants, with a slot the whole distance; X, a plate pivoted at P, and can be set anywhere in the quadrant by the set screws, S; Z, a slide, which can be worked up and down by the screw and handle, T; the slide pivots on K, and is fastened to the plate, X, at N. The two pedestals will easily be seen to be a part of the slide, having the cutter shaft through them. In the side view I have given the machine cutting a bevel wheel, the wheel being altered underneath the table by turning the spur wheel to the next tooth, the spring, M, keeping it to its place. W, a slide, worked backwards or forwards by the screw, V. The blank wheel to be cut is screwed on to an upright post, which is stiff, but turns round on the slide, W. This slide should have a slot in it in the P to P direction for skew bevels. The wheel underneath the table must have, of course, the same, or a multiple number of teeth as required to be cut. Should "J. C." want any more particulars I shall be glad to help him.—X. X.





[32752.]—**Lepidoptera.**—Butterflies and moths do not require stuffing. "Beginner" will only spoil his specimens if he attempts it. For information as to the best mode of setting insects he should read "Notes on Collecting and Preserving Natural History Objects," Dr. Knagg's "Lepidopterist's Guide," or Rev. J. Greene's "Insect Hunter's Companion."—Inquisitive.

[32752.] — **Lepidoptera.** — I would advise "Beginner" not to attempt stuffing any butterflies or moths. I know it is recommended in some books on entomology, but I have never found it necessary to stuff any insects in my collection, and I have some 6in. across the wings. I set all my insects on wooden blocks, each block being made to hold three specimens. There is a groove along the centre for the body, and the wings are held in position by cop wound lengthwise round block and over extended wings.—Wallasey.

[32767.] — **Safety-valve Question.** — Suspend over the safety-valve, in its proper position, a scale beam and pair of scale-boards, having the beam vertically over the lever of the safety-valve. Through the centre of one scale-board, say A, pass a hook with a large mushroom head to it, to prevent it slipping through the scale-board; and to the hook suspend a wire, with the ends hanging down. Now balance scale-boards, A and B, next secure the ends of the wire to the pin that passes through the valve link and lever. The valve being 2in. diameter, the area of the valve will be 3·1416 sq. in. Hence

3·1416 × 60lb. = 188·5lb., the further weight to be placed in the scale-board, B, to represent the force of steam exerted on the safety-valve at 60lb. pressure per sq. in. Lastly, tothe suspending link to which the working weight is to be attached on the end of the lever furthest from the fulcrum, hang on sufficient weights to justly balance the 188·5lb., &c., placed in the scale-board, B, when the requisite working weight will be determined. Provide the working weight. The lever may be graduated to show, 50, 40, 30, and 20lb. pressure on the safety-valve by following out the method described above, using the said working weight at various determined distances from the fulcrum of the lever.—S. J.

[32767.]—**Safety-valve Question.**—There is a little difficulty in answering this question as it stands, owing either to a misprint or to an oversight in the description of lever. Assuming the lever to be 24in. long from centre of fulcrum to where the weight is to be suspended, and 2in. long from fulcrum to centre of valve, the following will be the reply to the question. If the effective diameter of the valve is 2in., as a circle 2in. diameter contains 3·141 sq. in., the pressure on the valve at 60lb. per sq. in. will be 3·141 × 60 or 188·46lb., tending to raise the valve from its seat. To resist this tendency to rise we have first the simple weight of the valve and the pressure exercised by the unloaded lever, which together amount to 28lb., which, taken from 188·46, leaves 160·46lb. as the pressure remaining to be balanced by the weight acting through the lever. The lever, if of the dimensions assumed above, is in the proportion of 1 to 12, so that a weight of one-twelfth of 160·46, or 13·37lb. (13lb. 6oz. nearly) is the weight that must be suspended, at a distance of 22in. from centre of valve, for the valve to blow off at 60lb. The 32lb. weight proposed to be used would give a pressure of 131·16lb. per sq. in., or more than double the pressure required. It is necessary that dimensions should be taken extremely accurately for these calculations.—H. E. H.

[32769.]—**Brewing.**—Although I am at all times happy to give information upon brewing matters for the benefit of our readers, still I cannot always agree with many of the very common notions which people have concerning the trade, and must beg to be allowed to contradict any assertion which I may know to be incorrect, or based on false assumptions. "Victualler" considers, because a few large brewers in his neighbourhood own about 90 per cent. of the retail houses for miles round, where no other beer than that brewed by the owner of the public-houses must be sold, that it must of necessity follow the large brewers will foist a very inferior beer upon the working population. Now to this reasoning I cannot assent, and must most decidedly deny it to be the fact. Whether it would be more advantageous for the public good practically to allow free and unlimited opening of public-houses has been tried, and proved to be a failure. More public-houses means increased facility for getting drink, and has no beneficial effect on the quality of the article sold. The fact of a brewer owning a number of public-houses, and thus securing to a certain extent what may be termed a monopoly, is all the more reason why he should be careful to supply his houses with the best article that can be produced in that district; for, unless he sells an article which will please the majority of his customers, they will not consume it in sufficient amount to pay the working expenses of the houses, or to leave him a fair return on the capital he has invested. Every one must be aware that it takes a very large amount of capital to buy public-houses, and capital requires a good return in the shape of profit. Is it to be attained, therefore, by supplying a bad article, and by so doing restricting the amount of trade the houses may be able to do? On the other hand, will not a larger trade be secured by supplying a first-rate article—thus increasing the trade, and consequently the profits and reputation of the brewer? It is of no consequence what the trade may be, whether that of grocer, butcher, ironmonger, or any other, if the tradesman does not supply an article suitable to the taste of his customers they will go elsewhere for what they may require. I contend that it is impossible for any brewer to have a monopoly in his neighbourhood; he may own a large proportion of the public-houses and yet fail to secure the trade, unless he can successfully compete with other brewers. Are the public-houses the only places where beer can be purchased? Is it not the fact that a great number of grocers and general dealers have licenses to sell off the premises? They can get their beer where they like, and are under no obligation to the brewers. Yet, what do we find to be really the case? Why, that the majority of the persons holding out-door licenses get their beer from the large brewers in their district, so that they may be able to compete with the neighbouring public-houses. Again, seeing how necessary it is that a scientific brewer should be employed to manufacture the article of good quality, and at a cheap rate, does it not stand to reason that an extensive firm, being in a position to pay a good salary, will secure a first-rate scientific brewer with a reputation at stake? Whereas a man, making only some ten barrels a week, cannot be supposed to have had much experience in the science of brewing, and, in fact, is generally only the rule-of-thumb man who, as "Victualler" himself points out, must soon come to the wall. I do not believe there is a brewer in England but tries his utmost to produce as good and pleasing an article as he possibly can; but we must bear in mind that if all are not equally successful, neither have all the same advantage as regards water and position, and we may take it as an established fact that the large brewers commanding great capital, and being able to take advantage of all the newest discoveries in machinery and science, besides intrusting their brewing to the superintendence of a trained scientific brewer, must of necessity be able successfully to compete both in quality and price of the article with a man having little, if any, capital, and who, in all probability, has only been able to acquire a rough and very limited knowledge of the business, having to pay a higher price for his malt and hops, and whose plant is generally of a very primitive description. Depend upon it, if ever we have a beer law passed to restrict large brewers from owning retail houses (which I much doubt the possibility of), that it will not benefit the public consumer in the slightest degree. The estimation of the original gravity of beer and the percentage of alcohol contained in it, requires considerable care and manipulative skill, besides rather expensive apparatus; but as, perhaps, many of our readers may wish to try their hands at it, I have forwarded full instructions, which will be found in another part. Casartelli's dilatometer would not be suitable for the purpose. With regard to the best form of building and arrangements of a brewery for ten-barrel brewings, I will write particulars shortly.—H. P. HARRIS, Rotherham.

[32770.]—**Shot.**—If "Experimenter" will make his vessel in the form of a flat hopper, with the sides making about an angle of 120° with each other, I think there will be no danger of the shot jamming.—NOVUS HOMO.

[32771.]—**Wood Lice.**—Limewhite the cellar thoroughly, especially in the corners, laid on hot. If the operation be repeated two or three times after short intervals the enemy will be effectually vanquished. Quicklime sprinkled in the corners when the limewhite is dry will assist.—INQUISITIVE.

[32771.]—**Wood Lice.**—By woodlice "A. G.," I presume, means a species of Oniscus, the troublesome gentlemen who get into garden frames and mushroom beds, and roll themselves up into balls when disturbed. If so there is nothing for it but to catch them. Raw potatoes and turnips, cut in half, and scooped out, make excellent traps when placed in their haunts and examined daily, so also do boiled potatoes put into flower-pots laid on their side. If their lurking place can be spotted, a kettle of boiling water will give a good account of a few. I think coal-tar would keep them away, but it might be objectionable in the cellar.—SAUL RYMEA.

[32776.]—**"Vienna Flute" Organ Stop.**—In reply to "Musicus," the "Vienna flute" is an open wooden pipe, remarkable for its circular mouth, its tilted wind-channel, and the small pressure of wind required to sound it. For convenience, I will select middle C, accompanying the description with measurements and diagrams. (Corresponding parts are marked with the same letters in all the figures.) The sides, back, and block are put together in the usual way; the front, however, is cut the same length as the back, and before being glued in position has two holes cut in the lower part. One is the circular mouth, nearly ¾in. in diameter, bevelled away on the inside so as to form a sharp edge all round; the other is a rectangular opening corresponding to the wind-channel cut in the block. In the pipe now before me, the lower edge of the mouth stands 1in. above the upper surface of the block. These relations are shown in Fig. 1, which is a section of the pipe, drawn to scale, and one-half the natural size. After glueing up the front, two pieces have to be prepared to complete the wind channel—

FIG. 1

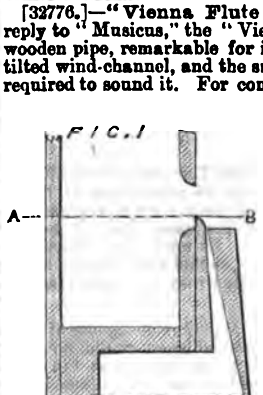


FIG. 2

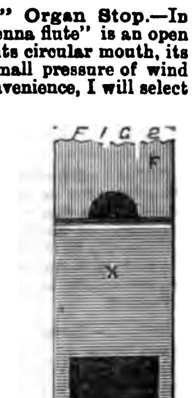


FIG. 3

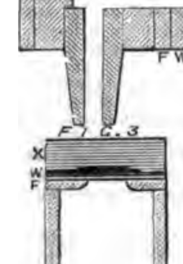
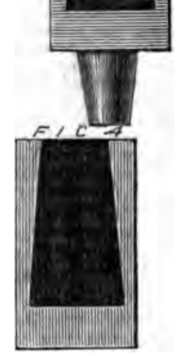


FIG. 4



viz., a wedge-shaped piece, W (Fig
cap, X. The wedge-shaped piece is
and tapers from about ¼in. thick at th
at the top; a rectangular hole is c
sponding to that already cut in the f
the top is bevelled off from the fro
figure. Fig. 2 is a front view of the
cap off, showing the wedge in pos
figures are drawn to the same sca
(shown also in Fig. 4) is likewise of h
wind-way is small and of an arched fo
about ⅜in. from side to side. X (Fig.
section through line A B (Fig. 1), sh
top surface of cap with windway.
measurement of the pipe is 1¼in. deep
the wood being ⅛in. thick. The total
and the diameter of hole in foot is
voicing is accomplished by means of t
the cap. In the pipe which I am now
edge of the wedge stands about ⅜in. ab
edge of mouth, and the top of cap star
level with it (Fig. 1). It is essenti
speaking parts should be made of hard
wood, and I have found that blac
burnishing the face and top edge of t
a remarkable influence on the purity
The following are measurements of tw

		4 foot C.
Total length	... ...	47½in.
Internal measure...	...	$2\frac{1}{16}$ × 1¾
Diameter of mouth	...	⅝in.
Thickness of wood	...	3-16in.
Hole in foot (diam.)	...	7-16in.

The form of the mouth is often va
specimens of 3 kinds—viz., (*a*) o
circular, (*c*) parabolic arch; the first
good notes, the third is not so satis
shape of the windway may also be
No. 254 of the ENGLISH MECHANIC "
a pipe in which the cap stands above
wedge.—C. E. SHEPPARD.

[32776.]—**Vienna Flute Organ**
scription of the flute in question, wit
lar, was given by "Adept" in ENGLI
of February 4th and 11th, 1870. The
round hole inverted mouth gives a f
but, unless the pipes can be placed at
distance from the performer, or in a s
will be disagreeably windy. Those h
circular mouth give the most pleasi
tone, and are not half so difficult to m
The stop with the round-hole for mout
cap, wedge shape, which directs the w
mouth somewhat. The stop is not n
since there are several other kinds of
ing the Vienna, and not half so diffi
the said flute has not come into ge
TAYLOR.

[32781.]—**The Gregorian Tones**
the questions in a manner likely to b
to an intelligent inquirer would dema
The treatises already published a
although in the English language, fors
few; and in those found in that langu
is referred at frequent intervals to fo
of authority. (1) As to the "origin"
or, as the querist puts it, "Whe
written?"—it is perhaps impossible
absolute confidence. Walker, in the
"Plain-Song Reason Why," says, "
the ecclesiastical chant is involved in o
most probable opinion is that in its si
e g., the 'cantus prophetarum and psalm
inherited either intact, or with some sl
tions, together with the writings of the
the Psalms themselves, from the Tem
gogue Service, and that afterwar
musicians submitted it to the rules
ments of the Greek music, rejecting,
enharmonic and chromatic genera in
diatonics." Janssen,* who is an accep
on the general subject, says they were
dans l'église depuis le temps des A
plus tard disposés dans un ordre plus r
Grégoire I.;" but, he adds, "on ne
avec certitude l'auteur de la mélodie o
tions. . . . D'après le père J. B.
auraient été inventées par David, et ser
jusquà nous, sans avoir subi des
notables." Premising that the Doric
use among the Hebrews, he shows how
preserved its identity during the hist
tudes of that people, and survived a
our Saviour; he says: "C'est ainsi
hébraïque des psaumes, conservé de
génération, put rester intact mêm
premier siècle de l'église;" and ar
chants de David ont pu traverser tant
leur forme primitive, qui pourra d
Apôtres ne les aient employés?
mélodies les premiers Chrétiens
adopter—eux qui étaient en grande p
du Judaïsme à la religion de Jésus C
Ainsi, tout nous porte à croire q
primitifs . . . ne sont autre cho
de la psalmodie tant célébré par les S
berceau du Christianisme." (2.) The
is from the term (*toni*) applied ge
modes or scales according to whic
melodies are composed: of the history
of these see C. C. Spencer's "Concis
of the Church Modes," and Helmo

---

* "Les Vrais Principes du Chant Gr

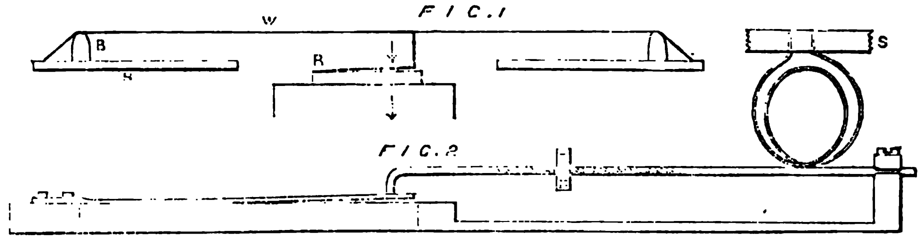
ırmonies to the Psalter Noted," both
; Novello. If the querist has not already
'ould recommend him to run through the
hey are harmonised in Mr. Helmore's
vill find them curiously interesting. (3)
ords for which the tones were originally
e the foregoing extracts from Janssen.
onation is "managed" as follows:—As
by the querist, it is sung to the first
of a psalm and of each of the canticles,
e (called evangelical) that are taken
w Testament, in which cases it is em-
tal use at every verse. I may add that
ered that these canticles should be sung
, even during penitential seasons. The
s (or should be) used invariably to com-
verse of the "Gloria Patri." It does not,
abolish the recitation note. It is a kind
the latter, and serves as a feeler for and
dominant, on which the recitation note
laced. In all properly-pointed psalters
s to be intoned upon it are divided from
on by a vertical line of dots. It is
however, for the precentor at the first
psalms or of a canticle to sing (solo)
on and mediation (*i.e.*, as far as the
ll as the intonation proper. There is a
published by Novello—compiler, J. T.
which the Psalm tones, with their
ntonations and various "endings," are
n which are some intelligent observations
quity of the "eighth tone irregular"
grinus). Although I do not coincide with
at the tones lose none of their character
nglicanised as they are in the sheet in
et I think the querist cannot do better
t it for general preliminary information.
only" 3d.—R. J. H. (Arwyddvardd).

The Moon.—This occurs at new moon.
son of it is that when the moon is new to
ll to the moon, and *vice versâ*, so that
ody of the moon is illuminated by the
earth, and it is by that light we see it.—

Concertina.—If Mr. Blasdale can cut
steel into vibrators he will surely have no
a placing them in the reed blocks of
certinas, where they are held by a little
couple of screws. He can get brass reeds
f the musical instrument warehouses.
st method of tuning the reeds when they
harp, I do not exactly understand what is
at the free end should be gently scraped
the heel end to flatten. Anything that
cleanly and preserve its edge will do.—
EA.

Wood Lice in Violoncello.—"Rufus"
mean woodlice (Oniscidæ) in the violon-
injury is most likely being caused by
of a coleopterous larva (Anobium), in
he will find carbolic acid to be the best
UISITIVE.

Hamilton's String Organ.—I am
that I am unable to give "Tortore"
ore than the barest outlines of a descrip-
Hamilton's string organ; but there is
rature" in connection with it which, if
to look it up, will give him a good idea.
paper by Mr. Hamilton in "Proceedings
al Institution" for 1875; in the *Philo-*
Magazine for February, 1875, there is a
Ir. Bosanquet on the mathematical theory
rument; in the English Mechanic, p.
XX., there is a report of Mr. Hamilton's
at the Physical Society, followed in Vol.
a letter by the late "Harmonious Black-
n p. 559, and another by Leigh Clifford on
n *Nature* for 1875 there were also one or
munications—notably one from Lord Ray-
far as I have been able to ascertain, no
t of the kind has ever been constructed;
was an experimental string organ of suffi-
to show the capabilities of the invention.
zed diagrammatic sketch (Fig. 1) will
one to grasp the general idea. It repre-
uction form of instrument, which, for
asons, affords facilities for connecting
ith the strings, and it shows the con-
k attached to the tip of the reed (which,
on to think, must have been a great mis-
he "instrument" was so constructed).
real difficulty in connecting the strings
ds in a pressure instrument; but the
ld require considerable thought before
e worked out to a successful issue. In
V represents the pianoforte wire stretched
undboard, S, which is perforated to admit
x. R is the reed, and the arrows show
wind. Of course the soundboard might
side of string, or the whole might be
ertically instead of horizontally. The
erely a diagram. The string shown is
resumably of the same pitch as the reed;
re that no advantage was found in the
g strings. The object, of course, is to
vibrations to the soundboard, and if, by
t shorter strings at a less tension than
required to produce a given pitch, that
be obtained when they are actuated by a
se is gained. It was possibly for this
at the first Hamilton string organ was
d by the suggestions for "controlling
which I attempted to describe in Vol. XXV., p. 510. Lord Rayleigh said, when the instrument was first introduced, that it ought rather to be regarded as a modified reed than as a modified string instrument. The inventor appears to have thought so, too—the nearest approach to a string (it is really two reeds, joined at what would be their free ends) being the arrangement shown in Fig. 2, which is taken from the same source as the illustrations I selected for letter 13009. In this the "string" (which has a regulator weight) communicates the vibrations to the soundboard through the coils. If "Tortore" is thinking of experimenting in connection with a string organ, I would suggest that, unless he has abundance of time and money, and does not mind disappointment, he would find a more profitable field for experiment in developing "Fiddler's" finger-keyed viol.—Saul Rymea.



[32800.]—**Grating Noise in Telephone.**—Screw the plates down tightly, and you will lose all grating sound.—W. J. Lancaster.

[32800.]—**Grating Noise in Telephone.**—"Epsilon" should have his joints soldered. This has been frequently pointed out in this journal. One of his joints is defective.—Wiesendanger.

[32802.]—**The Leclanche Battery.**—1. It is suited, but rather weak. 2. No.—Wiesendanger.

[32817.]—**Magnetising Steel Wire.**—Draw each steel needle 20 times over one pole of an electro-magnet, beginning each time with the same end. If you want to magnetise it in one piece, draw the wire over one pole of a magnet as indicated.—Wiesendanger.

[32819.]—**Joule's Magnet.**—Use silk-covered wire. Make a simple loop by drawing the end under the last ring.—Wiesendanger.

[32825.]—**Unfermented Bread.**—A box of scales and weights (½ grain to 2 drachms) can be obtained for half a crown, and an 8-drachm measure (glass) for 8d. Any druggist would supply the querist with the acid in the dilute state (as described in letter 14266, page 170), 24oz. acid to 56oz. water (by measure) if he elects to follow my direction, and would also weigh up a pound or so of the soda in 110-grain packets for a small additional charge if a "Would-be Baker" does not care for the trouble. A small phial bottle would do for a measure. Ask the druggist to put exactly 8 fluid drachms of water in it, and then with a file make a mark on the glass at the height of the liquid. By having the acid in a dilute state it can be kept in an ordinary bottle with a good cork, while the strong acid requires a well-stoppered one, and even then loses strength slowly. —Daghbert.

[32827.]—**Normal Sulphuric Acid.**—The composition of good soaps is simply a fatty acid combined with an alkali, together with a certain amount of water and a small quantity of foreign matter. If the acids were oleic, stearic, &c., the soap would consist of alkaline oleates or stearates; generally both acids are present. (1.) *Determination of the Moisture:* This is easily effected by heating the soap (in the form of thin shavings) in air bath to a temperature of about 130° to 150° C. for about 30 minutes. The soap having previously been weighed, the loss of weight after heating gives the moisture—*e.g.*, if 10 grammes of soap shavings were taken, and after heating weighed only 9·5, then $10 : 10 - 9·5 = 5 :: 100 : x$ = per cent. of moisture = 5 per cent. moisture. (2.) *The amount of fatty acids* present is thus found: A certain weight of the dried soap is put in a beaker, and a measured excess of the standard n. H_2So_4 run in. (This is easily shown by adding a drop or two of tincture of litmus to the solution, or by transferring a drop of the liquid to a litmus test-paper.) The acid should be well in excess. The fatty acids float to the surface, having been turned out from their alkaline salts by the sulphuric acid. They are collected by filtering the solution through a previously weighed filter paper, which is then carefully removed, dried in an air bath, and finally re-weighed. The weight, from which previous weight of filter has been subtracted, gives amount of fatty acids. (3.) In a fresh portion of the dried soap the alkali is estimated by adding a measured excess of standard n. H_2SO_4, and then running in the normal KHO till the neutral tint is arrived at. Subtract the No. of cc. of KHO used from No. of cc. of H_2SO_4, and the result is the No. of cc. of H_2SO_4 which have been used up by the alkali in the soap. Suppose x cc. to have been used, now 1 cc. of standard n. H_2SO_4 = 0·04 of a gramme of NaHo; ∴ x cc. = $0·04 \times x$ grammes of NaHo present. In each of the last two cases only 1 gramme of the dried soap need be taken. (4.) Adding up the total percentages, and subtracting therefrom 100, we get the amount of foreign substances present, which in unadulterated samples should not exceed 1 per cent. (5.) The alkali may also be determined by igniting the soap in a crucible. The residue consists of sodic or potassic carbonates. The ash may be weighed, and the quantity of soda calculated thus:—$Na_2Co_3 = (23)_2 + 12 + 48 = 106$. $NaHo = 23 + 1 + 16 = 40$. If residue weighs 0·3 gramme,

$$106 : 40 :: 0·3 : x = \frac{40 \times ·3}{106} = 0·113 \text{ gramme};$$

∴ residue is equal to 0·113 gramme NaHo; to find percentage: $1 : 0·113 :: 100 : x = 11·3$ per cent. of NaHo present. If the soap is impure, however, it is best to titrate the residue with standard n. H_2SO_4, and calculate results as shown in (3). There are two or three other methods for soap analysis, which I will send "Derby" if he finds a difficulty with this one, but this is by far the simplest. I am not sure whether oxalic acid would work in this process—*i.e.*, whether it would decompose the oleates and stearates; but when once the oxalic acid and KHO solutions have been made up any amount of the H_2So_4 can easily be made from them (as I explained in my last letter), and it will be by far the most economical and effective acid to use. The only book I know of which contains an account of soap manufacture, &c., is a volume of Richardson's "Chemical Technology," and which "Derby" would do well to see, though it is scarcely worth purchasing, on account of its high price. Watts, in his dictionary, devotes 10 pages to the subject.—H. L. Sulman.

[32843.]—**Musical Box.**—It is better to pull out all bent pins, as they would probably break in the attempt to straighten them. In some music boxes there is a cement run in after the pins are placed, and when this is so, it renders it a very difficult task to remove broken pins unless you can punch them through, for in boring it is difficult to keep the drill from running off the old pin into the brass, and so throw it out of position. New pins can be made of steel music wire, filed taper, and wedged in the hole. For further directions see page 611, Vol. XXVI.—W. H. Davies.

[32847.]—**Colourless Spirit Varnish.**—The best for the purpose is white hard varnish, sold at most oil-shops, or a good transparent varnish may be made by dissolving gum sandarac in methylated spirit.—W. H. Davies.

[32847.]—**Colourless Varnish for White Wood Articles.**—I have used the following for white wood carved work with success: Size twice with white of egg, clean off with fine glass paper; size again if necessary. Varnish with copal varnish.—G. H. Aubrey.

[32848.]—**Jamin Magnet.**—The Jamin magnet is not so suitable for bells as the ordinary horse-shoe magnet. If the resistance of your circuit is considerable use 3oz. of No. 26 silk-covered wire.—Wiesendanger.

[32855.]—**Electric Light.**—To get a good light for your purpose use 30 Bunsen's cells at the very least.—Wiesendanger.

[32859.]—**Microscopical.**—"Diatomaniac" wishes to know whether my exhibitor is a good oblique illuminator for showing the lines and dots on difficult tests. I can say, after many months' use of it, short of the expensive sub-stage illuminators of the best makers, I have never found anything which answered the purpose better. It is fair, however, to warn my brother maniac that it requires some measure of patience to bring out all it can do. So much depends, with this as with all other appliances for producing good oblique illumination, on the adjustment of mirror and lamp, that I have for ever found failure of such things to be the result, not of the illuminator, but its illumination. What I, after long practice, can effect at once, others may for a time fail to achieve. I have shown it often to most skilled observers, and all have admitted that, at least in my own hands, it is a perfect success. I with ease get perfect background, the diatoms well lit up, or a greyer backing, which I prefer. I have no interest whatever in praising it beyond the satisfaction I hope it may afford to those who, like myself, are fond of studying the wonderful field for observations diatoms afford. I gave my own models to Baker, and he has made some for me which behave admirably. I will only add that it is essential the instrument should be firmly clamped to the stage.—S. G. Osborne.

UNANSWERED QUERIES.

◆

The numbers and titles of queries which remain unanswered for five weeks are inserted in this list, and if still unanswered are repeated four weeks afterwards. We trust our readers will look over the list, and send what information they can for the benefit of their fellow-contributors.

Since our last "An Old G. N." has answered 32040; "D. A. N.," 32405.

32211. Organ Pipe Feet, p. 611.
32213. Collecting Insects' Eggs, 611.
32217. Battery, 612.
32220. Pumping Engine, 612.
32221. Sand for House Floor, 612.
32222. Glazed Pipes, 612.
32225. Engine House Building, 612
32230. Sofa Bedstead, 612.
32231. Use of Swiss Mandrel, 612.
32232. The Dicer's Theory, 612.
32233. Electro-Magnet, 612.
32236. Glass Balls, 612.
32243. Law Costs, 612.
32246. New York to San Francisco, 612.
32247. Calico Printers' Clay, 612.
32253. Books on Woollen Manufacture, 612.
32259. Salicylic Acid, 613.
32261. Revolving Wood Shutters, 613.
32263. Silk Manufacture, 613.
32264. Mechanical Question, 613.
32268. Spelter from Old Zinc, 613.
32271. Woollen Burr Destroying, 613.
32272. Testing Sugar, 613.
32279. G. W. Engines, 613.
32287. Galvanic Coils.—To Mr. Fennessy, 613.

32473. Plaster of Paris, p. 77.
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32498. Paper Canoe, 78.
32502. Launch Engine and Boiler, 78.
32505. Inhabited House Duty, 78.
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QUERIES.

◆

[32861.]—**Removing Cement from Iron Pipes.**—We propose altering the arrangement of the pipes that heat a greenhouse, and shall be much obliged for instructions how to remove the cement which appears to be made of iron filings, &c., from between the joints of the pipes.—Wallasey.

[32862.]—**Boiling Glue.**—Would any one inform me what kind of pan to boil glue in, and what quantity of water to put to one cwt. of pieces or shavings of hides, &c.?—O. O.

[32863.]—**Electro-Magnet.**—What size of wire would be most suitable for the magnet for a 12in. electric bell?—Drill.

[32864.]—**Gold.**—I have about 1oz. of gold with about 25 per cent. of copper in it. I would like to separate the copper from it if possible. Could some of your correspondents please say how I could do it? I have got plenty chemicals at hand if required.—H_2SO_4.

[32865.]—**Force Pump.**—I have a No. 2 horizontal slide-valve engine (Bateman's make), to which I want to attach a small force-pump to feed its boiler, its size being 8in. high, 4in. dia., with a copper fire-box, water all round fire, size 5in. high, 3½in. dia., all well riveted. Working pressure would be 60lb. to the inch. It has five ⅝in. copper flues.—Young Engineer.

[32866.]—**Greenhouse.**—I want to build a small greenhouse 12ft. long by 4ft. 9in. wide. What height should the back be if the front is 5ft. 6in. for draining off the rain? What size timber should be used and what joints would be best, as it must be so constructed as to allow of it being taken to pieces and not to become the property of the landlord? I should be glad of working drawings and would advertise my address on intimation that they would be sent.—Gardener.

[32867.]—**Clock Gongs.**—Will a contributor kindly say if American clock gongs can be had in various lengths and sizes, giving different tones, and where? Also what are the largest sizes that musical-box sounding-plates are made to, and if possible to obtain them large in this country without the boxes?—Autophone.

[32868.]—**Astronomical.**—Will Mr. Proctor, "F.R.A.S.," or some other gentleman, kindly inform me how I can ascertain the time of rising and setting of both sun and moon in each day for the year 1879. I have in my possession a copy of the *Nautical Almanac* for that year, if I can make the calculations from that. I may state that I wish to compile a calendar with the above, particulars added thereto, and to wait for the appearance of next year's almanac would not suit my purpose.—Little Harry.

[32869.]—**Sensitive Flames.**—Would Mr. Lancaster or other correspondent kindly give instructions for producing the above? What is the theory of their action?—Carbon.

[32870.]—**Chemical.**—Given the weight of a mixture of potassic and sodic chlorides, and the amount of chlorine contained, how can I find the relative quantities of the two chlorides?—Carbon.

[32871.]—**Reed Organ Pipes.**—Some months ago I asked a question respecting the making of reed organ pipes—that is the scales or sizes of the reed, mouths, and flues. Beyond the offer of, and your kind permission in a foot note for, a series of articles on the subject nothing more has appeared. If some kind friend, such as "J. D. W." or other, would kindly give the size, shape, and way of voicing the "hautbois," for instance, I should be extremely grateful.—Hugh Harding.

[32872.]—**Making Steel Rifle Barrels.**—Would any of our readers kindly explain the manufacture of rifle barrels (steel)? Also the different modes of forming grooves, and what may be considered long range with ·380 calibre long bullet?—Amos.

[32873.]—**Flue for Brickyard.**—Will any reader inform me of the most approved kind of flues for brickyard, 30 by 20 yards? Size of shed about 600 square yards, the most economical and cheapest form, giving sketch of flue and size of grate and bars will oblige—W. H. T. P. L.

[32874.]—**Coating for Bricks.**—Will any reader inform me of what the coating is composed, which burns blue or black for common bricks, as I have seen a good many samples of good blue bricks only coated with something that apparently has been washed on?—W. H. T. P. L.

[32875.]—**Hooks and Eyes for Catgut Band.**—My lathe is driven by a catgut band, and I am often very much annoyed by the hooks and eyes coming off. I should be glad to know if there is any better method of fixing them on than this? I screw them tightly on to the band and then burn the ends off. Is there any other way to join the ends?—Hooks and Eyes.

[32876.]—**Cutting Gauge Glasses.**—Supposing a gauge glass for showing height of water in a steam boiler, say ⅜in. diameter, with a bore of 5-16in., is two inches too long, what method of cutting it to required length is the quickest, and at the same time most certain not to splinter the end? Also suppose a similar glass ¼in. too long. How do the makers cut them before grinding the ends flat?—H. E. H.

[32877.]—**Indian Ink.**—Would any correspondent give a good recipe for making Indian ink? How is that brassy appearance observable in some inks obtained? Does it denote a good or a bad ink?—Daleth.

[32878.]—**Relacquering and Bronzing.**—Will any one kindly inform me how the dead gold and deep colour is got, also the red or brown bronze? The green I can do, but I cannot get the burnished parts to show up properly after being lacquered.—J. C. T.

[32879.]—**Caking Colours.**—Would any correspondent favour me with a few hints how to cake water colours—my attempts in this direction all succeeding in a mass which cracks all to pieces?—Daleth.

[32880.]—**Leclanche Cell.**—Would Mr. Lancaster, or some of "ours," kindly give me the proportions of the charge used in the porous cell of a Léclanché battery? I lately constructed four cells, using manganese, dioxide, and coarsely pounded coke. But as their performance is not at all satisfactory I am forced to believe that the charge was mixed in incorrect proportions.—Ropemaker.

[32881.]—**Gas Holder.**—Can some chemist or other person suggest to me a cheap gas-holder, to hold from two to four gallons, and which could easily be made at the cost of a few shillings? The holder would not be for pressure but rather for a steady suppy as in the case of Pepy's.—F. A. B. J.

[32882.]—**Paraffin Candles.**—I shall be glad if some of your correspondents will inform me how this composition is made. It is, I presume, a mixture of paraffin wax and fat. Having occasion to use this, I at present buy the darker kind of candles and melt them down, but this is, I presume, a wasteful way of working.—Civis.

[32883.]—**Railway Grease.**—Will some of your practical or chemical correspondents kindly inform me how the greases now mostly used are made, also the quantity consumed?—Engineer.

[32884.]—**Water Engines for Organ Blowing.**—What is the rule for finding the diameter of cylinder, &c., say, for one or two men-power, water pressure, 30lb. sq. in.? Any information or reference to works treating on same will oblige—M. O. W.

[32885.]—**Canoe.**—"E. H. J." will greatly oblige if he will kindly give me some information on the following points:—1. I am building a canoe 16ft. long, 2ft. 6in. beam, and 14in. deep, designed to carry two persons. Can you tell me how far from the stern the after seat is to be placed, the forward seat to be 3ft. 6in. from the after one? (2) What sized anchor is required for a canoe this size? When alone I intend sleeping on board her. Also how do you get the anchor from the stern round to the well? (3) Does the mizzen sheet work on a horse? If not, how is it fitted, and where is it made fast to?—Temeraire.

[32886.]—**The Pulsometer.**—Could any correspondent of the E. M. give their experience as to the working of the pulsometer? I am informed that it requires more steam to drive it as compared with a steam-pump performing the same duty. Is this the case?—Stromboli.

[32887.]—**Heat Regulator.**—I should feel obliged if any correspondent of the E. M. would kindly give me some hints as to how the heat in a kiln or oven could be regulated and kept at a constant degree of, say, 270 Fahrenheit. Could any arrangement of damper, or valve for shutting off the heat from the furnace, or for admitting fresh air into the kiln or chamber, be adopted, and could it be made self-acting by the expansion or contraction of a bar of metal operating by suitable levers upon such valves, and in this manner to control or modify the temperature? Is any such plan adopted for the annealing ovens of glass-works? I have an idea that the products of combustion, or heat from any kind of furnace, might be introduced into the chamber and diluted, or brought down to the required temperature by the admission of fresh air, the quantity of which would be regulated by self-acting valves. Would some correspondent inform me if there would be any practical difficulty in doing so?—Stromboli.

[32888.]—**Washing Powder.**—Many thanks to "J. L. K." for noticing my previous query. Can he inform me how to make a washing powder like Hudson's dry soap or Hemmingway's? Also a good washing liquid, and what kind of machine is usedf or grinding the washing powder? I mean one for hand-power.—C. S.

[32889.]—**Lathe Bearings.**—Will some
give me information as to the best forms of b
high-speed lathe about 7in. centres?—D. W.

[32890.]—**Astronomical—To "F. R**
The Nocturnal.—I have now looked up t
that I previously inquired about, and find it
in some respects from either of the forms
"F. R. A. S.," or the other two corresponden
about it. There is the second or intermediat
tioned by "F. R. A. S.," but instead of this
projecting tooth or index it has two—one ma
site 12 o'clock on the hour circle, and the ot
G at a quarter to 8 o'clock. I should remar
are two 12 o'clock marks, the hours being r
that the G tooth is opposite the quarter to 8 o
same set of figures as the L tooth, so that G
distant from one another 63¾ degrees. On th
of the instrument there is, opposite the hand
jecting tooth which corresponds with the 25
There is no indication what stars it is to b
The graduations are as follows:—On the main
are two circles, the outer one containing t
divided into spaces of two days, with extra m
odd days when there are 31, and the inner c
into twice 12 hours, with subdivisions of qu
On the second or movable disc there are also
the outer divided into 29½ equal divisions, an
into twice 12 with the quarters as before, the
the outer circle corresponding to one of the tw
marks on the inner one. I forgot to say that
12 o'clock marks of the main plate correspo
tooth that I mentioned as coinciding with
April. The long moveable arm is stamped I.
of the main plate is also marked and divided.
consists of a compass card of 16 divisions, m
E. W., &c. Around this are two circles, both
32 equidistant divisions. These are both m
degrees and minutes in groups or sets of n
would take too much space to insert all th
query, but I give a few of them. Opposit
point the outer circle number is 2·09 and the i
The letters L and G are also put respectiv
points. At 5 points of the compass from N.
the numbers are 0·06 and 2·13, the letters a
(which, I conclude, mean above and under) be
in the outer circle on each side of the 0·06 m
same letters occur in the inner circle at 2 poi
towards S., where the numbers are 2·01 and
next occur in the outer circle at 5 points fro
W., the numbers being 0·14 and 2·13, and,
point from W. towards N., where the numb
and 0·08. These numbers do not appear to r
the inner or outer circle) in such a way as to
lar series. For a part of the circle the num
inner circle are the same as those 180 degrees
this does not hold good for more than a few
Plumb-bob.

[32891.]—**Treatise on Comets.**—In
astronomical works of Dr. Dick, entitled "
Heavens," a chapter is devoted to "Comets," e
foot-note in which he says: "The most comp
of the phenomena, &c., of comets I have seen
in manuscript by the Rev. Thomas W. Webb
near Ross." Then follows a lengthy descri
contents, and it concludes with a hope "that
author, who is already known to a considerab
the scientific world by his communications t
and scientific associations, will soon receive
ment to lay this work before the public."
have been an astronomical student and gener
reader for some years, yet I have never m
reference to the above-named work on "Com
in "The Sidereal Heavens;" may I theref
through "our" journal, whether this treati
been published? I feel convinced that hu
myself would only be too glad to obtain a copy
work from the pen of our astronomical guide
of "Celestial Objects."—W. Salburgh.

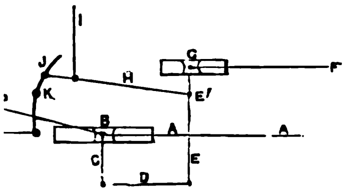
[32892.]—**Slates.**—I should be greatly o
informed of the names, prices, qualities, &c.,
roofing purposes. Recommendations of an
kind known to be good, and the characterist
any kind may be identified, would be esteem
by—C. O.

[32893.]—**Weakness.**—About two years a
lost the use of her left side, and although
tolerably good she has not yet entirely recov
of her hand and arm. When the doctor took
her he said all she required now was good f
door exercise, but she does not appear to ha
much during the last twelve months. Her b
thin and does not seem to circulate properly.
time her hands are quite bloodless and numb
be glad if any of your medical readers would
to what kind of food would be most suita
Would phosphorus be beneficial in her case?
articles of food contain the most? She is 21
As her leg and foot are pretty strong I fancy
of walking has been beneficial. I would be
reader would kindly recommend me to a
gymnastic exercise?—A Working Man.

[32894.]—**Canary.**—I notice that we
"Replies to Queries" columns some subscrib
evidently well versed in the keep and ma
canaries. Would any of those gentlemen k
me their valuable advice and assistance, t
medium, under the following circumstances?
I obtained a fine cock canary, which sang th
summer months so well and so sweetly as
many expressions of pleasure from my friend
the close of the year, in September last,
moult, as is the nature of such creatures,
feathers left him so did his voice, and from th
the present never a note has issued from his
he still occasionally casts a feather. I have r
bird management—I have consulted people
lore, acted on their advice, and tried every
thought might prove beneficial, but still he is
tomb. I may mention that I have never
before, although very fond of such pets.
have a chronic cold, such as an old lady o
might have, accompanied by a slight asthma
ing; but he is in no draught, is not near gas,
eats well and sleeps well, but sings not at all.
simple remedy other than I have tried may r
to my little friend. Can you assist me?—T. C.

icycle.—When ordering a bicycle the other vised to have one with the brake on front thought that if applied too strong or sud- t throw me over the front. Can any one give ice of it? The correspondent, R. H. Froude, , mentions a sliding saddle, but proposes to handle on bicycle for brake, which is not the brake might be on front wheel (applied in the usual way) with perfect safety. Now he greatest importance to bicyclists, riding district, or descending a steep incline, by ng the handle to shift the saddle back, or ithout dismounting. The Singer company s. 6d., a "sliding saddle clip" for a similar e attached to any machine. Any informa- e above will oblige.—Tangent Amateur.

Reversing Gear.—I have noticed the fol- nection with a locomotive, but fail quite to s action. Perhaps it may be of interest to riends, and also meet with an explanation. as no pretensions whatever to scale or pro- piston rod; *b*, crosshead working in guide as stiff arm secured to side of crosshead, and ame motion and stroke as the latter; *d*, con- o *e*, which latter is suspended by joint from of slide-valve rod working in a guide; *e′*,



ecting rod *h*, the other end of which, working , is raised or lowered to any position desired the rod *i*; *j*, curved link with internal slot studs at *k*; *l*, connecting rod between lower nd counter crank, *m* (in place of an excen- in crank, with the nipple of which counter ly connected; *o*, crank shaft or wheel axle; The action of this gear seems very good.—

Japanning.—Could any of your readers st mixture for japanning harness furniture?

Galvanometer for Use in Electro- ill "Sigma," or any other correspondent, what arrangement to make whereby I can ength of the current that is being used for ?—L. D.

Injecting Tissues.—Can any histological me an easy method of injecting tissues? of our microscopical friends who are so fond lots and lines would devote a little time to d give us their experience?—D. A. N.

Attraction. — Perhaps Mr. Proctor, ," or some other correspondent, will answer queries:—The attraction of the earth's mass its surface being *g*, what proportion does he sun's attraction for the same body placed surface? What proportion does the moon's r a body at the surface of the earth bear to g the sun's mass to be 25,590,000 times as moon's mass, and the sun's distance to be 353 on's distance, the sun's attraction for a body should be directly as the mass, and inversely distance, or as $\frac{25,590,000}{3,852} : 1 = 174 : 1$. What ertain is what proportion the earth's attrac- ly at its surface bears to these two forces? If the earth was concentrated at its centre the would be easy, but I fear, in fact, it requires grations?—Volvox.

Boiler Feeding. — We have a set of onomisers attached to two out of six of our s. We are satisfied that sufficient water can rough them to supply all six boilers. Would fuel be effected by passing all our water m, over present arrangement of feeding only hrough them?—James Heys.

Tanning Canvas for Barge Sails.— rrespondent kindly inform me the *modus* anning canvas for barge sails; where the tan ained ground; the colouring matter, if any, tion; the strength of the liquor; the length canvas is to be immersed; and how long the l be kept boiling?—Colchester.

Geometry.—To make an equilateral tri- in area to any given irregular triangle. Will utor kindly explain what geometrical prin- involved?—Enquirer.

Stone.—In walking over Blackfriars-bridge lay I noticed that there were two kinds of for the footpath—a dark and light variety. ed that the former was less worn than the the reason, I presume, that it is of a harder hould like to know the name of the stone, and arieties are used for such a purpose?—An

Pumping Engine.—A pumping engine stroke in the pumps goes five strokes per charges 1,200 gallons per minute. Give the ing barrel.—Dpty.

Oval Measure.—Would any of our sub- re a rule for measuring oval forms? For hat would be the area of a fire-hole door lft.?—G. W. Fireman.

Attaching Red Rubber to Iron and —I wish to attach a coating of red vulcanised . thick, to an iron rod that has been previously th ebonite, the rubber to be as soft as elastic is required to know time required, and neces- ature of rubber? Also how to roll the paste rst instance?—M. Volk.

SPHINX.

*** *All communications for the "Sphinx" should be addressed to* T. Mitchesson, B.A., *City of London School, Cheapside, E.C.*

Owing to the influx of mathematical correspondence a little time will be required for a satisfactory perusal and election for insertion, the space allotted for the "Sphinx" being necessarily restricted.

Questions.

753.—Integrate $x^2 r + 2 x y s + y^2 t = 0$ and $q^2 r - 2 p q s + p^2 t = 0$, by Monge's method, and show by the law of reciprocity that the second may be made to depend on the first?—J. F. W.

754.—A train consisting of 44 carriages, each four yards long, is travelling at the rate of 55½ miles per hour; it passes a man walking in six seconds; which way is the man walking and at what rate?—Eos Cleddan.

755.—Show by division of a line in what sense .6 can be said to be equal to ⅔?—Eos Cleddan.

756.—How many gallons of wine at 11s. 2d. per gallon must be mixed with 533 gallons, at 15s. per gallon, to gain 20 per cent., when the mixture is sold at 17s. 6d. per gallon?—Eos Cleddan.

757.—A finite right line cannot be greater than the sum of its projections on two planes at right angles to each other?—Leidhold.

758.—Show the point of intersection of the perpendiculars from the angular points of a triangle upon the opposite sides is the centre of the circle inscribed in the triangle formed by joining the feet of these perpendiculars?—Maggie.

759.—In the foregoing question (752) suppose that the man takes 14 of his weights at random 5 times, and finds that in each case they exactly balance the stone-weight, what is the probability that all the weights are correct, and that one chosen at random is correct?—Amara.

760.—Inscribe an ellipse in a rhomboid.—W. Hooper.

Solutions.

712.—Todhunter shows

$$n^r - n(n-1)^r + \frac{n(n-1)}{|\underline{2}}(n-2)^r - \frac{n(n-1)(n-2)}{|\underline{3}}(n-3)^r + \ldots = |\underline{n}, \text{ if } r = n,$$

but = 0, if $r < n$; hence

$$n^{n-1} - n(n-1)^{n-1} + \frac{n(n-1)}{|\underline{2}}(n-2)^{n-1} \text{ \&c.} = 0$$

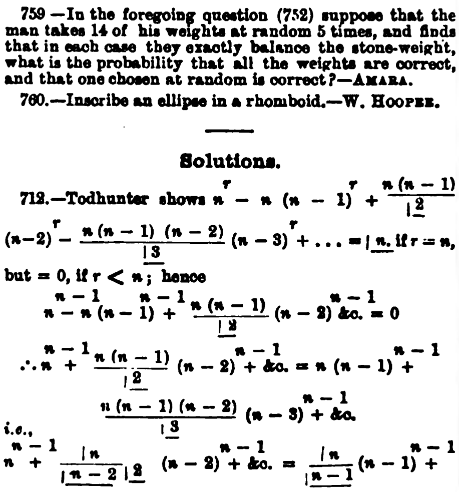
$$\therefore n^{n-1} + \frac{n(n-1)}{|\underline{2}}(n-2)^{n-1} + \text{\&c.} = n(n-1)^{n-1} + \frac{n(n-1)(n-2)}{|\underline{3}}(n-3)^{n-1} + \text{\&c.}$$

i.e.,

$$n^{n-1} + \frac{|\underline{n}}{|\underline{n-2}\,|\underline{2}}(n-2)^{n-1} + \text{\&c.} = \frac{|\underline{n}}{|\underline{n-1}}(n-1)^{n-1} + \frac{|\underline{n}}{|\underline{n-3}\,|\underline{3}}(n-3)^{n-1}$$

dividing by $|\underline{n}$ we get the required result.—Maggie.

727.—(Leidhold).—To dissect a square into three equal squares. Take any equilateral triangle D C B. Draw altitude, C A, and in A G produced take A G. = A C. Then $\frac{A\,B}{A\,G} = \frac{1}{\sqrt{3}}$. On A G erect a right-angled triangle, A E G, making A E = A B. Describe square on A G. Draw H N ⊥ E G, and K L to E G produced. Then E N, N L, clearly = A E, E G, respectively. And draw K M,



A Z, ⊥ H N. Bisect sides of square, M N L K, in O, P, Q, Z. Join O P, P Q, Q R, R O; then triangle A E G = triangle H M K, and triangle G L K = triangle A Z H. Transfer the divisions on triangle A E G to triangle H M K, and those on triangle G L K to triangle A Z H; and the square, A H K G, will be dissected into three equal squares, each = the square on A B. Wherefore, &c., Q. E. F.—A. B. C.

[Where is the demonstration?—Ed.]

737.—Separating the variables:

$$\frac{d\,y}{1-y} = \frac{d\,x}{(1-x^2)^{\frac{3}{2}}}.$$

By integration:

$$\int\frac{d\,y}{1-y} = \text{const.} + \int\frac{d\,x}{(1-x^2)^{\frac{3}{2}}};$$

whence

$$\log.(1-y) = -\left\{\text{const.} + \frac{x}{(1-x^2)^{\frac{1}{2}}}\right\}.$$

Solving for *y* and putting $e^{-\text{const.}}$ = an arbitrary constant C, we get

$$y = 1 - Ce^{\frac{-x}{(1-x^2)^{\frac{1}{2}}}}.\text{—Leidhold.}$$

739.—Let *x* = the number of pigs bought by any one of the wives $x + y$ = the number bought by her husband.

$$(x+y)^2 - x^2 = 63;\ 2xy + y^2 = 63;\ 2x + y = \frac{63}{y},$$

an indeterminate equation in which *x* and *y* are positive integers; therefore $\frac{63}{y}$ is a positive integer; therefore *y* is a factor of 63, and is either 1, 3, 7, or 9.

If $y = 1$, then $2x = 62$; $x = 31$ and $x + y = 32$
If $y = 3$, then $2x = 18$; $x = 9$ and $x + y = 12$
If $y = 7$, then $2x = 2$; $x = 1$ and $x + y = 8$
If $y = 9$, then $2x = -2$, a negative value which is excluded. Consequently the pairs are

Dick 32 and 31 Jane;
Tom 12 and 9 Mary;
Harry 8 and 1 Eliza.—J. A. H.

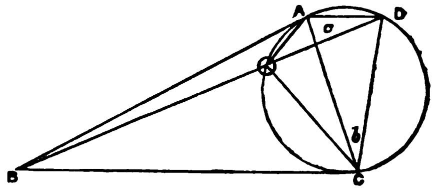
739.—The area of the end of the wire is $\left(\frac{31}{30}\right)^2 \times \cdot7854$, and this, divided into the cubic contents, must give length —*i.e.*,

$$1728 \div \left\{\left(\frac{31}{30}\right)^2 \times \cdot7854\right\} = 171\text{ft. } 8\tfrac{1}{4}\text{in.}$$

—Alex. Campbell.

742.—See Euc. I., 22.—Alex. Campbell.

746.—Make A C D = B, C A D = C, and describe a circle about △ A D C, cutting B D in O; join O A, O C; O is the point required. For A C D = B = A O D =



O B A + O A B = O B A + O B C; ∴ O B C = O A B. But C A D = C = C O D = O B C + O C B = O C B + O C A; ∴ O B C = O C A = O A B.—Maggie.

Solutions Received.

A. Campbell, 739; A. B C., 727; Q. E. D. and Itmex, 740; A. B. C., John Stevens (Paisley), C. Mitchell, jun., Amara (notice the new address), 749, 750, 751; Leidhold, 748; C. E. Soulsby, 750; L. S. (It is some mark of distinction in these days to *politely* acknowledge an error, as you do), 746.

Notices to Correspondents.

The last "Sphinx" contained a few easily rectified errors, owing to the "proofs" not having been corrected as usual.

West-Nor'.-West and E. S. C.—Shall shortly appear.

S. Stokes.—Propose your rule as a *question for discussion.*

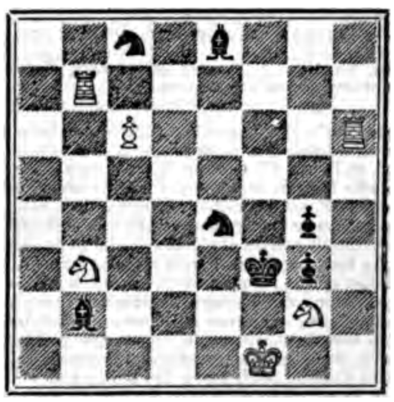
A "First Class Prize Medallist," of Liverpool College, says: "There is a question (746) so absurd that I wonder you allowed it to appear." "Maggie" is responsible for this, and had better see to it.

CHESS.

All Communications intended for this department must be addressed to J. Pierce, Copthill House, Bedford.

PROBLEM CCCCXXII.—By Dr. Gold.

Black.



White.

White to play and mate in three moves.

Solution to 420.

White.	*Black.*
1. Q to K B 3.	1. Anything.
2. Q, B or Kt mates accordingly.	

Notice to Correspondent.

H. M. Pridhaux.—Tidy and correct. Your questions we are unable to answer.

ANSWERS TO CORRESPONDENTS.

HINTS TO CORRESPONDENTS.

1. Write on one side of the paper only, and put drawings for illustrations on separate pieces of paper. 2. Put titles to queries, and when answering queries put the numbers as well as the titles of the queries to which the replies refer. 3. No charge is made for inserting letters, queries, or replies. 4. Commercial letters, or queries, or replies are not inserted. 5. No question asking for education or scientific information is answered through the post. 6. Letters sent to correspondents, under cover to the Editor, are not forwarded; and the names of correspondents are not given to inquirers.

The following are the initials, &c., of letters to hand up to Tuesday evening, May 7, and unacknowledged elsewhere:—

Geo. Kidd.—E. P. Alexander.—F. de Montmorency.—D. Allingham.—Welwyn Social Club.—G. Dashwood.—P. Renondini.—R. J. A.—H. Williams and Co.—Tanite Co.—R. C. Clifton.—W. L. Wise. — W. Grange.—A. B. M.—Aliquando.—Hugh Clements.—T. G. S.—Constant Reader.—E. Parr.—An Engineer.—A. A. Watkins.—W. B.—E. W.—H. P. Harris.—W. H. Escott.—Gold Star.—Z. D.—B. N.—Sitiens Scientiæ.—F. J. Jackson.—J. H. Collins.—W. Wilson.—S. Smith.—Wynnede Cerjat.—A. Gillies.—F. A.—A Country Reader.—John.—J. K. N.—Anxious.—A Reader.—Kelby.—G. Dashwood.—P. C.—F. C. Dennett.—Semibreve.—J. Johnstone.—A Fellow of the Chemical Society.—D. Traill.—Totham.—One Affected.—Union Jack.—Chas. Jones.—W. B. A.—R. G. L.—Galvano.—Perdu.—J. B. K. H.—H. B. F.—Kaikora.—D. Strathearn.—A. D. R. J.—Sperans.—Dudley.—N. Virch.—Phœnix.

J. Snell, and Corn. (Numerous remedies for corns have appeared in back vols., and we cannot devote more space to the subject. We have frequently recommended the use of acetic acid, and never knew it to fail when used with care and perseverance. Apply it every night to the corn when retiring to bed, but be careful not to let it touch the surrounding flesh.)

Young Mechanic. (The silicate paints, manufactured by the Silicate Paint Co., of Liverpool, are the best for the purposes indicated.)—Bantam. (Get Mr. Sprague's book on "Electricity," published by E. and F. N. Spon, of 48, Charing-cross. That will tell you all you want to know.)—Samuel Green. (We are unable to give the address; an advertisement asking for it in these columns might bring you a reply.)—Crooked. (We cannot recommend individual surgeons; your own medical man will determine whether the operation is necessary, and will suggest the most proper practitioner to perform it.)—Tatoo. (Impossible, except by a surgical operation.)—A Constant Reader. (Get "The Pattern Maker's Assistant," by Joshua Rose, published by E. and F. N. Spon. It is advertised in this number.)—F. R. T. D. (The company will lend on the policy according to its age, or any private lender will accept it as security.)—J. F. (W. J. Lancaster, Stanley, or Cox would inform you if you write direct to them.)—Anxious. (Better consult a veterinary surgeon.)—J. M. (You had better see a surgeon; the ear is far too delicate an organ to trifle with in the manner you have done. The second complaint is probably sciatica.)—Dpty. ("Molesworth's Pocket Book" (Spon), Templeton's "Workshop Companion" (Lockwood), or the "Colliery Manager's Handbook" (*Colliery Guardian* Office), would probably suit. The book you mention is published by Longmans, we believe. Nominal horse-power is a useless and misleading factor. The Admiralty rule is square the diameter of piston, multiply by velocity in feet, and divide by 6,000.)—E. Mawe Smith. (We do not know who sells it in London, but David Nutt, of the Strand, would probably procure it for you.)—J. R. E. (We do not know the book you mention; Gooding's "Manual of Domestic Medicine," published by Lockwood and Co., 7, Stationers' Hall-court, is a good one.)—Tyneside. (Please send.)—Ajax. (See back vols.; we cannot devote more space to the matter.)—Alpha. (See reply 28159, p. 92, No. 628 (April 6, 1877), for references to numbers containing directions for making wood and metal organ pipes.)—W. J. Chadwick. (Your letter next week.)

Anxious, A Subscriber of Many Years' Standing (?), Novice.—See indices to back vols.

J. F., W. M. N.—Your queries are advts.

A Reader of the English Mechanic, G. F. H., Charles L. Heth, L. H., L'pool, F. J. O'Connor, Novus Homo, Perdu, Smada, J. F. E., and others have replied to queries already similarly answered.

Douglass's Railway Coupling.—We have received the following description of the coupling alluded to in our "Scientific News," on p. 137. It is made by Messrs. Douglass, of Blaydon-on-Tyne:—Douglass's patent railway coupling consists in forging a loop or bridge across the end link of the present coupling chain at about two-thirds its length from the front, and a pole with a socket on the end. The object of the invention is to avoid the necessity of the shunter going between the trucks to couple or uncouple them, obviating all danger of his being killed or lamed. To uncouple, the shunter places the pole with the pin near the pole end inserted in the bridge of the link, and, using the buffer rod of the waggon as a fulcrum, he lifts the centre chain off the hook; then with a slight twist of the wrist the end link is tilted over and placed on the centre hook of its own waggon, or allowed to hang down. To couple, the shunter places the pole in the same position as before described, except at a greater inclination; then, drawing the pole slightly towards him, he raises the chain, and places it on the hook of the adjoining waggon. Or, what is easier, when the chain is hanging up on its own centre hook, the pole end may be inserted, as before, into the bridge of the link, the chain taken off its own hook and placed on the hook of the adjoining waggon.

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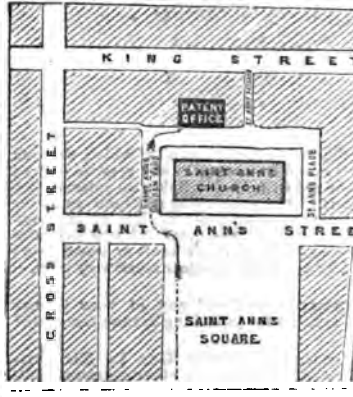

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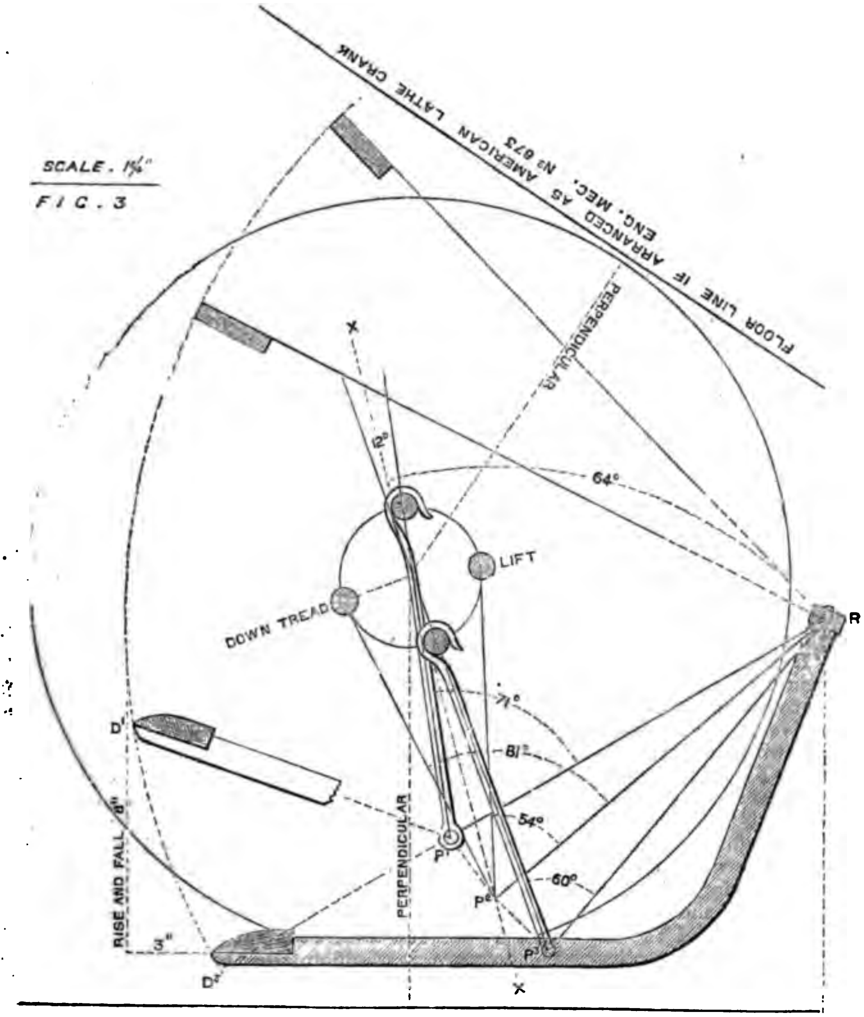
ARTICLES.

LATHE FLYWHEEL AND TREADLE.—III.

FIG. 3 shows the form given to the treadle in my own case. But this is, to a certain extent, a matter of fancy so long as its bend will cover the three points —R, P³, and D²—in their relative positions. The triangle—R, P¹, P², P³—is put in to show the angular relation which the pitman (or link) will occupy, in its rise and fall with the rotation of the crank, towards R, the fulcrum of the lever; and also to illustrate the principle on which this high hanging may be used to obtain some gain on the dead points. As this is the proposed object of the "American Lathe-crank" (ENGLISH MECHANIC, No. 673, 69) on which I propose to make a few remarks by-and-by, another treadle-arm is carried out above (on the two extreme positions of its oscillation) from the same rocking centre, R. If the reader will turn 3 round until the "Floor line of American Lathe-crank" is made the horizontal line instead of the other; and can dismiss from his mind's eye the existence of the other treadle—R, P³, D; and can regard R P³ and R P¹ as representing the extreme positions of the link arm of the American crank; and can imagine the pitman, with its hook, to be a link attached to the crank-pin by a collar instead; then it will at once become apparent that any gain upon the dead points obtained with the bell-crank form of treadle is equally obtainable with the very much simpler form of treadle now recommended. The only practical difference is, that, whereas the high hanging necessitates the forward fall of the foot (as shown by the dotted arc struck with R D³ as the radius), the bell-crank form of treadle may be hung and bent to bring out the foot-board to any part of the arc, and so to place the rise and fall of foot in any direction that may be desired. In Fig. 3 this rise and fall is made vertical for the bell-crank treadle, while it is necessarily oblique for the other. Having explained my own reasons for preferring the oblique forward fall, no more need be said on that point. But it may be worth while to point out here that—*cæteris paribus*—the oblique fall saves a trifle in knee-action. Thus in Fig. 3 the length of both treadles from R being equal, and all the other proportions being common to the two cases, it follows that the oscillation of each footboard will also be exactly the same on the dotted arc. It is, therefore, obvious that the rise of the oblique fall, with regard to the vertical height, will be somewhat less than that of the other, which oscillates vertically (or, speaking more precisely, in an arc the chord of which is vertical). The difference may, indeed, be far too trifling to notice in a single tread. But, when it is considered that the average rate of ordinary treading ranges from about 50 to 70 a minute, the economy of joint and muscle motion in an hour's work would amount to something worth consideration, even if the saving be only ½in. for each tread. I may here point out that if the footboard be suitably rounded, as at D², it will save some ankle motion, by accommodating itself to the position of the foot as it rises or falls, instead of leaving the foot to accommodate itself to the footboard.



FLOOR LINE FOR ORDINARY TREADLE AND PITMAN.

Having contrasted the relative claims of the two forms of treadle in applying the same principle, it will be well to examine thoroughly the principle itself, so as to estimate the drawbacks, which must limit the extent to which it can be profitably developed under any form of lathe-treadle. That the circle of a crank's revolution may be divided into unequal parts for the action of the treadle is abundantly evident. But any attempt to exaggerate this—say, beyond 10° or 15° gain in the 360°—can only be purchased by one or both of two great sacrifices—viz., loss of leverage on the crank, or great increase in the rise and fall of the foot. The proportions of treadle and crank in Fig. 4 are taken (by proportional compasses) from a scale drawing of my old treadle arrangement, and will, I think, furnish a fair average example of the usual hanging. In Fig. 5, the revolution of the crank and the length of treadle from the rocking centre, R, to the pivot, P¹, is made exactly the same as in Fig. 4, in order to compare on the same diametric line, X X, the action and reaction of crank and treadle on each other in each of the two cases. The same lettering is adopted for the several parts of each figure as that used for Fig. 3, so that the identity of principle may be more readily recognised under the three several forms. If it is desired to look at Fig. 5 in a working position, it can be

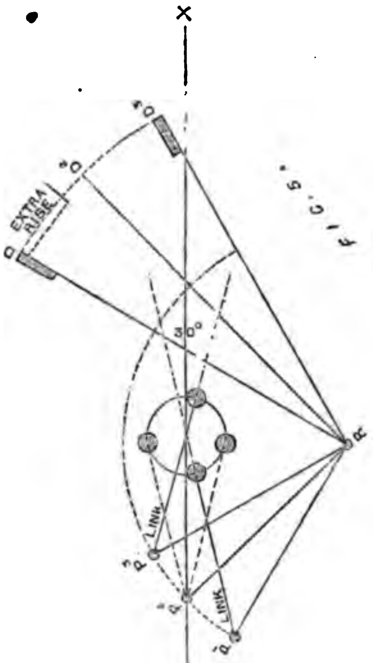


FIG. 5.

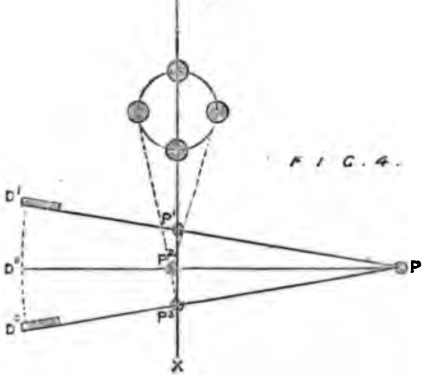


FIG. 4.

turned round until the treadle-arm is in the right place. It is true that the general form and appearance of the bell-crank treadle (Fig. 5) does not exactly conform with the arrangement which would be adopted. But this is unavoidable where the special object is to show, by comparison with Fig. 4, the character and consequences of the changes in the proportions of the parts which would be requisite; and the illustration of the principle at issue is not in any way affected.

Referring now to Fig. 4, it will be observed that the two extreme positions of the pivot of the link P^1 and P^3, and the two dead points of the crank are all on the same line, X X; and that the middle position of the treadle-arm, R, P^2, is at right angles (or perpendicular to) the line, X X, where it furnishes the chord to the arc of the treadle's oscillation. The revolution of the crank is here divided into two equal parts; and it will be obvious that this must always be the case whenever any line, as X X, drawn from the centre of the crank's revolution, will pass through the two extreme points of the pivot's oscillation; and that this must always place the half-rise of the treadle-arm, R, P^2, at right angles to the chord joining P^1 and P^3.

In order to obtain any gain on the dead points, it is therefore necessary to arrange the treadle so that the line of its half-rise *i.e.*, the line, P^2 R, bisecting the angle of its oscillation) shall make an acute angle with any line, X X, passing through the centre of the crank's rotation and the pivot of link, P^2. In Fig. 5, therefore, the link-arm of the bell-crank is so arranged that the bisecting line, P^2 R, shall make an angle of 45° with the line, X X, passing through the centre of the crank's rotation and the point, P^2. But this line cannot now supply the chord to the arc of oscillation, and this will now be *across* X X instead of upon it as before. The result in this particular example will be a gain of about 30° in the 360° in favour of the downward stroke of the treadle. The object of comparing the two arrangements in the same proportions will now be apparent. The gain on the dead points is not very considerable, taken at the most. Yet a comparison of Figs. 4 and 5 will show that this has to be purchased at an increase of nearly one-third in the rise and fall of the foot, and a considerable loss of leverage. For the action of any lever, whether straight or bent, is determined on the same principle of velocity ratio; and this, again, depends not only on the respective lengths of the receiving and operating portions of the lever, but also on the direction in which the power is received and communicated. Now the maximum of leverage, with any given proportions of arm, is obtained when the power is received, and the force communicated in directions perpendicular to the receiving and operating points of the lever (*i.e.*, to the lines joining these points with the fulcrum). It will be seen that this position is more *uniformly* approached in Fig. 4 (where the line, X X, passing through the centre of the crank's rotation, and representing the direction of the link or pitman, is perpendicular to the half-rise of the treadle, or lever), than in Fig 5, where the half-rise of the link-arm is at an acute angle with the line, X X, and where the force has to be communicated by the link in an oblique direction. I have been careful to say that Fig. 4 approaches the most favourable conditions for leverage "more uniformly" than Fig. 5, because this leads up to a question mooted by "J. L." in one of his letters (13971, No. 673), which I suspect has more to do with the advantage afforded by arranging the treadle for gain on dead points than anything directly derived from that gain itself. But in order to show that loss of leverage is a necessary condition of this arrangement, if carried to excess, from more causes than one, it will be well to point out, before going any further, that the extra rise and fall of the foot which it entails can only be got rid of by lengthening the link-arm from R to P^1, or, in other words, by lessening the velocity ratio in favour of the foot and reducing this more nearly to equipoise. Thus, loss of leverage from this cause alone, independent of the more oblique direction in which the link must act upon the crank in certain parts of the revolution, would seem to be an essential condition of any arrangement aiming at gain on the dead points; and the analysis of proportions in every drawing of a bell-crank treadle which I have seen tends to confirm this view of the case. It would perhaps be difficult to find a better illustration of this than that supplied unintentionally by "Dyke" in his two figures in 13969, No. 673. Fig 1, used to illustrate the principle of the bell-crank's intended action, is correct so far as the upright link-arm is concerned, but breaks down entirely in dealing with the lower or treadle-arm. The rock on which this figure is wrecked is to be found in the paragraph commencing "Let H M be the length of the treadle" (*vide* 23rd line from bottom of middle column, p. 552), where the writer assumes that the oscillation of the treadle-arm may be regulated by "convenience," and without reference to the oscillation of the link-arm acting on the crank. When one spoke of a wheel can be moved through any given space without moving each of the other spokes through exactly the same space, then "Dyke's" rule may be right. Until then the oscillation which the treadle-arm *must* make when that of the link-arm has been first determined (as in "Dyke's" Fig. 1), may perhaps be best ascertained by placing the compasses on H (the rocking-shaft centre) as a centre, and striking a circle cutting the oscillation of the link-arm and the treadle-arm. Whatever the chord of the oscillation may be for the one arm, must give the oscillation of any point in the other, oscillating on the same circle. Tested in this way, "Dyke's" convenient rise and fall of 7in. would (judging from Fig. 1) develop itself into about double. Nor is Fig. 2 less instructive in its way; for, this being a scale drawing, the treadle difficulty suppressed in Fig. 1 asserts itself by depriving the link-arm of nearly all the gain on dead points, which this form proposes to secure, as well as reducing the leverage to little more than the width of the footboard. If the scale drawing, Fig. 2, is correct, reference to this will show that the angle made by the bisection of the link-arm's oscillation, with a line drawn through the centre of the crank's rotation and the pivot of the link, is not more acute than about 75°, and that this does not give a gain of more than about 5° on the dead points. In short, the practical difficulty of arranging for the "convenient" rise and fall of the treadle in Fig. 2 has almost eliminated every trace of the principle which it is specially designed to carry out.

Yet all my own experiments have tended to prove that there is an advantage in adopting an arrangement which will secure *some* gain on the dead points. Much as the power of my wheel was improved by the adjustments for the weight alone, as illustrated in Fig. 2, there was still a perceptible improvement on this after placing the line, R P^2, at an angle of about 64° with the diametric line, X X (vide Fig. 3). As is there shown, this gives only a gain of 12° on the dead points; and as every attempt to force this gain beyond that seemed to deteriorate rather than improve the performance of the wheel, I think the chief source of advantage must be sought in some other cause.

It will be observed [illegible]ough the sharpest upward lift seems t[illegible]ke place at a very unfavourable angle—viz., 54°, yet the full force of the down tread will be felt by the flywheel when the crank and treadle arm are respectively in very favourable positions, which is very nearly what "J. L." suggests in his letter (13971), p. 552, No. 673. It will he seen in Fig. 3 that when the crank pin is at half stroke (down tread) the link is very nearly square with the crank, and at 81° with the treadle arm or operating lever. It is about this point that the pressure of the foot would be in full force, and it seems to me that the impetus to momentum given under such favourable conditions does more than compensate for the apparently unfavourable conditions for the lift, especially when these latter are directly met (on the principle of Fig. 2) by the gravity as well as the centrifugal impetus of the counterpoise in its descent. The virtaal difference between the arrangement of Fig. 3 and the ordinary pattern (Fig. 4), is that the former establishes conditions which favour the down stroke to the prejudice of the return lift, while the latter prejudices the down stroke for the sake of averaging the angular velocities of crank and treadle as nearly as possible for both tread and lift. In Fig. 3 the down tread is always working with link and treadle at an angle of less than 90°, but at the most favourable point places the link very close on this most favourable position with regard to both crank and treadle at the same time. Under the ordinary lever hanging the whole of the down tread is worked at an angle outside 90° (so far as the treadle is concerned); while, at the most favourable point for the crank's action, the link (or pitman) will make an acute angle of about 74° with it, and an obtuse angle of about 106° with the treadle. Thus what is gained for the lift is lost in giving the impetus which is to do the lifting; and my own experiments certainly tend to prove that, *within certain limits*, the other course is the most profitable. It is this limitation which makes it important to decide whether the profit is due to gain on the dead points or to the more favourable position of the link at the most favourable moments of the tread. In the first case the bell-crank form of treadle would be necessary, because, to secure any great gain on dead points by high hanging alone, would make the forward fall of the foot too oblique. But assuming that the merit of the bell-crank treadle lies rather in bringing crank, treadle and link into the most favourable relation for the down tread, and that a moderate amount of forward fall for the foot is advantageous rather than otherwise—then it would appear that the simpler arrangement of Fig. 3 may give every advantage that the bell-crank can claim, and without the same risk of exaggerating the principle beyond the limits exacted by the question of leverage, as illustrated by the comparison of Figs. 4 and 5.

It might seem, at first sight, as is if the best position of crank, treadle, and link for the down stroke might be obtained equally well by simply bringing the pivot of the pitman more forward towards the foot-board. But the very fact that doing so would lessen the rise and fall of the foot, while the revolution of the crank remains the same, shows at once that the effect of this is exactly similar to the effect of lengthening the link-arm of the bell-crank (as explained above)—viz., it reduces the velocity ratio in favour of the foot. So that what is gained in one way would be lost in the other. The high hanging and forward fall of foot avoid this.

To conclude a paper which has far exceeded its intended limits, I will only add that if any one should feel disposed to experiment on this subject, I shall be happy to illustr[illegible]ple and economical means by [illegible] I did so without more derangem[illegible] to the lathe than movable additions to the standards and treadle.

D. H. G.

AMERICAN ACADEMY OF SCIENCES—THE CARBON TELEPHONE.

THE recent meeting of the Academy of Sciences at Washington exhibits the existence of a considerable amount of life and go in the scientific world of America. With an Agassiz, a Henry, a Newcomb, a Marsh, a Dana, a Draper, and many other distinguished men, the United States has for years occupied an honourable place in the scientific world, and, if certain remarkable discoveries have brought American scientists into more prominent notice, we at least shall not begrudge them their well-earned honours. The meeting of the Academy of Sciences, which opened on April 18th, is remarkable for an improved method of ascertaining the velocity of light, and for the experiments relating to the scovery of oxygen in the sun, which were scribed by their respective authors—Pro-ssors Simon Newcomb and Henry Draper. We gave an account of the latter's great scovery on page 625 of Vol. XXV., and we learn that, since the announcement of his discovery, Dr. Draper has added ten nes to the twenty he had previously identi-d as belonging to oxygen. He gave an ccount of some ingenious apparatus he as devised for the better carrying out of s researches, for details of which we must, owever, wait. A description of one of hem will be looked for with considerable terest, as by its means the light of an candescent substance, the spectrum of hich is required for purposes of compari-n, can be controlled and intensified. The paratus has been named the "spark pressor." Prof. Draper reports that he s searched for other metalloids in the sun, d though he has obtained encouraging ults as to carbon, leading to a belief in presence, he is obliged to express con-erable doubt, at present, as to the exis-ce of sulphur in the sun. A careful ies of experiments indicate that oxygen not to be detected in the chromosphere, t gas having never been found above the el of the photosphere. Prof. Newcomb gested the employment of an improved hod of measuring the velocity of light a means of determining the distance of sun. There is reason to believe that n all the observations of the late transit Venus, both British and foreign, have n collated and properly reduced the re-lts will show at least as much divergence those already published. Indeed, it is impossible that the photographs will ntually be discarded as practically useless not misleading. Under these circum-nces Prof. Newcomb has issued what is ality an appeal to the United States ernment for the requisite funds to carry a series of experiments which he ieves will enable the velocity of light to determined with an accuracy at present ttained, and which will consequently ish the means for calculating the nce of the sun with a liability to error h less than that appertaining of neces-y to the transit of Venus method. The gement employed by Foucault is as known as that of Fizeau, both being trated in the textbooks on light. The ed-wheel method of measuring the ity of light, however ingenious it may scarcely capable of giving an accurate t, and an error of a few miles in the ity per second becomes a serious when multiplied by the time re-d to traverse upwards of 90 millions of Accordingly, it is by a modification ault's arrangement that Prof. Newcomb has sought to obtain the required degree of accuracy, and, from a few preliminary experiments carried out at Washington, he has satisfied himself as to the feasibility of the plan. A pencil of light is sent from a rapidly revolving mirror to a concave mirror, and, in order to catch the whole of the return ray, a second telescope is to be used. An electric light shining through a slit in the focus of the other telescope will furnish the sending ray. The results obtained at Washington with an 8in. mirror over a distance of 7,000ft. gave promise of future success, and, as the mirror may be made to revolve in opposite directions, a displacement amounting to two-thirds of a degree is produced, which would enable the velocity to be calculated within an error of a 2,000th part. Prof. Newcomb mentioned that an officer in the United States Navy had devised a new method of sending light from one mirror to another and receiving it back again on the revolving mirror, but at the time he had not been furnished with any particulars. There is little doubt, however, that the American Academy will induce Congress to furnish the requisite funds to carry out the experiment on a useful scale, and, if so, we may possibly find ourselves indebted to the Americans for an important factor in our Nautical Almanac calculations.

Mr. Edison's carbon telephone was, however, the greatest attraction at the meeting. That gentleman discovered that certain kinds of carbon are susceptible to great changes in electrical conductivity when subjected to pressure, and accordingly he conceived the idea of utilising that property for telegraphic purposes. A button of sensitive carbon (we presume all carbon is not sensitive) is placed between two pieces of platinum, the under-piece being connected to a telegraph wire and a small battery, while the upper is also connected to the battery and to the diaphragm of the telephone in such a way that the pressure of the sound waves is transmitted to the upper piece of platinum, which consequently affects the conducting power of the carbon. But Mr. Edison's improved telephone was scarcely born before it was eclipsed by the discoveries of Prof. Hughes, which, so far, are the most remarkable phenomena in connection with telephony. The most extraordinary apparatus exhibited by him is in reality so rough that it raises a smile from those accustomed to finish and polish in scientific instruments, and yet it is so excessively sensitive that it takes up and transmits the slightest whisper. Two small blocks of gas carbon have small cups scooped in them, and are attached to a thin piece of pine. The latter is glued to a piece of thick wood forming a base-board in such a way that an end view presents the shape of the letter L. A small stick of gas-carbon (such as is used in the electric lamp), pointed at each end, is supported by the blocks of carbon, the points resting in the cups. Wires enter through the back of the soundboard into the carbon blocks which are thus connected, the one with a battery, the other with a line-wire. A Bell's telephone, at the other end of the circuit, is connected with the line-wire and the battery—and that is all. At the time of writing, this instrument has only been constructed in the roughest manner, and yet so sensitive is it that the stroke of a feather on the base-board becomes audible to the listener at the telephone miles away. Speech is transmitted with wonderful power and distinctness, and soft sounds are converted into loud noises. A glass tube filled with "white silver powder" (tin and zinc), and stopped at each end with carbon plugs pressing on the powder is capable, when laid over a resonating box (any thin wood construction with five sides) of becoming a very sensitive receiver in connection with an articulating telephone. The discovery is of the first importance in connection with telegraphy, and those who declined to adopt the Bell telephone in its simplicity will doubtless lay claim to a prevision they never possessed. We shall, probably, give a more lengthy description of the experiments next week. In another column we publish the paper on sonorous vibrations read by Prof. Hughes at the Royal Society, for an early copy of which we are indebted to the author.

THE EDINBURGH ASTRONOMICAL OBSERVATIONS.*

IF, as has been said, a good man struggling against adversity is a sight for gods and men, the Astronomer Royal for Scotland may well excite the interest of both these orders of being. Presiding over an observatory which is but poorly paid, and miserably undermanned; and which, moreover, possesses nothing in the shape of instruments beyond an 8-foot Transit instrument, and a 6-foot Mural Circle (both "very antiquated and frail"), he has produced a volume of observations which, for beauty of typography and illustration, and, in some respects, for scientific value, is unsurpassed by anything which we have previously seen of a similar character.

The first part of this really remarkable book consists of a catalogue of 641 stars comprised between 0h. and 4h. of Right Ascension, a page being devoted to each object. The arrangement of this possesses a certain amount of novelty. The first column contains merely the number of the star; the next its history, and, if a double star, measures of the distance and position of its components from the *Cycle* of Admiral Smyth, or from Struve. We venture to think, though, that Professor Piazzi Smyth might have made more judicious selection of his authorities for some of the statements which he here gives. He employs as one of them, for example, rather too frequently, a mad little pamphlet called "Mazzaroth;" while, on p. 593, we have a reproduction of Mädler's hypothesis that η Tauri is the central sun about which our sidereal universe is revolving; although it is now wholly exploded, and known to be absolutely untenable. The remainder of each page is occupied with the details of the co-ordinates of R. A. and N. P. D. of the star to which it is devoted; and here a feature is introduced which seems both novel and valuable. It is a series of blank spaces for the insertion of observations made elsewhere, the object being to clear up the *vexata quæstio* of discrepancies in the calculated proper motions of many of the stars described. With reference to this, however, we would just say that proper motions computed from observations with a transit instrument, which the mere heat of the lamp illuminating its wires caused to "swerve" wildly, must be received with a certain amount of caution; and, in the next place, remark that Professor Smyth seems curiously to ignore the fact that the proper motions of the B. A. C., nay, even a considerable number of its mean places at its epoch (to say nothing of its star-magnitudes), are now, and have been for some time, considered as perfectly untrustworthy. A really good star-catalogue is one of the astronomical desiderata of the present day; and one to which, we would suggest, that the Royal Astronomical Society might not unprofitably devote a portion of its funds.

Following the Star Catalogue, of which we have thus briefly spoken, is a series of observations of terrestrial temperature made with the earth thermometers, which were broken by a mad sailor in September,

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* Edinburgh Astronomical Observations. Vol. XIV., 1870-1877. Star Catalogue, O,H—3,H.

1876; but no special reference is made to them here.

The succeeding part of the volume is, however, of very great scientific interest; consisting, as it does, of a most elaborately illustrated record of a mass of Spectroscopic Observations of the red end of the spectrum, and of the spectra of the zodiacal light, the aurora, &c. In addition to numerous splendid maps, illustrating the effects of various meteorological conditions upon the lines and bands in spectrum, there are some beautiful and artistic chromo-lithographic views of the zodiacal light, the aurora, twilight, varieties of daylight, &c., which add materially to the interest of the charts of the spectroscopic results obtained under the conditions which they illustrate.

Taken altogether, this sumptuous volume must form an enduring monument of the wonderful industry and capacity to overcome obstacles of the Director of the Edinburgh Observatory; and can scarcely fail to induce a hope that he may speedily be supplied with instruments more worthy of him, and the institution over which he presides, than those that he now possesses.

THE LATHE.—IV.

By FRED. HOFFMANN, Engineer.

A SIMILAR method for finding whether one part of a slide-rest is at right angles to another is often made use of by fastening a bent scriber into a rod. The saddle (Fig. 1) of a lathe not being at right angles to the bed, to a great extent spoils the lathe, which cannot be said to be the case with centres not opposite, or lathe spindle not true, as these can be rectified and packed. A common notion is to suppose that a lathe spindle must be true in every way, and more especially be in a line with the bed. If we suppose the spindle not to shake in its bearings, any work fastened to it must describe a circle round some centre, and the fact of the lathe-spindle not being in a line with the bed has merely the same effect as if the spindle was parallel to the bed and the slide-rest crooked. In turning or sliding up a shaft or spindle (Fig. 2) it will be seen that the spindle moves round freely between the two centres, and on a centre line formed by joining these two points, irrespective of the truth of either movable or fixed headstock. It is, on the other hand, of the utmost importance that the movable headstock should be in a line with the bed, because the rest may be set parallel, and turn a long spindle parallel, and then when the centre is screwed out perhaps turn the shorter spindle taper (Fig. 3). It is also of the greatest importance to have the two centres the same height above the bed, as though it would be immaterial if they were not, in turning short spindles where the top rest can be adjustable, yet it is all-important in sliding shafts of any considerable length. Perhaps one of the most important things in designing a lathe is to make the pulleys wide enough for a good broad belt. It is not necessary to have a quantity of pulleys on the cone, if there is a back gear and overhead gear. As a general rule lathes are made to run too slow. There are so many ways of gearing up wheels for screw-cutting that it would not be of much use if I were give a table; any one can set the wheels if they recollect that the speed of wheels is inversely proportional to their respective diameters,* and that the speed of leading screw should be to speed of lathe spindle as the number of threads in the leading screw is to the number of threads in the screw to be cut. The following is the reason of cutting a false thread:—Suppose our leading screw to be four threads to the inch, and that we have struck out a screw of, say, six threads, and taken off our tool, and moved back the saddle to the beginning; now it will not do to lock the saddle anywhere on the leading screw. Four threads of the leading screw correspond to six threads on the spindle, and if the saddle was locked in successive inches along the leading screw no harm would be done, or even in successive half inches; but as each single thread (Fig. 4) on the leading screw in this particular case corresponds to one
threads on the spindle, it will be s
moving the saddle ¼in. or one thre
and locking it there, we come exact
of the screw that is being cut.
plainly (Fig. 5) the necessity of a
locking nut, and one that slides up
without any side play. The han
locking nut should have a counte
prevent it falling into gear by mis
lock nut is generally moved up an
means of two pins, fastened one in
of the nut, which are lifted by curv
the plate of the locking handle. I
have the handle plate and counter
any) in one piece, as trouble is often
the handle coming unscrewed. It
practice to have too many threads i
ing nut, and care should be taken th
halves meet properly. Every facilit
given for oiling the screw-cutting g
lathe has always a great deal to do
and moving the saddle. The lead
should have no back-lash whatever
and should be adjustable at the fa
couple of locking nuts or any simil
Another thing is not to have the lea
too far below the lathe bed; in fact,
has his leading screw symmetrical wi
to the saddle, and running down the
the bed. The position of the leadin
however, oftener considered with reg
change wheels. In some lathes, in o
a left-handed thread, an extra whee
put in the gearing to reverse the m
the best way, where it can be done,
an intermediate gearing at the end o
spindle similar to that used by most
reversing their saddle-feed shaft (Fi

FIG. 1.

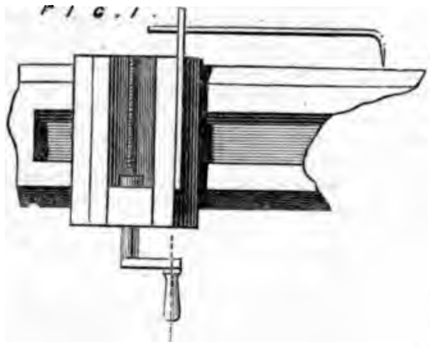


FIG. 2.

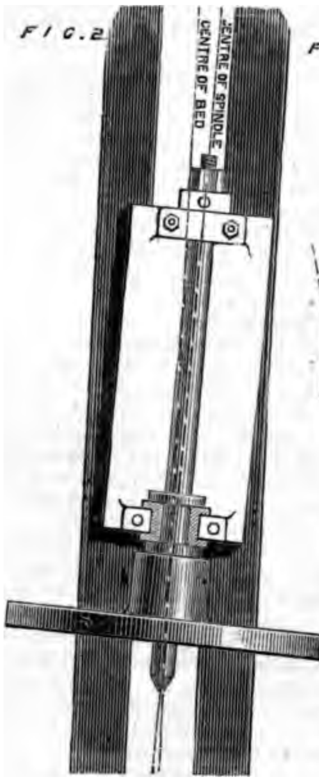


FIG. 3.

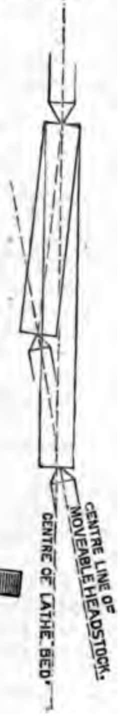


FIG. 4.

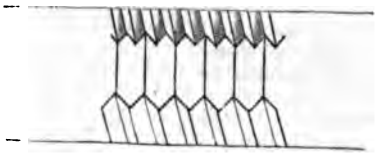


FIG. 5.

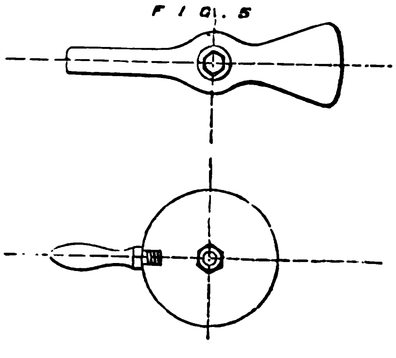
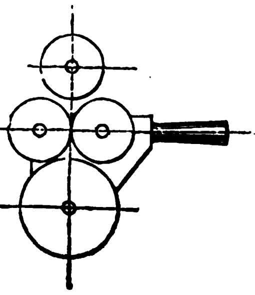


FIG. 6.



(To be continued.)

TOUGHENING AND ANNEA GLASS.

TWO methods of toughening glass
introduced to public notice w
last few years, with large promises
future; but at present the glass so t
has not reached a very extended sal
some cases it has earned an unenviab
ter by spontaneously exploding wit
apparent cause. A beaker or tumble
merely crack and fall into two or thr
but the glass literally explodes, cru
small fragments and dust. A m
toughening that is equivalent to stren
glass, and rendering it better able
blows, is, however, so valuable an
that, even if accompanied by a liabili
part of some pieces to break spontan
cannot fail to find a wide field of u
Besides a method of toughening glass,
what is required is some process
render glass proof against accide
changes of temperature. Lamp chim
instance, unless carefully annealed, cr
in a most unaccountable manner, a
many lamps are employed they cons
form a serious item of annual expense.
genious, and we believe novel, pr
annealing glass, even that known as
has been recently invented by Baron A
M. J. M. A. Weyer, of Paris. It co
burying the articles to be annealed in p
stone, plaster, lime, fire-clay, &c., or i
oil, the melted nitrates of potash and
fact, any liquid or solid capable of recei
required heat and remaining in a c
suitable for the process. By this mea
articles are not only rendered more ca
sustaining sudden transitions of tem
but they are also strengthened to a
able degree. For instance, champagn
made by the processes at present in v
unable to sustain a higher pressure
atmospheres, but, when annealed by
method, they will withstand 50 atmo
Similarly lamp chimneys may, when
heated, be plunged into cold water wit
danger of cracking. The method of im
the articles in powder renders it po
anneal at a very high temperature,
impossible unless some means are prov
supporting the articles and maintaini
shape when reduced to the softene
necessary to secure perfect annealing.

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* Willis's "Principles of Mechanism," page 21.

rocess the articles are filled with the
ed stone or other substance, and are
laced in crucibles and completely sur-
d with the pulverised substance em-
being covered to a depth of at least
'he crucibles are then subjected to a heat
lly increasing to 800° C., or even to
:., in a suitable oven for from four to
rs, and are then slowly cooled, the opera-
ting for 24 hours when the articles are
Where there is little danger of spoiling
pe of the articles the method of anneal-
ase of liquids gives similar results more
and at less cost. In carrying out this
two boilers are employed, so placed that
iid can be run from the upper into the
If nitrate of soda is employed the tem-
e will be over 260° C. before the salt is
and the articles are then immersed in
l state, and the temperature raised in
ie to 800° C., the highest degree possible
:rate of soda. They are then allowed to
owly, and when the temperature ap-
s 260° C., or solidification point, the
is run off into the lower boiler, and a
ire is maintained beneath the upper
o prevent the too rapid cooling of the
By this means the articles are perfectly
d without injury to the surface or the

ABLOCHKOFF'S METHOD OF ELECTRIC LIGHTING.

method of splitting up the electric
irrent so as to supply a number of
ating apparatus from the one source,
y published by M. Jablochkoff, com-
also a method of strengthening the
s by means of atmospheric electricity.
r to obtain useful results from a current
ling from a source of dynamic electricity,
of operating directly with the currents
tofore, M. Jablochkoff, according to his
invention, causes the same to undergo
e transformation by first converting the
c electricity into statical electricity, and
converting it into dynamic electricity,
s by means of the latter current that
ins useful results. For the above pur-
stead of closing the circuit of a source
tricity by means of a continuous con-
he unites the conductor coming from
he poles of the electrical source with
he armatures of a condenser, composed
or more Leyden jars of large surface,
tructed of layers of metal and insulating

other conductor is connected in various
f which the principal ones are shown in
companying drawings. At Fig. 1, the
ductor, G, proceeding from a magneto-
machine, M (giving alternating
s), is connected with the interior sur-
several Leyden jars, B B, or of the con-
C. The outer armatures of these con-
are connected to one of the charcoal
D, of the electric candle, or with one of
s of the slab of kaolin, E. The other
l point, or the other end of the kaolin
connected to the second conductor, H,
electric machine. At Fig. 2, the two
ors, G H, proceeding from a magneto-
machine, with alternating currents,
nected to the inner surfaces of the con-
, B B, C C. The outer armatures of
conductors are connected with the
us for producing light, of which the
charcoal point, D, or the other end of
lin slab, E, is connected with earth. At
the two conductors proceeding from the
chine are connected with the interior
res of the condensers. The outer
res, at the left hand of the machine, M,
nected with earth, while at the right
hey are connected to pointed prongs
allow more readily the escape of the
ity into the air. In this case the
ating apparatus is placed between the
ad outer armatures. The interposition
ondensers allows the current to be dis-
l in several directions, and it also has
ect of developing atmospheric electricity
accumulating it in the condensers from
t is directed in the form of currents to
minating apparatus. The total quantity
tricity supplied to these apparatus is therefore greater than that supplied by the primitive current, and consequently produces a stronger light than that which the latter would give if led directly to the illuminating apparatus. It will be evident that this electricity can, according as may be required, be supplied either in quantity or in tension. Instead of Leyden jars it is more convenient to use as condensers those made up of plates or layers of metal, separated by insulating slabs, the metal plates, Nos. 1, 3, 5, &c., and Nos. 2, 4, 6, &c., being respectively connected with each other. Each set of plates acts as one of the armatures of the Leyden jars. For obtaining greater tension the insulating layers are constructed of a number of alternate insulating and conducting leaves or plates which are not in contact with one another. The form of the condensers may, of course, be varied, and several may be connected in quantity or in tension.

FIG. 1

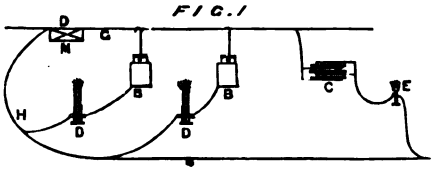


FIG. 2

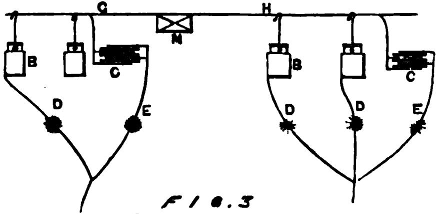
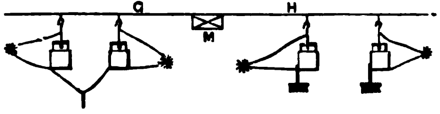


FIG. 3



THE ORGAN: A COMPREHENSIVE TREATISE ON ITS MANUFACTURE, PROCURAL, AND LODGMENT.*

By John Watson Warman,

Associate of the College of Organists, London.

PART I.—GENERAL TREATMENT IN MANUFACTURE.

o. *Three Mans., one a Solo.* When these are the manual sections it may be laid down that as many as three pressures will be *necessary.* Tubas must have a strong pressure or they lose their very nature; a Pneumatic is now practically indispensable; and this ought to be independent of Tubas and regular Manual work. It is not advised to use more than three pressures, as the *complete* Instrument, as just said, must have four Mans.

See also Borrowings (26, e., to end).

p. *Four Mans.* At least three winds become now a matter of course; as Organ enlarges use more pressures, according to circumstances.

See also Borrowings (26, e., to end).

q. *Ped. on Separate wind.* This has been reserved to be fully treated of here, because, if it be observed, it practically amounts in many cases to an increase in number of Bellows, if not of Pressures. It is hardly worth while to increase the one without the other, and it is evident that the Ped. wind will not, as a rule, serve Tubas or Pneumatic, or even Solo; therefore, as just said, it practically amounts to an increase in number; or else imposes, as will be seen by the foregoing economic Instances, a most mischievous and vexatious fetter on the Apportionment.

r. How the notion first came about that the allowing the Ped. and Mans. to draw from the same Bellows practically perils the steadiness of the Manual speech I cannot certainly imagine. I have little doubt, however, that it did so merely, as it were, by analogy; it seemed natural that the sudden opening of a large valve should peril the articulation of a delicate Pipe of much smaller size sounding with it. The first, so far as present writer knows, to put the idea into print was Mr. Hopkins, *see* par. 1,178 of his "Organ," 1st edit.; and again still more strongly in the 2nd edition, in describing Lewis's Organ for St. Mary's, Newcastle-on-Tyne (*see* Lewis's "Organ Building," page 46). Mr. Lewis himself has evidently fallen under the same notion by his treatment of the Wind-supply of that Instrument; also of that which stood for some time in the Hanover-square Rooms, and is now (1877) at St. James's, Westmoreland-street, Marylebone. This latter is also alluded to, in respect of the wind arrangement, by Hopkins, in his description (2nd edit.), and quoted by Mr. Lewis at page 41 of before-mentioned work.

s. The simple facts of the case are these: every pipe sounded or introduced during the actual speaking of any other pipe supplied from the same wind does really and necessarily affect the speech of the latter: a moment's consideration will show that this is, as a simple fact, inevitable; a portion of the wind passing to Pipe No. 1 will most indubitably be drawn away to assist in filling the vent furnished by the opening of the Pallet to Pipe No. 2. The diversion of the wind may not continue more than a second, neither need it be of sufficient amount to be practically of any moment whatever; but, as just said, exist it will, and it was primarily to remedy this, and *not* any unsteadiness in supply (which may be corrected by *other means*), that that most valuable, most effective, and most simple contrivance, the Concussion Bellows, was devised by Mr. Bishop; and for which he, considering that it was never in any way protected, and is at the present moment introduced as a matter of course in almost every really good Instrument, seems to the present writer to have received very scant justice.

t. In this instability or *diversion* of wind the Pedal Organ, having the largest Pipes has naturally been regarded as the chief source of anxiety; hence the partition or Apportioning of wind, as just alluded to. The idea, however, is an erroneous one, as a few words will demonstrate. The Pipes composing the Pedale are, it is true, of large size, and the valves that supply them necessarily of corresponding proportions, and when a large Pipe is touched there *is* a sudden large draft upon the Bellows and all other Wind-chests in connection with it: but the evil effect to the Manuals is met by three corrective influences; 1, The necessity of the Manual utterances being proportioned to that of the Pedale; 2, the intervention between Man. and Ped. Chests of an elastic column of wind, to say nothing of that in the Bellows themselves; 3, by the Concussion Bellows.

u. No. 1 acts as an important safeguard; thus, suppose the Ped. Open be drawn, it will necessitate the use of a corresponding amount of Manual tone—say, at least three Stops. We will imagine the common chord of C to be put down on the Man., and the bottom C of the Ped. Open touched staccato; now, supposing only the Dulciana drawn on the Man., there *might* be a tremulousness, for there is but a small quantity of Manual wind passing, and the diversion or appropriation by the Ped. *may* amount to sufficient to practically affect; but suppose the Flute and Clarabella also drawn, then there will be at least three times the Manual wind then passing, yet the abstraction from it by the Pedal will be *actually* the same, and consequently *proportionally* much less. As a homely illustration, consider that the loss of one pea from a dozen would be very difficult to detect at a glance; the loss of one out of four will be a very different matter.

v. No. 2 is a very important point; short trunks are by many believed to be essential; I trust before this *Department* is finished to show conclusively that they are in many cases rather mischievous than otherwise. A moment's consideration will show that to interpose between the Bellows and the Pallet an elastic column or spring to receive and deaden any too violent impulses *to* or drafts *on* the former is a matter of simple common sense, and its value here will be demonstrated beyond the shadow of a doubt by a simple experiment to be directly noticed.

w. No. 3 requires no enlargement upon here; it is enough to state that, when properly made and placed, it *perfectly compensates* any sudden brief draught made on the Chest to which applied.

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* All rights reserved.

x. The experiment is this: take any Instrument that contains an Open Diap. only on the Ped., and has also Concussion Bellows so placed as to be visible to player (if attached to under side of Wind-chest the removal of Bookboard will naturally give a view); now draw the Dulciana of the Soundboard to which the visible Concussion Bellows is attached, draw also the Ped. Open Diap.; put down any chord with the hand—say, C—then touch the bottom C of the Ped.; the Con. bellows will be seen at every sounding of the Ped. C to collapse about ½in. Now remove the foot, and put down with the right hand any ordinary harmony—say, C; then, without taking up the right hand, strike the full common chord at or near the bottom of the Manual, and it will be seen that the Con. bellows now oscillate to the extent of 1in.—that is, *double* that which they did before. If the Con.-bellows be properly constructed, no unsteadiness will be perceptible in either case.

y. It may perhaps be objected that this is not a fair test, for with a larger Pedale would come a larger Pallet for it, and this, even although but one Ped. Register out, would cause on the first opening a larger draught or diversion of wind. This is perfectly true, but then it must be remembered that, on the other hand, the test is more severe than would be the case in actual use. The putting down of a full staccato chord with the left hand might be done at any time; but the use of the Ped. Open, with nothing more than Dulciana drawn, is totally out of question, except on some wholly exceptional occasion. Then, again, it must be borne in mind that as the Pedale enlarges, its Pallets should increase in *number*, the other one being on another pressure (*see* Instances, back, comm. at 10, w.) consequently cut off from the Manual Chest under consideration. Thirdly, if Disc or Puppet Pallets be used for Pedale, no *increase* of *chance* of unsteadiness can possibly arise, for there will, of course, be in all cases only just the proper amount of wind passing which the Pipe in use actually requires.

z. From the foregoing we may safely conclude the following:—

1. That with proper treatment, and use of Concussion bellows no unsteadiness of wind from one Pipe diverting from another need be in the least degree apprehended.

2. That *whatever* risk of this nature exists from the Ped. drawing from the Manual, exists *twofold* in the case of the lower half of the Manual drawing from the upper.

3. That the presence of a sufficiently long Wind-trunk is a most valuable aid in preventing unsteadiness. The wind admitted to the C C C Ped. Open may be considered fully equal in amount to that used by the Dulciana common chord; and, the pressure being the same, it must follow that it is *only* the interposition of the elastic column that prevents the sudden draught of the single note disturbing the Concussion bellows as much as the full chord of the Dulciana. This is more gone into under own *Depart.* of Wind-trunks.

[13, a.] I have dwelt at such length on this point because it is one which, as already stated, much affects the fundamental set out of the Instrument. If it could be demonstrated that there is any real necessity for separating the Ped. wind from that of the Manual a very important and, at the same time, harassing restriction would at once be imposed on the apportionment of pressures, and one which must in many cases practically result in necessity for increase in their number. The foregoing simple experiment will, however, be quite conclusive, and I must say I cannot help wondering that the notion should ever have obtained serious consideration from practical men. That Mr. Hopkins, whose structural and physical knowledge is by no means of the profoundest (*see Deps.* of Soundboard-grooves and Wind-trunks), should have entertained the idea is not at all to be wondered at; but that Mr. Lewis, an actual builder, should do so is quite a different matter, and shows conclusively how one really able to turn out a respectable instrument may nevertheless be a careless researcher on an important point.

* Choice of Actual Pressure.

b. The determination of the exact Pressure is not *fully* gone into here for the simple reason that it need not, so long as the apportionment and relative strengths have been decided on, much affect the laying out, and, in fact, is frequently modified after Organ is actually going. It must also be understood that very many and very diverse opinions prevail on this question, some builders advocating low pressures and large scales (as Mr. C. K. Bishop, page 2 of his work on the Organ), others smaller scales and heavier pressures (as Hopkins, *see* par. 1,191, 1st edit.). The carrying quality, which it is generally understood as the express aim of heavier pressures to produce, is distinctly asserted by the first-named author to be better achieved by a large scale and light pressure.

c. That this latter view is erroneous there can, I think, be no doubt. What is it, for instance, that enables a railway whistle to be heard so far a distance? What is it that gives the Cathedral Tuba such lightning-like play throughout the whole building?

d. The truth really is that any antagonism here is profitless and mistaken; a *truly* complete Organ demands a use of *various pressures* as of *various scales*, and this is the view that will be steadily adhered to throughout the present work.

(*To be continued.*)

POLARISATION BY REFRACTION; ALSO OTHER SPECIAL FORMS OF OBLIQUE ILLUMINATION.*

By L. R. Peet.

ONE evening, a little over a year ago, I was sitting at my instrument, examining a slide of miscellaneous fossil objects, *Actinocycli*, *Heliopeltæ*, *Coscinodisci*, &c. Having used the direct pencil for some time, and perceiving that the charm of that kind of contemplation was waning, it occurred to me to see how my knowledge might be increased by intentional and very careful casting of shadows from the neat little prominences into the smooth valleys below. I soon found my interest in the particular group of diatoms in the field so enhanced that I addressed myself in earnest to the shadow-casting, and kept it up for two or three hours—first from the right, then from the upper, or, so to speak, north side; afterwards from the lower; finally from the left, or side towards the lamp.

The left-hand effects proved much the best, and I became so intent upon my occupation, holding the mirror constantly in both hands, that I lost perfect control of my muscles, and one of those ill-timed, quite undesigned jerks, which at critical moments do damage, and are sometimes emphatically rebuked, carried the mirror so far to the left as to leave the field entirely dark. A long breath was drawn, the hands rubbed together, and the mirror grasped again. The next instant a similar unpremeditated twitch of muscle ensued; but, lo! a revelation! Two large *Actinocycli*, in the middle of the field, flashed out with a brilliancy of beauty exceeding any previously impressed upon my retina. It was as if each of those wonderful frustules had been suddenly lighted up at a thousand points by as many minute calcium lights, the colours red, green, and gold, being about equally represented. Floating near—all seemed in a kind of nether midnight sky—one *Heliopelta* showed its slim triangular divisions in alternate green and gold, with a bright yellow rim, and marginal projections, each in three colours. A *Coscinodiscus* on the other side was in pure luminous yellow, with faint green in the centre.

Being of a philosophising turn, I presently waved off the poetical phase of the matter, and asked, Whence this? A confident reply came at once: These objects are made thus beautifully radiant by polarised light. But how such peculiar ether motions got there was not so readily answered—was not, indeed, answered at all for several months.

Ordinary black-ground illumination was a familiar thing, and I at first compared what I had discovered with that. It at once appeared that there was a difference. No mere black-ground illumination ever gave an approach to the brilliancy, and variety, and most delicate distribution of colours shown by the new light. Only the polariscope could do it, and that failed to distribute the colours so minutely. Diffraction was once suggested by an observer; but the idea was put suddenly out of the question by seeing that the ground was entirely black—no hint of tint of any kind—and that all parts of the field were equally illuminated. Furthermore, a change of position in the mirror gave alternation of supplementary colours.

The only explanation which recommended itself, by its plausible aspect, was the following, based upon the discovery of Fresnell: He has demonstrated that light, on passing through a plate of glass, is brought by refraction to the circular stage of polarisation, but that this is done only in case the pencil impinges at the angle of 57° with the surface of the plate. Careful examination showed that the light struck the lower surface of the slide at about that angle. Why should the light, then, not be brought to the circular stage on reaching the upper surface? That would explain the black ground, the circular stage being the same as that shown at the crossing of the tourmaline crystals. A perfect result of this kind would depend upon the perfect homogeneousness of the structure of the glass. A slide of inferior quality, especially having twists in its internal structure, renders a good black ground impossible. A persistent, vague illumination, sometimes from no particular point, at others quite manifestly from right or left, or some other point, spoils the field. If the slide be of good quality, this never occurs. The black ground comes over the field with a sharply defined front, and however the slide may be moved about, the perfect absence of light continues.

Of course the main body of the pencil must be excluded from the object-glass. Only the thinnest possible shaving, as it were, is taken, and that from the side nearest the lamp, so as wholly to avoid what may be called the crude or unpolarised light.

A small portion of the polarised light passes through the slide; and if there be no object in the field, these ether motions go on up the objective to the eye, making no impression on the optic nerve. There being an analysing object present, the wavelets in whose path it stands, strike it. According to the power of analysis possessed by the object in its external or internal structure, the light is forwarded to the second elliptical stage, in which alone colours are shown. As the object which has the power of analysing, has also the power of polarising, we may, perhaps, suppose that a second polarisation and analysis take place; and this may account for that feature which first strikes the observer familiar with the polariscope—namely, the extraordinary delicacy of distribution of colour. The colours are of every conceivable shade, and being luminous, no shadows are cast, only darker shades of colour are presented. A portion of any part of the surface of the pencil will give similar results; but one from the lamp side gives, as we might *à priori* infer, decidedly more pronounced results, the refraction on that side being more marked.

A description of my way of doing the thing comes properly in here.

The lamp, a strong broad-flamed one, without a screen, and about 13in. high, is placed fourteen or fifteen inches from the instrument, the latter standing at right angles to the former, and to the right hand; to the left would probably answer just as well. A slide of analysing material—of crystal or diatoms—is put on the stage and focussed as usual by direct light. The mirror is then carried slowly to the left, being occasionally depressed by the left hand, so as to keep the field illuminated as long as possible. At the extreme verge the black ground will show itself, passing from the side towards the lamp to the opposide side; and as it goes over the field, the object seems endowed with the power of giving out light of its own. By very careful adjustment of the mirror, this radiation is brought to its maximum, the colours being generally most distinct at that point; yet sometimes they are better shown by slightly subduing the light.

Without a condenser, the effect will be comparatively feeble. This has probably led to the failure of others to make it seem of value. A strong condenser must be applied, after the best result with the mirror alone has been reached. I imagine the shape of the condenser has something to do with the effect. I use a concavo-convex lens (best bull's-eye), so mounted that it can be carried under the diaphragm, and adjusted, concave side up, close to the latter, the largest aperture being employed, adjusting towards the left hand. Besides, the mirror should be capable of easy adjustment in any direction, the concave side being used. My mirror can be lowered, and I always place it at the lowest point on its rod.

A ¼in. objective, with a B ocular, is the best average power, so far as I have observed.

The higher powers shut out too much light, and the lower admit too much—the brilliancy not being favourable to minute scrutiny, however pleasing to the eye. The object must be extremely thin, otherwise the thicker portions will send out a kind of glare, obscuring the parts adjacent. All fossil objects should be mounted in balsam or damar, as well as all cretaceous material. Crystals may be dry; indeed, any medium, except air, so far interferes with them that when it is possible to preserve them dry, they should by all means be thus mounted. Butterfly scales (dry) of all kinds are excellent objects. All parts of insects, which the polariscope transmutes are suited to this light. Living animalcules are wonderfully defined, and often rendered exquisitely beautiful. The hairs of plants—the deutzias, elæagnus, *Solanum mimosum*, and the like—are changed into apparent crystals, gleaming with lustre, and gaining, as every suitable object does, a definition of minutiæ not attainable by any other form of illumination.

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* From the *American Journal of Microscopy.*

It is not improbable that all the conditions of complete success are accidentally present in my instrument; and that with many of a different pattern (this I know to be true of Beck's and Zentmayer's) all the conditions are not found; hence what seems to be a thing of some practical importance will remain unutilised, until instruments are constructed with a view of obtaining the results named. That this can be done is very certain.

As to the value of these results, I will cite the remark of an experienced microscopist, who was at my house a few weeks ago. Said he: "The effects are somewhat different from those of the polariscope; yet, from what I have seen here this evening, I should say the difference is in favour of your form of illumination."

In conclusion, I will mention a form of radiation which I have found very valuable. It occurs just before the black ground makes its appearance. The light at that moment seems to come from above the slide. A very nice adjustment is necessary, in order to get it at its best. The slide takes on the appearance of a buff ground, the objects lying about upon it; and they are so equally illuminated that an almost supernatural distinctness prevails. I get this effect with my highest power (1,200 diameters), and find it very favourable to all kinds of resolution. My strong condenser is always present.

One thing more occurs to me. With a Gundlach ¼in. objective, I am able to polarise all kinds of plant crystals, often with startling beauty, and have the field lighted up at the same time. There is an angle, very difficult to hit, at which the light is put in such a state as to be analysed by crystals of that kind. I think it is about that of 50 from the line prolonged through the axis of the object-glass. That it is not the fault of the objective is shown by the perfect definition, even where the colour is most distinct. I think that if any reader should be sufficiently interested in the foregoing to criticise, and offer some other and better explanation of the phenomena described, the rest of us would be glad to have him do so.

ON THE ACTION OF SONOROUS VIBRATIONS IN VARYING THE FORCE OF AN ELECTRIC CURRENT.*

By Prof. D. E. Hughes.

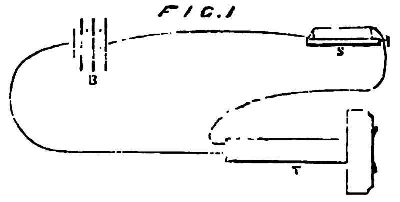
THE introduction of the telephone has tended to develop our knowledge of acoustics with great rapidity. It offers to us an instrument of great delicacy for further research into the mysteries of acoustic phenomena. It detects the presence of currents of electricity that have hitherto only been suspected, and it shows variations in the strengths of currents which no other instrument has ever indicated.

It has led me to investigate the effect of sonorous vibrations upon the electrical behaviour of matter. Willoughby Smith has shown that the resistance of selenium is affected by light, and Börnstein has led me to believe that many other bodies are similarly affected. We know also that the resistance of all metals is materially influenced by heat. Sir William Thomson and others have shown that the resistance to the passage of currents offered by wires is affected by their being placed under strains, and, inasmuch as the conveyance of sonorous vibrations induces rapid variations in the strains at different points of a wire, I believed that the wire would vary in its resistance when it was used to convey sound. To investigate this I made a rough-and-ready telephone, with a small bar magnet 4in. long, half the coil of an ordinary electro-magnet, and a square piece of ferrotype iron, 3in. square, clamped rigidly in front of one pole of the magnet between two pieces of board. When using the pendulum beats of a small French clock, or the voice, as a source of sound, I found this arrangement supplied me with an extremely delicate phonoscope or sound detector.

All the experiments detailed in this paper were made with the simplest possible means, and no apparatus of any kind constructed by a scientific instrument-maker was employed. The battery was a simple Daniell's cell, of Minotto's form, made by using three common tumblers, a spiral piece of copper wire being placed at the bottom of each glass and covered with sulphate of copper, and the glass being then filled with well-moistened clay and water. A piece of zinc as the positive element was placed upon the clay. Insulated wires were attached to each plate, and three of these cells were joined in series. All experiments were made on a closed circuit, the telephone being used as a phonoscope to detect variations in the current and the consequent reproduction of sound. The apparatus, or materials experimented upon, were used in the same way as the transmitter of the speaking telephone of Bell. The sketch (Fig. 1) will make this clear. B is the battery, S the source of sound or material examined, T the telephone or phonoscope.

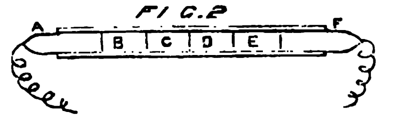
I introduced in the circuit at S a strained conductor—a stretched wire—listening attentively with the telephone to detect any change that might occur when the wire was spoken to or set into transverse vibrations by being plucked aside. Gradually, till the wire broke, the strain was varied, but no effect whatever was remarked except at the moment when the wire broke. The effect was but momentary, but invariably at the moment of breaking a peculiar "rush" or sound was heard. I then sought to imitate the condition of the wire at the moment of rupture by replacing the broken ends and pressing them together with a constant and varying force by the application of weights. It was found that if the broken ends rested upon one another with a slight pressure of not more than one ounce to the square inch on the joints, sounds were distinctly reproduced although the effects were very imperfect.

FIG. 1



It was soon found that it was not at all necessary to join two wires endwise together to reproduce sound, but that any portion of an electric conductor would do so even when fastened to a board or to a table, and no matter how complicated the structure upon this board, or the materials used as a conductor, provided one or more portions of the electrical conductor were separated and only brought into contact by a slight but constant pressure. Thus, if the ends of the wire terminate in two common nails laid side by side, and separated from each other by a slight space, were electrically connected by laying a similar nail between them, sound could be reproduced. The effect was improved by building up the nails log-hut fashion, into a square configuration, using ten or twenty nails. A piece of steel watch chain acted well. Up to this point the sound or grosser vibrations were alone produced, the finer inflections were missing, or, in other words, the *timbre* of the voice was wanting, but in the following experiments the *timbre* became more and more perfect until it reached a perfection leaving nothing to be desired. I found that a metallic powder such as the white powder—a mixture of zinc and tin—sold in commerce as "white bronze," and fine metallic filings, introduced at the points of contact, greatly added to the perfection of the result.

FIG. 2



At this point articulate speech became clearly and distinctly reproduced, together with its timbre, and I found that all that now remained was to discover the best material and form to give to this arrangement its maximum effect. Although I tried all forms of pressure and modes of contact, a lever, a spring, pressure in a glass tube sealed up while under the influence of strain, so as to maintain the pressure constant, all gave similar and invariable results, but the results varied with the materials used. All metals, however, could be made to produce identical results, provided the division of the metal was small enough, and that the material used does not oxidise by contact with the air filtering through the mass. Thus platinum and mercury are very excellent and unvarying in their results, whilst lead soon becomes of such high resistance, through oxidisation upon the surface, as to be of little or no use. A mass of bright round shot is peculiarly sensitive to sound whilst clean, but as the shot soon become coated with oxide, this sensitiveness ceases. Carbon again, from its surface being entirely free from oxidisation, is excellent, but the best results I have been able to obtain at present have been from mercury in a finely divided state. I took a comparatively porous non-conductor, such as the willow charcoal used by artists for sketching, heating it gradually to a white heat and then suddenly plunging it in mercury. The vacua in the pores, caused by the sudden cooling, become filled with innumerable minute globules of mercury—thus, as it were, holding the mercury in a fine state of division. I have also tried carbon treated in a similar manner with and without platinum deposited upon it from the chloride of platinum. I have also found similar effects from the willow charcoal heated in an iron vessel to a white heat, and containing a free portion of tin, zinc, or other easily vaporised metal. Under such conditions the willow carbon will be found to be metallised, having the metal distributed throughout its pores in a fine state of division. Iron also seems to enter the pores if heated to a white heat without being chemically combined with the carbon as in graphite; and, indeed, some of the best results have been obtained from willow charcoal containing iron in a fine state of division.

Pine charcoal treated in this manner (although a non-conductor as a simple charcoal) has high conductive powers, due to the iron; and, from the minute division of the iron in the pores, is a most excellent material for the purpose.

Any one of these preparations confined in a glass tube or a box, and provided with wires for insertion in a circuit, I call a "transmitter."

Reis, in 1860, showed how, by the movement of a diaphragm, intermittent voltaic currents could be transmitted, agreeing in exact number with the sonorous waves impinging on the diaphragm, and thus reproducing music at a distance by causing an electro-magnet to vibrate in unison with the diaphragm; and, with an iron diaphragm, Graham Bell showed how the vibrations of that diaphragm in front of a polarised electro-magnet could similarly induce magneto-currents, corresponding in number, amplitude, and form, with the sonorous vibration, and thus reproduce all the delicacies of the human voice. Edison and others have produced variations in the strengths of a constant current by causing the diaphragm to press directly upon some elastic conductor, such as carbon, spongy platinum, &c., the varying pressure upon these materials varying the resistance of the circuit, and consequently the strength of current flowing. Graham Bell and others have produced the same effect, by causing the vibrations of the diaphragm to vary the electromotive force in the circuit. It will be seen, however, that in the experiments made by myself, the diaphragm has been altogether discarded, resting as it does upon the changes produced by molecular action, and that the variations in the strengths of the currents flowing are produced simply and solely by the direct effect of the sonorous vibrations.

I have found that any sound, however feeble, produces vibrations which can be taken up by the matter interposed in the electrical circuit. Sounds absolutely inaudible to the human ear effect the resistance of the conductors described above. In practice, the effect is so sensitive that a slight touch on the board, by the finger nail, on which the transmitter is placed, or a mere touch with the soft part of a feather, would be distinctly heard at the receiving station. The movement of the sofest camel hair brush on any part of the board is disticntly audible. If held in the hand, several feet from a piano, the whole chords—the highest as well as the lowest—can be distinctly heard at a distance. If one person sings a song, the distant station, provided with a similar transmitter, can sing and speak at the same time, and the sounds will be received loud enough for the person singing to follow the second speech or song sent from the distant end.

Acting on these facts, I have also devised an instrument suitable for magnifying weak sounds, which I call a *microphone*. The microphone, in its present form, consists simply of a lozenge-shaped piece of gas carbon, one inch long, quarter inch wide at its centre, and one-eighth of an inch in thickness. The lower pointed end rests as a pivot upon a small block of similar carbon; the upper end, being made round, plays free in a hole in a small carbon-block, similar to that at the lower end. The lozenge stands vertically upon its lower support. The whole of the gas carbon is tempered in mercury, in the way previously described, though this is not absolutely necessary. The form of the lozenge-shaped carbon is not of importance, provided the weight of this upright contact piece is only just sufficient to make a feeble contact by its own weight. Carbon is used in preference to any other material, as its surface does not oxidise. A platinum surface in a finely-divided state is equal, if not superior, to the mercurised carbon, but more difficult and costly to construct. I have also made very sensitive ones entirely of iron.

The best form and materials for this instrument, however, have not yet been fully experimented on. Still, in its present shape, it is capable of detecting very faint sounds made in its presence. If a pin, for instance, be laid upon or taken off a table a distinct sound is emitted, or, if a fly be confined under a table glass we can hear the fly walking, with a peculiar tramp of its own. The beating of a pulse, the tick of a watch, the tramp of a fly can thus be heard at least a hundred miles distant from the source of sound. In fact, when further developed by study, we may fairly look for it to do for us, with regard to faint sounds, what the microscope does with matter too small for human vision.

It is quite evident that these effects are due to a difference of pressure at the different points of contact, and that they are dependent for the perfection of action upon the number of these points of contact. Moreover, they are not dependent upon any apparent difference in the bodies in contact, but the same body in a state of minute subdivision is equally effective. Electrical resistance is a function of the mass of the conductor, but sonorous conduction is a function of the molecules of matter. How is it, therefore, that a sonorous wave can so affect the mass of a conductor as to influence its electrical resistance. If we assume a line of molecules we know that a sonorous wave is accompanied by alternate compressions and rarefactions. If we isolate the part under compression from the part under dilation we vary the dimensions of the mass, and we alter its electrical resistance. In any homogeneous conductor of finite dimensions the effect of the one will exactly compensate for the effect of the other, and we get no variation of current, but if we break up this homogeneous conductor into a series of minute subdivisions without actually breaking their electrical continuity we destroy this neutralising influence, and we render evident the effect of sonorous vibrations in varying the dimensions of the mass of the conductor, and therefore in varying its electrical resistance, for we reduce the length of a portion of the conductor to a fraction of the length of a sonorous wave. Molecular action alone explains to me all the effects produced. Size or shape does not affect them. A piece of willow charcoal, the size of a pin's head, is quite sufficient to reproduce articulate speech. I regard the action as follows:—If we have two separate conductors joined simply by contact this contact offers a certain resistance. Now we can vary or lessen the resistance by increasing the pressure, thus bringing more points in contact or closer proximity. Now, as I employ a constant pressure on the contact, which is exactly under the same influence of the vibrations as the points of contact, more points or closer proximity can only be obtained through the molecular swelling or movement of the contact points.

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* A Paper read before the Royal Society, May 9th, and forwarded to us by the author.

If we assume a line of molecules at the point of contact of the the minute masses of conducting matter in their neutral condition to be arranged thus—OOOOO, they will appear thus under compression — 00000, and thus under dilatation — ○○○○○.

In the former case the electrical resistance would be less, and in the latter case more than in the normal condition. Hence we should get variation in their electrical resistance, and thus sonorous waves could vary the strength of an electric current, and the variations of the electric current can be made to reproduce sonorous vibrations. These, however, would only produce the result in a certain line, say horizontal; but those perpendicular, while producing the same result, would be a half vibration behind, and thus if two contacts, the one horizontal and the other perpendicular, were on the same piece of charcoal and the conducting line joined to both, we should have interference. The contrary takes place the more contacts we have, and the more varied their direction on the same the louder and purer the sound becomes. Hence there is no interference, and consequently the whole mass must swell and diminish equally in all directions at the same instant of time.

The tube transmitter, which I exhibit this evening (see Fig. 2), consists of an exterior glass tube 2in. long and ¼in. in diameter. In it are four separate pieces of willow charcoal, each ¼in. long and two terminals of the same material. The terminals are fastened in the tube, and connect exteriorly with the line and interiorly with the four loose pieces.

Here A is made to press on B, C, D, E, and F, until the resistance offered to the electrical current is about one-third that of the line upon which it is to be employed. It may be attached to a resonant board by the ends A or F. If the result was simply due to vibrations we should have A and B making greater contact at a different time from E and F, and consequent interference. If it was a simple shaking or moving of B, C, D, E, and F, it could produce no change, as if B pressed more strongly on C it would be less on A, and also if the tube was attached by the centre we should have no effect; but if the effect is due to a swelling or enlargement of B, C, D, E, F, it would make no difference where it is attached to the resonant board, as is actually the case. Again reduce the pressure of A upon B, &c., until they are not in contact, and no trace of current can be perceived by shaking the tube. The instant the sonorous vibrations pass in the tube there is electric contact to a remarkable degree, which could only have taken place by the molecules enlarging their sphere under the influence of the sonorous vibrations.

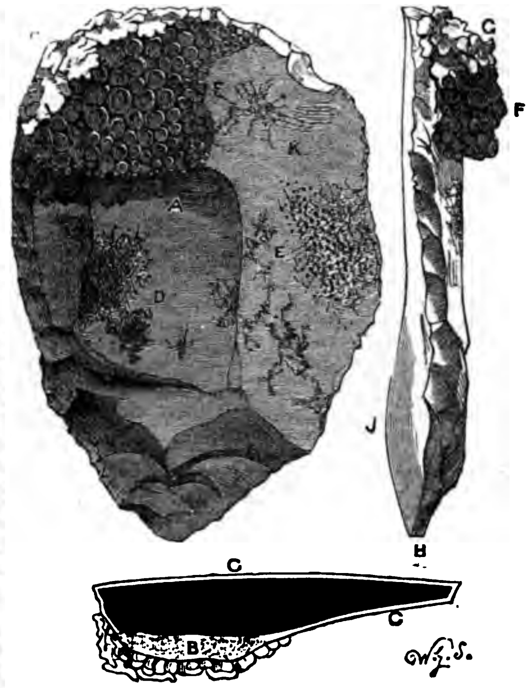
It is impossible to say what can be the applications or the effects of the discovery which I have had the honour of bringing before the Royal Society, for the whole question has been studied with crude materials, and scarcely sufficient time has elapsed to enable me to consider its ultimate uses. I do not desire to assert that there is anything in what I have brought forward that is superior to or equal to other transmitters used for telephony. It is as loud and far more sensitive than any I have yet heard, and it may be increased by multiplication of transmitting contacts in quantity or intensity; the loudness is at present limited by the capability of the receiver. The materials at my disposal, and the arrangement of them, have not yet been sufficiently studied. I only wished to show that is possible to transmit clear and intelligent articulate speech, and to render audible sounds which have hitherto been inaudible by the operation of sonorous vibrations upon the conducting power of matter. My warmest thanks are due to Mr. W. H. Preece, electrician to the Post-office, for his appreciation of the importance of the facts I have stated, and for his kind counsel and aid in the preparation of this paper. I do not intend to take out a patent, as the facts I have mentioned belong more to the domain of discovery than invention. No doubt inventors will ere long improve on the form and materials employed. I have already my reward in being allowed to submit my researches to the Royal Society.

A FLINT FLAKE AND ITS STORY.*

BY W. G. SMITH, F.L.S.

THE flint flake illustrated in Fig. 107 was picked up a week or two ago by the writer on the Sussex downs near Eastbourne. Similar flakes of flint are far from uncommon at the place mentioned, and they are to be found in certain positions all over Britain, and probably indeed over the entire world.

Flints which have naturally burst or become splintered in their original matrix of chalk, or have been broken for road-making by the roadside, are to be seen almost everywhere, but the worked flint illustrated—a scraper—differs from these, inasmuch as it was carefully worked into shape by human hands some thousands of years ago, and probably before metals were known in this country. Mr. Evans has computed that the more recent of these instruments of stone were made 1000 to 1200 years B.C., and continues: "How much further back their use might be carried it is impossible to say."



The flint illustrated was without doubt worked into shape on the spot were it was found, as it was picked up on a known British camp, and was in company with a large number of other stone implements and flakes. At first sight it seems somewhat curious that these objects of antiquity should still be resting on the surface of the grass, and nestling amongst the common plants of chalky downs. The surface-soil where this flint was found varies from an inch or two to a foot or more in thickness, and one would imagine that in a minimum number of years, amounting to 3,000, the decomposition of the plants, the action of worms and their casts, as described by Mr. Darwin, and the dung of birds and other animals would ere this have effectually covered flints of the size figured from sight; but such is not the case. I have found many worked flints on the Chiltern Hills, resting on the surface of the ground where the earth had been thrown out in prehistoric times for the formation of huts. When flints are first taken from the chalk they are encrusted with a white external stratum which is due to the decomposition of the flint, the decomposition taking place from the outside inwards; if a flint is freshly broken it shows a black or coloured internal mass, which will in its turn at length become which and porcellaneous by the decomposition of the surface —*i.e.*, if the flint is kept in the air or in a porous soil. All the worked flints on the Sussex downs are white from their many long years of exposure.

In the accompanying illustration, the left-hand figure shows the front and worked face of a flint probably used in prehistoric times for scrap skins of animals; the right-hand figure sho edge of the implement, and the lower figure its verse section; the back is unworked—*i.e.*, p plain. Many of the worked flints near East show part of the original crust of the flint, one does now under description. When our ment was in process of manufacture the struck from the face for some reason fell sho stopped suddenly at the point, A, leaving a p the original decomposed crust, which is clea on the section at B, and also seen covered with on the front and side view, F, G. How lo thickness of crust required for its formation the flint was still in the chalk it is impossible but the time that has passed since the flint w worked has been sufficent for the formatio second and much thinner white porous and laneous crust, as seen at C C in the section.

On a freshly fractured flint it is probable vegetable life of any sort could exist, but as the surface becomes roughened and abraded weather, as on old window glass, vegetable l low order gains a footing, and more or less the decomposition. So absorbent of moist some old and decomposed flint flakes that t weigh 1-12th more after being placed in wa when in a dry state. This slight retention o is sufficient to support a few unicellular al other plants of a low order. Growing on our downs flint there are no less than four lichen surface which has been worked is not yet suf decomposed to support fully-developed liche black patches at D therefore belonging to Ve nigrescens are invariably sterile, as small olivaceous pustules at E, wl long to the rudimentary condition Lecanora gibbosa. On the piece of crust, however, and where more retained, the moisture enables L parella at F F to grow with cons and perfect luxuriance, and even l perlata, G G (a lichen commonly to trees), to obtain a secure and pe foot-hold. Who can tell how ma thousands of years must pass awa the worked surface of the flint, whi from phehistoric times, will be in tion ready to receive the parasites ating on the fragment of the f ancient original crust?

It may be asked, how is it kno this fragment of flint was worked in times dating back to extreme an The reasons are several. 1. Rud ments of similar form are still mad Esquimaux. 2. Worked flints s spot where the blow was admi which struck off the flake. as at H. flakes display a conchoidal curve "bulb of percussion" on the plain at J. 4. They are, as a rule, tri worked on one side only; and 5. E of the face shows a *depression* (which corresponds with the bulb cussion present on each seconda which has been struck off. Geolo evolutionists are always asking f they are always stating that the ti historical period has not been suffi bringing about changes of any m In the Sussex downs flint we ha an instance of how "geological sufficient to produce a surface on a flint su the growth of one of the most humble of whilst time, dating from remote prehistoric is quite unequal to any such result.

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* We are indebted to the courtesy of the *Gardeners' Chronicle*, from which paper this article is extracted, for the use of the block.

LATHE TOOLS AND TOOL POST S

FOR the performance of a large quantity by the lathe, no greater necessity ex for heavy turning tools. The numerous of thirty and of ten years since to use cutti for turning have all ended in practical fail nicety of shape or fitness to meet the exact ment for easy cutting of metals will recomp want of material, both in continuity and i to conduct away the heat of the cut and of on the cutting surfaces. The smallest work for turning iron should be 1¼″ × 1¾″ stee shank, the slot of the tool post of the lath swings 10″ only over the ways, should t dimension easily; 1¾″ × 1⅛″ steel is not e for tools for the 30in. lathe, where profitab for use of the lathe is expected. The post selves, with their griping screws and beari can hardly be too heavy, while they can easi weak. For a 48in. lathe it does no harm the slot in the post 2⅛″, or 3″ × 2⅛″, or 2⅞ 2in. screw. The refinement of spring heavy cuts or for long cuts without re-sha are well enough for tool rests with V lathes where the ways have V's; but excellence of workmanship, nor speed of nor heavy cuts, will result from makes lathes, or of turning tools.

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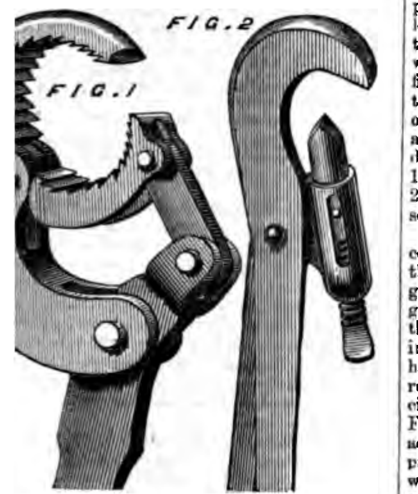
* By ROBERT BRIGGS, in the [illegible]

MPROVED PIPE WRENCHES.

pipe wrenches shown in the annexed gravings, are illustrated by the *Scientific* an as improved forms. The first (Fig. 1) vented by Mr. C. Coleman, of Honolulu, an Islands. In that, as will be seen, the jaw the handle is bent, and at the angle a curved jaw is pivoted. To this a smaller jaw is hinged about midway its length, so that e corresponding portion of the large jaw it when closed, a nearly entire ring about the bar. A link unites the outer end of the with that of the smaller jaw, so that when the ke hold, the movement of the handle acts the link to press them the more closely r. The inner faces of the jaw are corrugated ent slipping, and a thread may also be cut these corrugations, so that when desired the may be made to seize a nipple, and screw it nto place, without marring or injuring the The jaws so nearly inclose the pipe that a ong grip may be had without danger of or breaking the latter.



cond (Fig. 2) is an adjustable pipe tongs, so t no smith's work is needed for dressing up. inutes' grinding being all that is required the implement in good working order. The edge consists of a cylindrical piece of best , which is quickly adjusted to the pipe by bscrew, and which, as shown in the illustra- two edges. When the edge in use has ull, the bit can be reversed, and it will be at the friction on the lower edge has l the one not hitherto used. The bits are noved, and may be re-ground until worn en they can be replaced by any mechanic, ply pieces of round cast steel with an ob- el edge. The thumbscrews have square and are case-hardened to insure durability nt spreading at the point, and generally the de in an excellent and substantial manner. er particulars address the manufacturers, ancoast and Maule, 243 and 245, South eet, Philadelphia, Pa.

ANALOGY BETWEEN LIGHT AND SOUND.—V.

By Prof. W. F. Barrett.

leave these facts in your hands, they must ken for what they are worth, and conclu- t only to be drawn from them with extreme nd care. Let me now direct your attention r aspect of this relationship which brings symmetry of form as well as colour and oubtless harmony in the three great di- art—painting, music, and architecture— ately upon a physical basis.

sible to obtain a real optical expression of ical intervals. This was first accomplished sajous, who employed tuning forks, to one which little mirrors were attached. By a beam of light from one vibrating tuning other, placed at right angles to the first, light are obtained, which curves vary to the combination of forks we select. ves—Lissajous' figures they are usually in fact the optical equivalent of the com- we hear from the two sounding tuning ave here a very beautiful arrangement for ese curves, the forks being sustained in y means of electro-magnets, and a beam lectric light being reflected from one fork r, and thence to the white screen behind e first place we will select two forks in at is the most perfect harmony obtainable, e upon the screen the simplest possible mely, a circle gradually changing to an ellipse, indicative of the fact that the two forks are, by an inappreciably small amount, out of tune. No method of tuning approaches in delicacy this beautiful optical analysis. Next I will change one of the forks and insert its octave, we have now on the screen the figure of 8, a simple figure, but not quite so simple as the last. Next here is the interval of the fifth, and the figure you observe though beautiful is a little more intricate; the interval is not quite so perfect as the last.

Milton, when he wrote "L'Allegro," little imagined his words would receive so literal a demonstration as that given by the scientific discoveries of the present day. For does not this optical expression of concord remind us

> Of notes, with many a winding bout
> Of linked sweetness, long drawn out,
> Untwisting all the chains that tie
> The hidden soul of harmony.

If we now select a dissonant interval, such as the second, you note how extremely complicated is the figure on the screen; it is nothing but an interlacing network of lines of light, with every luminous thread in a state of ceaseless unrest. In fact, the complexity of the figure increases as the concord lessens, and the restlessness of the figure grows as the tuning becomes imperfect. This large diagram, which is hung behind me, gives you at a glance the figures produced by various musical intervals and the phases those figures pass through. I have put over each figure the name of the interval represented and the ratio of the number of vibrations corresponding to that interval. Thus in unison the ratio is 1 : 1, in the octave the ratio is 1 : 2, in the fifth it is 2 : 3, in the major third 4 : 5, and so on, and in the second the ratio is 8 : 9.*

Is it not very beautiful to notice the points of contact in the harmony of colour, music, and form, the simplest numerical relationships giving us the greatest sense of pleasure? The great Euler suggested that the reason for this was to be found in the fact that we experience less fatigue in attempting to unravel simple combinations; but Helmholtz has shown the true physical basis of harmony resides in the fact that the "material ear does precisely what the mathematician effects by means of Fourier's theorem, and what the pianoforte accomplishes when a confused mass of tones is presented to it. It analyses those wave-forms which were not originally due to simple undulations, into a sum of simple tones, and feels the tone due to each separate simple wave separately," and this irrespectively of the fact whether the sound issued from the instrument as a compound tone, such as that yielded by a bell, or was the result of the mingling of two or more simple tones, such as those yielded by our tuning forks just now.

And now the question arises, is there an analogy between the eye and the ear in the *perception* of compound colours and compound tones? We fear we must answer no. The eye, so far at least as we know at present, is unable to decompose the compound systems of luminous waves, which give rise to various compound colours. As Helmholtz remarks, "It experiences from them a single, unanalysable, simple sensation, that of a mixed colour. The eye has no sense of harmony in the same meaning as the ear." But we can hardly give our assent to the great master's words, when he says, "It is indifferent to the eye whether this mixed colour results from the union of fundamental colours with simple or with non-simple ratios [that is, the ratios of the vibration-numbers, or of the wave-lengths, which give rise to the sensation of colour]. There is no music in the eye."

Is this so? If we furnish the eye with a prism and thus analyse some lovely compound colour, we shall, I think, in general, find that there is a simple ratio between the vibration number of the constituents of the mixed colour. Take, for example, this beautiful purple yielded by a solution of permanganate of potash: the prism shows its constituents are red and blue, and the ratio of the vibration-numbers of these colours closely corresponds to that of a fifth in music. So we might take other compound tints. Whether such analogies are more than accidental I am not prepared to say, the matter is worthy of more exhaustive inquiry, and certainly it would not only be æsthetically interesting but practically useful if we could rely on such an analogy, and thus decide questions of taste as to the proper use of colours in decoration and dress by comparing them with their musical equivalents. Like music, colour, as Ruskin remarks, "is wholly relative, each hue in a work being altered by every hue added in other places."

In the quaint words of Sir Thomas, Brown, in his "Religio Medici," we may say, "There is music wherever there is harmony, order, or proportion; and thus far we may maintain the *music of the spheres*; for these well-ordered motions, and regular paces, though they give no sound to the ear, yet to the understanding they strike a note most full of harmony." And I need hardly remind you of the well-known passage in the "Merchant of Venice," where Shakespeare gives poetic utterance to the same ancient conception. Indeed, the whole order of nature looked at aright is but "linked sweetness long drawn out." Creation to the student of nature is a silent song, but one full of meaning to the reverent mind. Amid the mutability of all things we may hear the music of their march. And this surely is one of the charms of scientific inquiry. By exalting our conceptions of nature it widens our mental horizon, and increases our capacity for intellectual enjoyment of the healthiest and happiest kind.*

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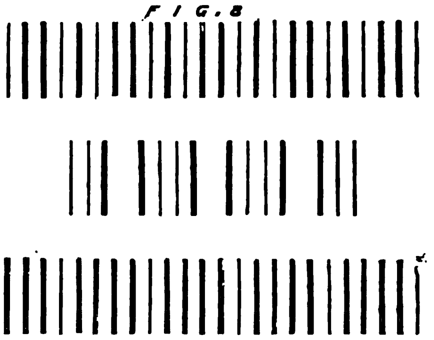
* There are other modes of showing Lissajous' figures than employing tuning forks. An ingenious arrangement, made by Sir Charles Wheatstone, was shown on the lecture table; also a simple device made by the lecturer, consisting of two flat pieces of steel fastened at right angles to each other, fixed in a vice at the lower end, and with a bead fastened to the upper end, after the manner of the kaleidophone. But the most beautiful and effective arrangement is that devised by Mr. Pichler, who uses two harmonium reeds with mirrors attached. Mr. Pichler's instrument was exhibited in the Loan Collection, and he most kindly took considerable trouble to show it in the foregoing lecture.

* The tendency of motion is to assume a rhythmic character, whether the motion be one of masses or of molecules. The shock which any body receives after the initial disturbance has subsided gives a final resultant motion which is both vibratory and isochronous. The values of the periodic times of the different types of vibration are given, as Prof. Clerk Maxwell remarks in his article on "Atoms," in the 9th edition of the "Encyclopædia Britannica," by the roots of a certain equation, the form of which depends on the nature of the connections of the system. "In certain exceptionally simple cases, as, for instance, in that of a uniform string stretched between two fixed points, the roots of the equation are connected by simple arithmetical relations, and if the internal structure of a molecule had an analogous kind of simplicity, we might expect to find in the spectrum of the molecule a series of bright lines, whose wave-lengths are in simple arithmetical ratios. But if we suppose the molecule to be constituted according to some different type, as, for instance, if it is an elastic sphere, or if it consists of a finite number of atoms kept in their places by attractive and repulsive forces, the roots of the equation will not be in connection with each other by any simple relations, but each may be made to vary independently of the others by a suitable change of the connections of the system. Hence we have no right to expect any definite numerical relations among the wave-lengths of the bright lines of a gas." Notwithstanding the conclusion thus arrived at, Mr. G. Johnstone Stoney, in conjunction with Professor Emerson Reynolds, published in the *Phil. Mag.* so long since as April and July, 1871, two profound papers, less known than their importance deserves, wherein "definite numerical relations among the wave-lengths of the bright lines of at least two gases" were found by experiment and mathematically discussed. The two gases were Chlorochromic-Anhydride and Hydrogen. In a recent letter to the present writer, Mr. Stoney gives the following interesting abstract of the papers referred to:—"In the Absorption Spectrum of Chlorochromic-Anhydride, we observed 105 lines, of which we measured 31, all harmonics of a fundamental motion in the gas, whose periodic time is $\frac{T}{2\cdot70}$, with a probable error of about $\frac{1}{100}$ of this value. In this, T is the time light takes to advance one millimetre in vacuo. It is, therefore, $\frac{1}{298,000,000,000}$ of a second. Therefore the periodic motion in the gas is repeated in each molecule rather more than 800 thousands of millions of times in each second. The observed harmonics were from the 628th to the 733rd of this fundamental motion.

FIG. 8



Absorption-spectra of Chlorochromic-Anhydride.

The intensities of the successive harmonics were indicated by the strength of the lines in the spectrum which gave in different parts the patterns above delineated. (Fig. 8). Now these patterns would all present themselves in different parts of the series of harmonics, if the fundamental motion obeyed the same law as that of a point of a violin string struck nearly but not quite [illegible]ths of the length from one end. The resemblance goes extraordinarily far: however, it is not a case of identity, for the *order* in which these patterns succeed one another is different in the Chlorochromic-Anhydride from what it is in the violin string. The law of motion is therefore in some way related to that of the aforesaid point on a violin string, but not identical with it. In hydrogen there are four lines within the visible spectrum, C, F, a line near G which may be called G′, and h. Of these C F and h are the 20th, 27th. and 32nd of the series (*i.e.* the 19th, 26th, and 31st harmonics) of a motion with a periodic time of $\frac{T}{76\cdot2}$, the outstanding probable error being excessively small. This fundamental motion is, therefore, repeated rather more than 22 millions of millions of times each second in the molecules of the gas. Now if two tubes, resembling two organ pipes, closed at one end were placed with their mouths close together

SCIENTIFIC SOCIETIES.

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THE INSTITUTION OF CIVIL ENGINEERS.

AT the meeting of this Institution on Tuesday, May 7th, Mr. Bateman, President, in the chair, the paper read was on

The Construction of Steam Boilers Adapted for Very High Pressures,

by Mr. James Fortescue Flannery. In the discussion following a paper on this subject, read before the Institution of Naval Architects, Mr. McFarlane Gray compared the relative economy of present and former engines, showing that in former practice, the boiler pressure was 25lb., or 40lb. absolute pressure per square inch, yielding 6 h.p. for a certain quantity of coal; but that now with 65lb. boiler pressure, or 80lb. absolute pressure, for the same quantity of coal, the result was 8 h p.; that was to say, the pressure had been multiplied by 2, and 2 added to the 6 h.p. And from this comparison and from calculation, Mr. Gray inferred that "the h.p. increased in arithmetical progression, and the pressure in geometrical progression," and that "it would require 1,280lb. on the square inch to double the present efficiency, even if that pressure could be carried without additional drawback."

There was at present no proof that practical difficulties would reduce to so serious an extent the theoretical gain incidental to increased pressure and expansion. Assuming, however, that by increasing the present boiler pressure, and adopting suitable expansion, it would be possible to increase the economy only 20 per cent. The advantage at sea would be most important.

No doubt could be thrown on the statement that boilers of the existing types, especially marine boilers, would not carry much higher pressures than they were now subjected to, even though the usual factor of safety might with propriety be reduced; the limited space allowable on board ship for boiler room, and the necessity of occupying that space in the most economical manner, left scarcely any choice as to the external size of each separate boiler, and the size being thus dictated, the pressure to be carried was necessarily limited by the possible thickness of the iron of the outer shell, and the means of rivetting it. By an extension of the heating surface in relation to the grate surface, so that the temperature of the escaping gases might be reduced to a minimum, the evaporative economy of all boilers might be made nearly the same, but a boiler having favourable disposition of the surfaces would more readily be adapted to such reduction of the temperature of the escaping gases, and the maximum efficiency could accordingly be obtained in such a boiler with the least extension of the heating surface, and therefore with the least size and weight. On this ground alone it was believed that important economy might be obtained by the use of the water-tubes.

Another important advantage incidental to the water-tube or sectional boiler, if well designed, was its facility for expansion and contraction under varying temperatures without undue strain upon the joints. It was well known that one of the greatest evils of the present cylindrical marine boiler was the wear and tear, and ultimate leakage of the seams of the shell, from its unequal expansion. There seemed little hope of removing this defect from the cylindrical boiler, but the sectional boiler was, in almost all cases, entirely free from it.

The report of the boiler committee, in allusion to the Perkins system, said: "The committee very much regret, in view of the further information collected by them on this subject, that difficulties should have interfered with the carrying out of their suggestion[*] as to the trial of the tubulous system; and, after the further experience they have gained, it is still their opinion that the system should be fairly tested as soon as possible in sea-going ships of her Majesty's Navy, on land, and, if thought desirable, in steam pinnaces and cutters; boilers of the latter size being readily obtained on the plans referred to." The vital feature of the Perkins system was the continued use from port to port of the same water, without leakage, and free from impurities likely to be deposited. It was admitted by Mr. Perkins that, in an engine working with a vacuum, portions of the tallow used in the stuffing-boxes of the piston-rods would be sucked into the cylinder, and carried through to the boiler; and beyond this it was not easy to imagine that in large engines no internal lubrication would be required; should it be necessary on long voyages to apply oil or tallow, even in small quantities, deposit on the boilers must necessarily take place; and deposit upon boilers having little natural circulation must be a serious evil. If in a boiler there was rapid circulation of water, the tendency to deposit would be less, and if the construction of a boiler admitted of easy access for scaling mechanically, the deposit was of less importance; but it must in fairness be pointed out that the construction of the Perkins boiler was such as greatly to hinder scaling by mechanical means; and in his evidence before the committee Mr. Perkins recommended periodical washings for removal of scale. It must be evident, however, that in the case of large deposit such a system of cleaning was not likely to be satisfactory, and, indeed, after a Perkins boiler had been so cleaned, it would be difficult to know if deposit still remained.

In connection with the question of weight, which had such an important bearing upon the policy of fitting tubulous boilers for marine purposes, there were one or two points demanding consideration. When comparing the total weight of machinery of different types, it was only fair to include the weight of coal necessary for a given number of days' consumption in each case, and, regarded in this light, the tubulous boiler by reason of its greater economy would have some advantage. Again, if economy of weight in connection with high pressure was desired, the grate surface might be so much enlarged in proportion to the heating surface, that abundant steam generation with small weight might be obtained, but at the cost of increased consumption. Of course this was so for all types of boilers; and it was a question of experience how to proportion the grate and heating surfaces to each other, that the escaping gases might be of the most suitable temperature. In the best marine practice, boilers of the cylindrical type were now made with about 3 square feet of heating surface and 0·12 square foot of grate surface per indicated h.p.; that was as 25 to 1. In the examples of tubulous boilers already described the proportions were approximately as follows:—

Name.	Indicated h.p.	Grate Surface.	Heating Surface.	Grate Surface per Indicated h.p.	Heating Surface per Indicated h.p.	Proportion of Heating Surface to Grate Surface.
		Sq. feet.	Sq. feet.	Sq. feet.	Sq. feet.	
Red Rose	600	72	1,587	0·120	2·64	22 : 1
L' Actif (Belleville)	400	75	2,347	0·188	5·86	31 : 1
Propontis	1,100	143	8,700	0·130	7·9	61 : 1
Montana	4,500	540	21,710	0·12	4·82	40 : 1
Watt's Patent...	—	—	—	0·12	3·0	25 : 1
Perkins' Patent	150	19	760	0·126	5·0	40 : 1
Barron's Patent	—	19	494 fire-surface	—	—	26 : 1
			636 oil-surface	—	—	33 : 1

An interesting discussion had recently taken place upon the comparative advantages of vertical and horizontal heating surfaces, especially as applied to high-pressure boilers. The question appeared to lie within very narrow limits. It was necessary to remember that the action of circulation was due to gravity alone, the steam bubbles tending to rise and the water to fall, and, where evaporating water was confined in a narrow tube, if that tube wa
in an exactly horizontal position the stean
could only rise through the height of the
of the tube, and would accumulate at the up
if they did eventually have any circulation
be borrowed from the currents ascending tl
vertical, or approximately vertical, line;
velocity of the circulation would be corresp
reduced. On the other hand a vertical tub
properly supplied with water led through a
downcast, might have no real circulation, b
be full of steam struggling upwards again
struggling downwards, and destroying cir
It appeared then that the employment of
horizontal, or nearly horizontal, positions w
give good results; but the use of tubes of
proportioned diameter and length, in a
sufficiently inclined to allow the steam bu
ascend along the tube by gravity, and havi
wards an uninterrupted flow to the stea
would be safe and efficient. Under all circu
a boiler should possess separate upcasts
newly generated steam, and separate down
the water to take its place. A point of equa
ance was the free access to all parts of the
the purpose of cleaning. From the natu
case the tubulous boiler was difficult to ar
this respect, and some examples, after worl
for a time, had failed from the large deposi
for which no ready-means of removal were

MICROSCOPICAL SOCIETY (
LIVERPOOL.

THE fifth meeting of the tenth sessio
Society was held on Friday evening,
inst., at the Royal Institution, Liverpo
George F. Chantrell, President, in the chai

Captain Perry (associate member) exhibi
leaves of Verea crenata, cut from the pla
three months ago. They still retained their
and nourished many young plants sprouti
the surface. Captain Perry also exhibited
number of slides of diatoms prepared by I
Hamilton L. Smith, of Hobart College,
New York.

The Rev. W. H. Dallinger, F.R.M.S., a
the bereavement sustained by Dr. Drysda
loss of his son, and a resolution of symp
recorded. Mr. Dallinger exhibited Nachet's
lucida for use with upright microscopes, ill
practically its success with high powers. I
linger also showed the application wit
"asbestos paper" as a non-conductor, pr
the radiation of heat from metal chimneys i
scope lamps.

The President called attention to some
gelatinous balls he had recently met wit
ponds near the Hooton railway station. O
balls was as large as his fist, and was of a
green colour externally. On examination
the colour due to the presence of vorti
animalcules, imbedded and somewhat
arranged within it. The bodies of the ani
when extended are spindle-shaped, and w
tracted are oval, or nearly spherical—the he
like that of a vorticella. The remarkable p
consists in the large proportion of clear fir
the mere film of colour on the outside, whic
is due to the animalcules above described.
berg has named them "Ophyridium versati
gives no particulars of their life-history, no
account for the fact of their being parasit
balls of jelly. An investigation of their lif
was well worthy the attention of the socie
meeting concluded with a conversazione,
nothing but living objects were exhibited.
tions on the special subjects illustrated were
the Rev. H. H. Higgins, M.A., Mr. Jno. A
Dr. Hicks, Mr. J. C. Thompson (hon. s
Rickard, Mr. Chantrell (the president), and

New Guinea Gardeners.—As the res
recent observations in New Guinea, the
Macfarlane states that the people of Kere
Hula are by far the finest-looking nativ
seen in the island, and the most industrio
met with throughout the South Seas. Thei
are unusually neat and clean, their ho
canoes well-built, and their plantations l
cultivated gardens in England. Mr. M
saw the work in its different stages. Th
turned over, as if it had been ploughed, b
men with pointed sticks, which they simul
plunge into the soil and use as levers. I
broken and neatly levelled by the women, af
bananas, sugar-cane, yams, &c., are plante
Mr. Macfarlane saw several square miles
gardens, all neatly fenced in and thoroughl
with bananas and vegetables planted in
straight as an arrow. The people observe
system of working two days and resting
they are very systematic in their wor
devoting themselves to agriculture and o
fishing.

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and the columns of air set vibrating, the compound system would emit certain harmonics only, the rest being stifled by interference. If the tubes were respectively ·424 and ·576 of the total length, the harmonics which would be strongest among those corresponding to the limits of the visible spectrum would be precisely the 20th, the 27th, and the 32nd of the series, the three that present themselves in the hydrogen spectrum. The foregoing observations appear to warrant the conclusion that there are motions within the molecules of the two gases experimented on, which furnish either true harmonics, like those of strings and columns of air in musical instruments, or else motions which so closely approximate to being harmonics as to be distinguishable from them, like the transverse vibrations of a free thin elastic bar."

[*] A recommendation that Perkins' system should be tried (1) on land; (2) on board one of the Admiralty harbour vessels; (3) on board a small sea-going man-of-war, was made by the committee in September, 1874.

SCIENTIFIC NEWS.

THE prizes offered by the Turners' Company have become an annual institution looked forward to with at least as much interest as Lord Mayor's day by the outside world. The exhibition to be held on the 8th, 9th, and 10th of October next will, we imagine, attract turners from all parts of the kingdom, for, in addition to the competition in wood turning, throwing and turning in pottery, diamond-cutting and polishing, a sum of £10 has been placed at the disposal of the company by Past Master C. Christopherson, to be awarded as a prize for the best specimen of amateur ornamental turning, either in ivory or hard wood. The work must have been done during "the period of competition" (that is, we presume, between March and October), but it may have been accomplished by any lathe apparatus—a concession which is not granted to the professionals. We shall, probably, have something more to say of the competition, and of the energetic manner in which the Turners' Company is doing a useful work, and we hope, for the sake of encouraging the professionals, that the amateurs will exhibit in great force. The prize is nothing in itself to many of our best gentlemen turners, but there would be an honour in winning it, and a satisfaction in handing the money back as an extra prize to encourage the apprentices.

Amongst the principal objects of interest exhibited at the soirée of the Royal Society were the telephone harp of Messrs. Gower and Matthews, which we illustrated last week; Mr. Sedley Taylor's Phoneidoscope; Mr. Spottiswoode's large Holtz machine, with 12 sets of plates 30in. in diameter; an ingenious metallic thermometer, devised by Mr. Bessemer; and, of course, the phonograph.

At the soirée Mr. F. Galton exhibited his experiments on "composite portraits," which he described in a paper read before the Anthropological Institute. When the images of many persons are successively thrown for a short time on the same portion of a sensitive photographic plate, the composite figure produced is found to have an unexpectedly good definition. The process consists simply in collecting photographs, taken in the same attitude, of persons having the same general type of features. They are reduced to the same size, and adjusted until one wire of a cross will cut the pupils of the eyes, and the other bisects the interval between them. Register marks are then made, and the portraits are bound at one edge, so that each can be presented to a camera in turn. The composite picture is a handsome face, presenting what is common to all the portraits, but suppressing individual peculiarities. It may, however, be doubted whether it is of any real value in procuring anthropological types, by comparing the "average likeness" of a family of one race with that of a family of another race.

The experiments with the electric light at the Mansion House, last week, were not entirely successful, and it is so far a matter for regret that they were undertaken before success was insured. To those acquainted with electric apparatus the feasibility of the proposal was completely demonstrated, but to outsiders who regard unavoidable hitches as evidence of failure, the experiments of last week were sufficient to show the unsuitability of the electric light for illuminating the space between the Mansion House and the Bank. Some of our contemporaries confused the experiment with the attempts to light the gas lamps by electricity, and, without exactly knowing why, pronounced it a failure. A large Bunsen battery was used with a Duboscq regulator, the principal novelty being the lamp, which consists of a peculiarly-shaped reflector and a flattened convex opal glass. The light was very pleasant, but more than two lamps were required to light up the large area, and a dynamo-electric machine should have been tried instead of a battery.

Under the auspices of the Sanitary Institute of Great Britain, a series of experiments with ventilators will take place by permission of the Kew Committee of the Royal Society, at the Experimental House, Kew Observatory. As soon as the arrangements are complete tickets of admission will be furnished, on application to the registrar of the Institute at 20, Spring-gardens, W.

The Exhibition of the Royal Cornwall Polytechnic Society will be opened on Tuesday, August 27, and intending competitors can now obtain the list of prizes from Mr. Edward Kitto, the secretary. The 45th annual report of the society has been published, and shows that many of our best machine-makers think it advisable to exhibit their productions in Cornwall.

The Willem Barents sailed for Jan Mayen on May 6th with three officers, a crew of eight men, and three scientific experts. The little vessel is exactly the same size (80 tons) as the Hopewell, the craft in which Henry Hudson discovered his "Tucthes," or, as it has since been named, Jan Mayen. From that island the Dutch expedition will sail to the north-west coast of Spitzbergen, and about the middle of July will make for Novaya Zemlya. Thence the gallant little band will make their way as far as possible to the north-west, and return home before winter. This expedition has been fitted out by voluntary contributions, and accordingly, although the vessel is fitted with all needful appliances, steam power is dispensed with, and her crew will be without luxuries. Whether it is wise to depend upon a sailing vessel, when even a small auxiliary power may be at times the difference between safety and disaster, does not admit of argument; but what Hudson or Barents did can be done again, and we will wish Lieut. Bruyne and his brave companions a better fate than awaited either. It would be humiliating, though, if this little expedition should do more than the costly and completely equipped vessels which returned not many years ago.

Prof. H. A. Nicholson has commenced the Swiney lectures on geology at Jermyn-street Museum. They are free, and will be continued every Monday, Tuesday, and Wednesday at 3 p.m. until the 5th of June.

Some chemists have long been of opinion that gadolinite does not merely contain as bases yttria and the oxides of erbium and terbium. M. Soret has now strengthened this view by showing that the ultra-violet spectrum of the bases in question presents lines which certainly do not belong to any known metal. Chemistry thus seems to be on the point of being enriched with a new simple body, the discovery of which will be due to spectrum analysis.

Some careful experiments on the excretion of carbonic acid by the skin in man have recently been made by MM. Fubini and Ronchi, of Turin. The method was to inclose the hand and forearm of the person in a glass tube made air-tight with rings of caoutchouc. A constant current of air without carbonic acid was drawn through this vessel, and the quantity of CO_2 in the issuing air determined. The experiments were made on a man of 27, weighing 50 kilo. Assuming the surface of the forearm and hand to be to that of the whole body as 1 : 16, the total CO_2 excretion in 24 hours was estimated at 6·80g. Among other results it was found that the CO_2 excretion from forearm and hand in darkness was to that in light as 100 : 113. Temperature has a very marked influence: thus the excretion at 16° to 20° C. was to that at 24° to 30° as 100 : 283. The excretion with an empty stomach was to that during digestion as 100 : 112. With an animal diet less CO_2 was excreted than with a vegetable one, the ratio being 100 : 116.

The following observation on circumspection of ants has lately been recorded by Prof. Leidy:—To ascertain whether a house he had just entered was (as he suspected) seriously infested with red ants he placed a piece of sweet cake in every room. At noon every piece was found covered with ants. Having provided a cup of turpentine oil, each piece was picked up with forceps, and the ants tapped into the oil. The cake was replaced, and in the evening was again found covered with ants. The same process was gone through the following two days, morning, noon, and night. The third day the number of ants had greatly diminished, and on the fourth there were none. He at first supposed the ants had all been destroyed, but in the attic he observed a few feasting on some dead house-flies, which led him to suspect that the remaining ants had become suspicious of the sweet cake. He accordingly distributed through the house pieces of bacon, which were afterwards found swarming with ants. This was repeated with the same result for several days, when, in like manner with the cake, the ants ceased to visit the bacon. Pieces of cheese were next tried with the same result, but with an undoubted thinning in the number of ants. When the cheese proved no longer attractive, recollecting the feast on dead flies in the attic, dead grasshoppers were supplied from the garden. These again proved too much for the ants, and after a few days' trial neither grasshoppers nor anything else attracted them. They appear to have been thoroughly exterminated, nor has the house been infested with them since.

The subject of friction between water and air is one on which we have few data, and these are somewhat contradictory. Venturi affirmed that the air, moved by a water jet, set light bodies in motion, while Magnus denied this, having found that a flame brought near a vertical water jet revealed no motion of the neighbouring air. Some ingenious experiments in this connection lately made by M. Von Lang, are described in *Wiedemann's Annalen*, and seem to prove distinctly that friction actually occurs between water and air. Without entering into detail, we may state that a stream of water falling vertically through a tube, caused suction in an adjoining tube, the amount of which was measured by displacement of a soap film.

According to Dr. Jobert, who is at present engaged on a mission in the region of the Upper Amazon, there are in that river several kinds of fish which swallow air, and in which the intestines, furnished with papillæ containing blood-vessels, perform the function of lungs. In some cases, the vitiated air is ejected by the anus, in others by the mouth.

To explain the daily oscillation of the barometer M. Cousté has recently advanced the theory (in the French Academy) that it is due to superposition of two phenomena. On the one hand, under solar action the vapour, previously in the vesicular state, is transformed into vapour, properly so called, and adds its pressure to that of the air. On the other hand, and in an opposite direction, the heating of the air, due to the sun, produces ascending currents, and consequently a relative vacuum at the surface of the ground, which is manifested by descent of the mercury column. The same phenomena would also explain nocturnal oscillations.

It has been recently announced by M. Bouvet, as the result of experiment, that the decomposition of water by the electric current is independent of pressure. He has gone as high as 154 atmospheres, and hopes to try much higher pressure. The expenditure of electricity, moreover, is the same at all pressures for decomposition of a given weight of liquid.

Some stir was lately produced by the discovery, in Lyons Library, of a globe of 1701, in which the Zaire Congo was represented as flowing from a large lake westward to the Atlantic, much in the direction shown by Stanley. M. Costambert remarks in a recent number of *La Nature*, that not only in this case but in all old documents from the fifteenth century such representations occur. The knowledge acquired was doubtless due to the Portuguese, who, from the fifteenth century, repeatedly crossed the African continent, both from west to east and from east to west. They went rather as merchants than explorers, and were often, no doubt, ill-informed; yet they were able to give pretty precise information about the centre of Africa. In most of those old maps the Congo is shown as flowing in a nearly direct line from lake Zaire or Zembra to the Atlantic. On one Spanish globe, however, probably dating about 1530—1540, the river appears as rising from a lake, flowing northwards, describing a large curve north of the equator, then turning west-south-west towards the Atlantic, more nearly as Stanley represents. Some of these maps are reproduced in *La Nature*, May 4, and are well worth examination.

The occurrence of a tree-like fossil plant, Glyptodendron, in the Upper Silurian rocks of Ohio, is announced by Professor Claypole, and said to be of special interest, as no indisputable traces of land plants had previously come to light from so low an horizon in America, and no remains of arborescent vegetation were known with certainty from strata of so old a date in the new or old world.

The Chinese giant, Making Châng, who figured at the last Vienna Exhibition, has (we learn from *Les Mondes*) arrived at Paris. He measures 2m. 17ctm. in height. He has four travelling companions, six Chinese exhibitors and four members of Jury of the Exhibition.

The French *Société contre l'Abus du Tabac* offers several prizes this year. 1. One of 100 francs for a proof from reliable documents of the good results obtained by preventing young people learning to smoke. 2. One of 200 francs for facts and figures showing the influence of tobacco on the aptitude and assiduity of students of any order. Is it a constant fact that non-smoking students, in general, take the priority of their smoking fellow-students, as M. Bartillon has proved at the Polytechnic School? 3. Prize offered to medical men for an inquiry as to whether the immoderate use of tobacco has really an injurious influence—(1), on the aptitude of smokers for procreation; (2), on the constitution and health of their children. The reward is 23 vols. of the *Gazette Medicale de l'Algerie*, and a medal. 4. One of 300 francs for an inquiry into the influence of tobacco on the army; showing whether smokers undergo more punishment, are more exposed to diseases, and do inferior service; privations endured by smokers, either when they can't get tobacco, or are prohibited from using it. 5. Prizes are also offered to those who have been most zealous in the propagandism of anti-tobacco views, in getting the practice of smoking interdicted in public resorts, &c.

A recently-published German work on the chemistry of beer, by M. Reischauer, states that the use of beer dates from very early times. Tacitus says, in his book on the manners of the ancient Germans:—"Potus humor ex hordeo aut frumento, in quandam similitudinem vini corruptus;" and also that these Germans were indeed simple and moderate in their food, but less so in the use of this drink from barley or wheat. Diodorus Siculus (30 B.C.) affirms that Osiris even (1960 B.C.) introduced a beer made from malted grain into Egypt. Archilochus (720 B.C.) and Æschylus and Sophocles (400 B.C.) refer to a barley wine (vinum hordeaceum), and Herodotus (450 B.C.) relates that the Egyptians made wine from barley. The Spaniards knew beer, Pliny reports, as "celia" or "ceria," the Gauls under the name "cerevisia." In England and Flanders beer was commonly in use at the time of the birth of Christ; while old books represent Gambrinus, King of Brabant (1200 A.D.), as the inventor of beer. It is certain that beer was known to the Chinese from very early times. In the middle ages there was a celebrated brewery at Pelusium, a town on one of the mouths of the Nile.

"The Black and White of Music."—Under this title we have a lithographed sheet representing the keyboard in full size, as far as width of keys is concerned, with the corresponding notes of the stave printed on them, together with their names. The sheet, which is published by Messrs. Cramer, will be found of use in teaching children, and will help those who are endeavouring to learn without the help of a master. Mr. E. R. Dale is the designer.

The Telephone.—One of the most interesting and valuable applications of Professor Bell's telephone in the United States was seen in a recent railway disaster near Hartford, Connecticut. An excursion train, returning from Moody and Sankey's revival meetings, plunged through a bridge, killing or wounding many passengers. Brought by telegraph wires to Hartford, the news was taken up by a system of telephone wires connecting a chemist's shop with the residences of twenty-one physicians. So prompt was the summons that in half an hour the physicians, fully equipped, were at the railway station, where a wrecking-train conveyed them to the scene of death and suffering. Thirteen thousand telephones are now in operation in the United States.

LETTERS TO THE EDITOR.

[We do not hold ourselves responsible for the opinions of our correspondents. The Editor respectfully requests that all communications should be drawn up as briefly as possible.]

All communications should be addressed to the Editor of the English Mechanic, 31, *Tavistock-street, Covent-garden,* W.C.

All Cheques and Post-office Orders to be made Payabl to J. Pasmore Edwards.

*** *In order to facilitate reference, Correspondents, when speaking of any Letter previously inserted, will oblige by mentioning the number of the Letter, as well as the page on which it appears.*

"I would have everyone write what he knows, and as much as he knows, but no more; and that not in this only, but in all other subjects: For such a person may have some particular knowledge and experience of the nature of such a person or such a fountain, that as to other things, knows no more than what everybody does, and yet, to keep a clutter with this little pittance of his, will undertake to write the whole body of physicks: a vice from whence great inconveniences derive their original."
—*Montaigne's Essays.*

PORTABLE SAFETY OXYGEN APPARATUS.

[14321.]—Since the last description of my oxygen retort in these columns, of March 30, 1877 (p. 57, Vol. XXV.), while still keeping to my original form, I have thought proper to modify its method of fastening, both for convenience and safety; and, as it is now complete in all details, and combined with a portable gas-holder, I have no doubt many of your readers would be interested in knowing something more of it.

Fig. 1.

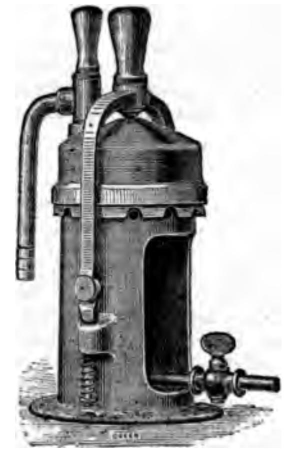
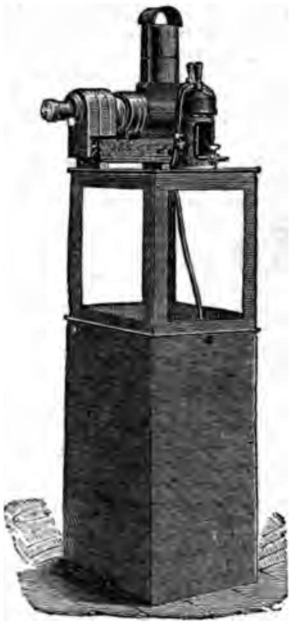


Fig. 2.



The chief features in the apparatus are portability, dispensing with the use of gas-bags, pressure boards, and weights, &c., for lime-light effects and perfect safety.

In the first place, the principle consists in generating oxygen in small quantities at the time of consumption (whereby a continuous supply is maintained) from charges of chlorate of potash and oxide [illegible] made into solid cakes of about 3in. diam. and ¾in. thick, which are quite produce, clean to handle, and about as ha piece of coal.

The principle of the retort (or generator) clearly seen from the accompanying woodcut It consists of two pieces, a flat plate and shaped cap, supported by a stand, in which a Bunsen burner of improved construction cap has an aperture at the top, in which is a pipe, &c., for conveying away the oxyge made. In other respects the retort proper of two simple iron castings turned and grou gas-tight fit.

The fastening consists of a bow, clearly s the woodcut, at the extremities of which a spiral springs, so adjusted to maintain a equal to 1¾lb. per square inch, which pre far in excess of what is necessary for ordina light arrangements. Now it is obvious that the passage from the retort be closed (alth this apparatus there is little likelihood of occurrence), the pressure in the retort wo until it had arrived at 1¾lb. per square inc the gas would escape; and as soon as the was clear again the gas would take its right relieving the pressure inside the retort, and i of the springs the top would close, resum original position. When exhibiting the ap at several scientific societies to illustrate its qualities, as the gas was coming off rapi outlet pipe was closed (by a tap purposel duced), and the oxygen, still being generated, through the joint, as intended, with perfect To open the retort for recharging, &c., p the wood handle fixed to the top of the bow, cap may then be removed by the wood han thereto, and to close the apparatus revers operations. The handles being made of w vent the possibility of burning the fingers use.

The method of making the cakes is as fol To 4 parts of chlorate of potash and 1 manganese, add sufficient water to moisten, wet; after mixing well, fill the mould, usi pressure, smooth off the surplus with the as of a dinner knife or spatula, turn over, cakes will leave the mould entire. After s cakes are thus made, they are set to dry, ei gentle heat or spontaneously; when dry, the are coated by dipping into a mixture of ma and water, about the consistency of cream they are ready for use.

This coating of the bottom with plain ma is to prevent the spent cake sticking to the being the only part in contact with it.

The gas holder is very similar (but with modification) to one invented and introduced Samuel Highley, in 1862, in which lanterns a apparatus could be packed, and was also u stand for the lanterns, a description of wh published by that gentleman in the *British of Photography*, April 1st, 1863, and since other scientific works.

By a displacement chamber introduced in th casing, the water for luting is reduced to mum, about one ordinary bucketful being su

The displacement chamber, which is alw is used for packing apparatus, such as l slides, screen, &c., and is of sufficient cap hold all required for a magic-lantern ex The chamber is provided with a lid and lock-up attachments.

When in use, the pressure is applied by water in a reservoir provided for that maintaining one uniform pressure through can be regulated from a small to a great p according to the quantity of water used. convenient, any other substance than water used for weighting. Fig. 2 shows the appara as a stand for the lanterns—in the presen sciopticon admirably arranged for the lime-lig adapted.

W. J. Chad

THE MATHEMATICS OF MUSIC EQUALITY AND CORRELA NATURES OF THE MAJOR OR MONIC AND THE MINOR OR HARMONIC CHORDS—THE M SCALE EQUALLY HARMONIC HYPHARMONIC.

[14322.]—I am gratified by the continue of my critics, Captain Steel, "P. L.," Fraser, and other correspondents, to eluci subject so that it may be at length clea whether simplicity of ratio is or is not the of the structure of the so-called major diato and, indeed, of all the relationship of the music. Now, it appears to me that nearly respondents have the highest regard imagi the major or harmonic chord, holding it as t and sole structural or determinant eleme scale form, or of the evolution of notes simplest mathematical order, and that in every one may have a perfect view of what the major diatonic scale is constituted, wh look askance at the minor or hypharmonic at a poor and distant relation; wher it atical nature and position, the perfect equal favourite—the harmonic chord. This is, I ignominious treatment of the minor chord, nsist here on the due appreciation of its atical character and dignity.

be it well borne in mind, we are at present ng the mathematics only of music, and so I this assertion, that the major and minor r concords are equally and perfectly simple n and form, be the first to be definitely or confirmed. That they are thus perfectly nd equal I say is obvious, because the ratios tes of each are the products or effects of the r primes in their immediate order, the ratios ne being the reciprocals of the ratios of the o wit, the ratios of the major or harmonic —1 : 1, 2 : 1, 3 : 1, 4 : 1, 5 : 1, and their s by 2 : 1, as far as allowed by the limits of sound; and those of the minor or hyphar- ncord—1 : 1, 1 : 2, 1 : 3, 1 : 4, 1 : 5, and ltiples by 1 : 2, within the same limits. This estion which requires to be first settled, and l again to Mr. Colin Brown, as having y, on his own authority, opposed the onic view of the minor form of relationship d, to say whether he finds the assertion ne or not, as it is possible he may thereby he discouragement he has given to some in their attempt to understand the struc- e minor concord as being the mathematical f that of the major concord.

having attained to this thorough view of o correlated structural elements of scale n—the harmonic and hypharmonic concords see in what manner they coalesce to form a

we take doh, soh, me, the effects of 2, 3, 5, them their replicates, all of which we in- he idea of the harmonic concord; also we lah, doh, the reciprocal effects of the same nd with them their replicates, all of which we include in the idea of the hypharmonic and we observe that all the dohs and mes on to both concords; a fact which estab- e closest possible mathematical relation he two chords, causing them to unite in an tnership, as we find them to unite and to n the so-called major diatonic scale. It hen, that this scale, so far as it consists of armonic concord, and the me hypharmonic is equally of harmonic and hypharmonic . This is the second matter to be accepted l.

xt step is to unite with the doh harmonic nother of the same order. The next note as represented by the ratio 2-11, is ffect of the prime 3. Therefore soh is the rder to become the origin of a harmonic and to it belongs the concord consisting of te, and their replicates. And, on the d—i.e., the hypharmonic side—lah, as the effect of the prime 3, is the next to become n of a hypharmonic concord, and to it hat which consists of lah, rah, fah, and cates.

e now two harmonic concords, the second levelops simply from the first—viz., doh, &c., and soh, ray, te, &c., and two related hypharmonic concords, me, lah, and lah, rah, fah, &c., and these two onstitute the major diatonic scale. It is, obvious that the structure of this scale is armonic and hypharmonic. In other is a perfectly symmetrical and regular nt of notes, and not, as described by Dr. , "a singularly unequal arrangement." n illustration from geometry, it would be to say that the form of an ellipse was a unequal arrangement, the seeming of the arrangement of which vanishes ave regard to the equal rule held by its So, when we have regard to the two l correlated structural elements of the ecessary natures of which are determined of simplicity of ratio, the "inequality of ement" of the notes forming this scale nishes. It is a mere phantom.

I ask, does or does not the principle of cal simplicity determine the development ur concords in the order I have shown? then, on mathematical, which is to say, , grounds, the so-called major diatonic sts in its collective form of the notes doh, me, fah, soh, lah, te, doh^1. As to the hat is, the practical part of the question— h to say here that the only disputed point rah. But that rah belongs to the scale has been most conclusively shown by teel (No. 660, letter 13543).

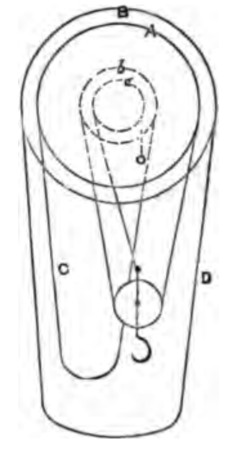
to those correspondents who think it to regard the scale as harmonically ?) from fah in three successive chords— ah, doh; doh, me, soh; soh, te, ray—I y that it would be just as sufficient, but ufficient, to regard it as hypharmonically from te in three successive chords, the s of those put forward—thus, te, soh, me; h; lah, fah, rah.

"P. L." asks, "why should we be called upon to accept the 'hypharmonic theory?'" Perhaps "P. L." means the hypharmonic part of the theory of mathematical simplicity in music. I answer that the principle of simplicity necessarily implies to an equal extent the co-existence of both orders of note relations.

May 4th. **Fred. J. Jackson.**

THE COMPOUND PULLEY BLOCK.

[14323.]—Will Mr. Jewsbury say if the annexed is a correct circular-face view of the compound pulley block of letter 14281 (May 3), with its chains, B being one with *b*, and A one with *a*, and A and B being equal, and *a* and *b* equal? And will he intelligibly explain the action of the block, both for raising and lowering, and his figures as to its effectiveness in respect of power? **Aliquando.**

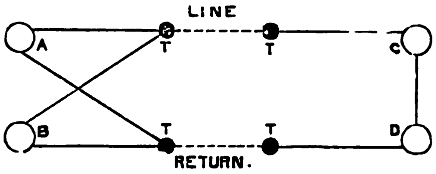


THE TELEPHONE.

[14324.]—The subject of electric telephony has hitherto received well-nigh exhaustive treatment in your valuable pages, but there is still one point to which, perhaps, I may be allowed briefly to draw attention.

Most experimenters in this direction, like myself, I imagine, will not be content with a single pair of telephones on the circuit, however powerful they may be, but will hasten to avail themselves of the extra power and convenience so easily derived from using a double pair.

These may be connected either in multiple arc or in series. The former, I believe, is the method usually adopted, but a little consideration, I think, will show that the latter is the better plan. It will be evident, on reference to the Fig., that, when A is spoken into, the greater half of the current passes through B, and thus fails to be utilised—in fact, the arrangement is short-circuited. On the other hand, if all the four telephones are connected in series as shown at C and D, although the resistance of the circuit is greater, the whole of the current is made available, and the sound consequently is very much stronger. Of course it is quite possible, in the former arrangement, as suggested by one of your correspondents, to disconnect B by means of a key while speaking into A, but the latter is practically the simpler plan, and the current must then be uniform throughout the circuit.



I may say that I have found 40ft. of silk-covered copper wire ·025in. diameter, for the coils, give better results than 40 yards of No. 36, and cotton braided gold twist is an excellent material, on account of its pliability, for connecting the telephones to the terminals. **W. B.**

THE TELEPHONE HARP.

[14325.]—The article upon the "Telephone Harp" in the current number of your journal, though careful and accurate in the main, contains one serious error, which I must ask you to correct. You refer to the telephone harp as "invented by Mr. M. J. Matthews, and made by the Messrs. Mason and Hamlin." It is true that Mr. Matthews, who is a most ingenious and skilful musician and mechanician, as well as the Mason and Hamlin Organ Company, of which he is a member, rendered me invaluable aid in the production of the telephone harp—aid which I have acknowledged upon both public and private occasions (including the soirée of the Royal Society, May 1, and the meeting of the Society of Telegraph Engineers, May 8), and which I valued so highly as to include Mr. Matthews' name with my own in the American patent specifications. But it is equally true that neither Mr. Matthews nor the company mentioned has ever laid claim to the invention in the manner implied in your article, and that the ascription of it, as a telephonic instrument, to them places them in a false—and, as I have every reason to believe, an unwelcome—position.

Frederic A. Gower.

Morley's Hotel, Trafalgar-square,
London, May 11.

TELEPHONIC.

[14326.]—Would not the telephone be improved in its sounding capacity if the hand of the person holding it were better insulated? At present, the hand grasps the wooden case, and it seems to me that an ivory or glass knob inserted in the side would cause the vibrating current to act entirely on the diaphragm, instead of, as it must to some extent do now, going down the body to earth. I append a letter cut out of the *Sydney Morning Herald* of this date, that may prove of interest.

Sydney, March 14, 1878. **P. D.**

"Telephones.—To the Editor of *The Herald*.—Sir,—Having recently made a quantity of telephones for a well-known firm in this city, I feel myself in a position to offer a hint to your readers that may possibly assist those interested in becoming as successful as myself.

"It refers to the diaphragm. In all published notices stress is laid upon its thinness, and ferrotype plates were soon in great demand. My first pair were made with such plates—the articulation was faulty, and the volume of sound small. I now use common tinned iron plates 4in. in diameter; the tin is turned off over a clear fire, and they are so arranged as to have a clear vibrating space of 3in. These are successful to a degree that quite surprised me, the ticking of a small clock, and the breathing of the operator are heard in an unmistakable manner.

"One experiment is worth recording. Two instruments were attached to despatching end of line, and one at receiving. A lady and gentleman sang at despatching end, 'Home, sweet home,' the lady singing soprano in one instrument, the gentleman tenor in the other; at receiving end both voices were heard harmonising, or could be individually heard at will of receiver, whilst every word in this pretty ballad was distinctly recognised.—T. E. Hewett, Neutral Bay, March 11th."

THE TRANSIT OF MERCURY.*

[14327.]—I came up to town from Tunbridge Wells on Monday (May 6), in the hope, but not with the expectation, of seeing Mercury in transit. Throughout the ingress the sky was overcast (at Clapham), except for a second or two, when I caught a glimpse of Mercury rather more than half immersed. At 3h. 21m. the sun shone out for awhile, and from then till about 3h. 50m. he could be seen during intervals of greater or less length, but nearly all the time there was so much haze that no darkening glass was required. I was using the solar eyepiece with two prisms, and the full aperture (8½in.) of my Browning-With reflector. A bright ring was seen round Mercury, darkening off to the limb of Mercury as described by Mr. Talmage; but the ring as I saw it was far narrower than he describes it. Its breadth was little more than half the radius of the planet. A bright spot was seen on Mercury's disc. It appeared to me perfectly central and of sensible magnitude. My eldest daughter, who observed with me, described it as a mere point, and quite central, as if the disc were a round piece of black card, and the bright spot were a hole pierced through with the compass-point in striking out its circular outline. I noticed one feature in the bright spot which seemed to me decisive as to its subjective nature; when a small cloud passed over part of the sun's face, nearly the whole of which was in the field of view, the bright spot perceptibly waned in brightness, though not crossed by the cloud. This I noticed distinctly three several times. Another feature—perhaps a mere illusion—was that it seemed to me, as the spot thus waxed and waned in brightness, that it was triangular in shape. I could not distinctly recognise this peculiarity when the lustre of the spot was steady. The aspect of the spot was not perceptibly modified when the telescope was released from the driving-clock and Mercury allowed to approach the edge of the rather wide field of view. But the weather was altogether unfavourable for observation of this kind, as the brightness of the solar image was constantly varying. After 4 o'clock only two momentary glimpses of the sun were obtained.

The opening in the clouds, which allowed the sun to be seen at 3h. 21m. at Clapham, was no doubt the same through which Mr. Cole at Sutton watched the ingress, and through which Mr. Talmage at

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* From the *Times*, May 9.

Leyton saw a later stage of the transit. The clouds were travelling rapidly towards the north-west.

I venture, by the way, to note that astronomers, and especially the American observers of the total solar eclipse of 1869, will hear with some surprise that M. Janssen discovered the solar corona in 1871. He observed it very successfully in 1871, but he was certainly not credited with its discovery, any more than last autumn, when he very successfully photographed the sun, he was credited with the discovery of that luminary. It would seem we must transfer to M. Janssen what was said eight years ago in (good-humoured) jest of another solar observer:—

> "Of the solar corona,
> He says, 'I'm the owner,'
> And sneers at the moon as far rockier."

Richard A. Proctor.

Tunbridge Wells, May 7.

[14328.]—TO-DAY the transit of Mercury was very excellently observed at Newcastle-upon-Tyne. The sky was clear during the transit, and the planet formed a well-defined circular spot on the sun's disc, which at present is entirely free from regular sun-spots. The minute of ingress was, as well as I could perceive, 3.15.

26, Archbold-terrace, Newcastle-on-Tyne, May 6. **T. P. Barkas.**

[14329.]—THE weather here was very unfavourable for observing the transit, as the sun was obscured by clouds, particularly at the commencement, when the sun was totally obscured. I first saw Mercury at 3h. 28m 58s., or 16m. 33s. from the commencement of transit. Distance from sun's centre, 14′ 37″; distance from sun's E. limb, 1′ 15″. At 3h. 58m. it became cloudy, and so it continued until sunset. **B. J. Hopkins.**

Latitude, 51° 33′; longitude, 0h. 0m. 0s.

[14330.]—MONDAY, the 6th inst., was, in this part of Ireland (Co. Limerick), unusually cloudy, with continual rain. However, at 5.30 the clouds suddenly opened, revealing the sun, across whose disc the planet had now more than half way passed. For upwards of an hour, whilst the sky was clear, I viewed the transit, using an achromatic with a power of 60, the best the air would admit of. When the sun shone brightest the colour of Mercury appeared a greyish brown (mouse colour); often this shaded into inky blackness as clouds flew over and partly veiled the sunshine. There was no spot on the sun, but the mottling of the surface was very easily observed. Mercury showed a decided border of brightness, a fringe or penumbra, perhaps a result of contrasted brightness. The power I used was insufficient to notice any spot on its globe.

E. B. Fennessy.

[14331.]—I WAS able partially to observe this transit here on Monday, the 6th inst. The sky cleared sufficiently to reveal the sun and planet just at the moment of internal contact, about 3h. 14m. G.M.T. After that the transit was visible more or less perfectly through the drifting clouds for about 20 minutes. I saw no aureola, nor any white spot on the planet. The planet was a round black spot on the sun, and no more. I observed with a 2¼in. aperture and a power of 65.

47, Byrne-road, Balham, May 7. **D. Traill.**

NOTES ON OUR SATELLITE.

[14332.]—THE new method of nomenclature mentioned and illustrated on p. 139 *ante* is very ingenious, but I should like to suggest one or two slight modifications. Let Roman letters be employed for craters and depressions; Greek letters for hills and mountains; italics for clefts; ordinary numerals for the valleys and gullies between mountains; Hebrew letters for light streaks, to prevent confusion by lettering them the same as the mountains; and asterisks, &c., for doubtful objects.

In a figure accompanying letter 14144, p. 67, "W. J. B. R." shows two craters about a diameter S.S.E. of Cathrina. On April, 8d. 11h. 10m., 1878, I noticed the eastern of these two to be composed of two adjoining craters N.W. and S.E.

Short notes describing Hansteen and Billy may not be altogether amiss at present. The former (1878, Feb. 14d. 12h.) has a ring (ancient I should rather fancy) of irregular height upon its floor, having an altitude scarcely one-half that of the outer ring—which itself is not very high—and a central hillock higher than the interior, though not so elevated as the outer wall.

Billy (April 14d. 12h. 15m., 1878), has a very dark floor; its narrow, lucid wall is broken in the south by a small dark craterlet, just north of which a little hillock was suspected near the S.W. wall, while tiny patches of light were suspected (only just suspected though this might be worth mentioning) on various parts of the floor.

With my instrument, 1878, March 15d. 11h. to 11h. 50m., the region Lee, between Vitello and Doppelmayer, was transformed into two large broken (in the N. bends) rings, respecting which I may perhaps say something before long, after a little further observation. One or two sketches from other pencils might prove useful. I was using the 2¼in. **F. Compton Dennott.**

Southampton, May 6.

CASTOR—THE USE OF THE SIGNS ′ AND ″.

[14333.]—I WAS startled to read from the pen of "F. R. A. S.," "I do not possess 'Slugg's Observational Astronomy,' but 4in. seems to be a funny distance for the components of Castor." As I happen to possess and to use that work, I felt sure there must be a mistake. On referring to the letter of "Argus," I find he does make that statement. The fact is Slugg's work distinctly says of Castor "Distance 4″." There is a most ridiculous practice springing up of using the signs ′ and ″ to represent feet and inches, instead of minutes and seconds. The case in hand shows the absurdity of it, and has led "Argus" to do an act of injustice, by misrepresenting the work he quotes from.

Kelby.

TELESCOPIC APERTURES—SIRIUS—STELLAR PHOTOMETRY.

[14334.]—"8¼IN. O.G." has been so well taken in hand by others that I need not waste space about him, except to give an extract from Vol. I. of Dr. Kitchiner's "Economy of the Eyes," p. 150, which reads very differently to the extract he gave some time back about telescopic drawing. It runs: "The same evening, that with a power of 180, the planet Jupiter has appeared to me to be about an inch and a half in diameter, a person who observed it the next minute said it looked as big as the moon; another, about four inches diameter; and a third thought it did not appear quite so large as a small pea."

I noticed the tint of Sirius mentioned by "Brickwall" in letter 14110, p. 38, first on December 26, 1877, when I have the note, "Sirius certainly not white but a beautiful blue (No. 3 blue Smyth's chromatic scale), and very vivid. The same fact pointed out to me by an inexperienced observer at 10h. 15m." On December 29 I noted "the blue tint of Sirius, and an exactly similar tint to Rigel (β Orionis) again noted." January 6, 1878, "Sirius appears whiter than formerly when seen by direct vision, but the beautiful blue colour remained very intense by averted."

Query.—Was this excessive blueness noticed in other stars, because if so it is most probably due to an increased clearness of our atmosphere during the winter months gone by?

On January 6, and again on January 9, I made some experiments which may be interesting to some. On the first occasion I have the note, "Sirius, when its reflection is examined side by side with Rigel, is a very little the faintest, but is about equal (perhaps a very little brighter than) α Orionis. The reflecting surface was pale blue glass, and the reflected image was placed side by side (distant about 2°) with the comparison stars." On the latter occasion my note says, "Sirius—the brightest of the two reflections given by a sheet of clear glass is rather fainter than β Orionis, though rather brighter than α Orionis. Capella is nearly equal (when thus reflected) to the belt star, δ Orionis."

May 6. **F. C. Dennott.**

COMPRESSION OF GASES—ASTRONOMICAL.

[14335.]—I HAVE repeatedly seen it stated in text-books that gases contract under the influence of reduction of temperature to such a degree that 273 volumes at zero become 273 − n volumes at a temperature of − n°. The inference is, as some of them point out, that at − 273 the gas would disappear entirely. If this is not utterly inconceivable and absurd it might be instructive to perform the converse of the experiment, thus:—

Having completely exhausted a litre vessel at the temperature of − 273, let heat be applied, and on attaining an ordinary temperature the vessel will of course be full of gas. The one inference seems to be as reasonable as the other.

There appears, however, to be a simple solution of the difficulty. We are told that the law of 273 − n is only strictly true while n remains small, and I think the reason is that the gas loses not 1-273 for the first degree, 2-273 for the second, and so on; but that it loses 1-273 on the second occasion, not from the original quantity, but from what remains after the first loss. This law will only differ very slightly in its effects from the old one so long as n remains small, while it saves us from the reductio ad absurdum. According to this rule—

1 vol. at 0° becomes $1 - v$ volumes at $-1°$,
and $(1 - v) - (1 - v)v$, or $(1 - v)^2$ vols. at $-2°$,
and $\{(1-v) - (1-v)v\} - \{(1-v) - (1-v)v\}v$, or $(1 - v)^3$ vols. at $-3°$,
and $(1 - v)^n$ at $-n°$, and similarly $(1 + v)^n$ at $+n°$, where $v = 1\text{-}273$, and of course x volumes would become $x(1 \pm v)^n$ at $\pm n°$.

According to this formula the law becomes quite independent of the arbitrary zero, and would work equally to the same results with any other scale, which certainly cannot be said of the old system, supposing, for instance, that the law were arranged so as to start from the boiling instead of the freezing point. A little consideration will render this clear.

By the above formula 273 volumes will become 720 at 273° instead of 546, and will shrink at − 273° only to 101, instead of undergoing annihilation, which I have always understood to be impossible for any kind of matter, according to our modern chemistry. Possibly the materialists may be able to argue from this in favour of the annihilation of the human existence after death, that the body could be rendered gaseous and then reduced to − 273.

I believe it would be interesting to others besides myself to have some further information relative to the newly-discovered satellites of Mars, their elements, &c. Is it possible that their discovery may correct the still outstanding serious error of the lunar theory? and how is it that they have never been observed to transit the disc of the planet?

Inland Revenue, York. **Lator.**

CONSTRUCTION OF BREWERIES AND ARRANGEMENT OF APPARATUS.

[14336.]—HAVING been requested to give our readers some idea of the best form of building and arrangement of brewing apparatus, the following may perhaps prove serviceable. Of course it will be understood that this is written more especially with reference to the requirements of a medium-sized brewery, and that a very small plant, capable of brewing only about 10 barrels, will not necessitate such complicated apparatus and utensils as a larger plant would.

As the majority of the breweries now in operation have been built many years, we cannot suppose that all of them have been constructed on the most scientific principles, or even in the most suitable manner; neither will they be always situate in the most convenient locality for acquiring good air, efficient drainage, and a water supply free from organic contamination, and containing in solution those salts necessary for the production of a first-class pale ale; therefore, when new premises are to be constructed, or even when old ones require altering, the following suggestions may prove of great service:—

In the building and arranging of brewery plant all depends on what system of fermentation is followed, whether the Burton Union, Skimming, Cleansing, or Stone-square—each different system involving the necessity of different construction of plant. For this reason it is quite impossible to lay down fixed rules, although certain factors common to all bear with importance upon the question of site and selection of brewery buildings. Therefore, the first consideration is the necessity of good drainage, so as to allow the bye-products of the brewery (which quickly decompose and give off offensive gases) to be washed away; and for this purpose we must secure a good supply of water, with drains perfect enough to prevent any contamination of this supply, from percolation of impure liquids into the water-bearing strata.

In constructing a brewery building the brew-house should be sufficiently high to allow of a regular flow of the liquid by gravitation, from the time when it commences as an infusion of malt [illegible] water until it finally appears in the cellars as finished beer. We shall thus prevent any necessity for pum[illegible] and elevators; and by so doing we save expe[illegible] and abolish many utensils which are and alw[illegible] will be a fruitful source of acidity, dirt, and wa[illegible] Circumstances may arise which will prevent us f[illegible] arranging the buildings of sufficient height, b[illegible] the event of a brewery being built, as advis[illegible] will be only necessary to elevate the unground [illegible] so as conveniently to run into the mill; and al[illegible] pump the brewing water to the top of the [illegible] house, and having done so, we shall not re[illegible] any further help from elevators or pumps, wit[illegible] exception of what water may be required fo[illegible] frigerating and attemperating. Much risk of [illegible] tamination from the formation of a minute soluti[illegible] the metal, by the passage of the worts through metallic pipes, will thus be obviated.

Each department should be separate, and [illegible] connected with the next in natural sequence [illegible] mills and grist bins should be well above the [illegible] tun, and the taps from the tun should flow int[illegible] coppers without the interposition of an underb[illegible] thus we do away with the necessity for wort pu[illegible] prevent much acidity, and save fuel. The co[illegible] should run into the hop-back, which must be [illegible] enough to contain an entire boiling, and from t[illegible] the wort should flow into the coolers (unle[illegible] dispense with them entirely), then throu[illegible] refrigerator passing into the fermenting tu[illegible] into the settling back, and finally running [illegible] vats or barrels; and if the levels are arra[illegible] systematic manner, hardly any pumps will be required, and much complexity of arrangement obviated. Shortly, what we require is to build a tower in which we can place the malt mills and mash-tun high above the other utensils, dividing the coppers from the cooling and fermenting departments, to prevent any possible retardation of the cooling process by steam, and also any injurious effect which it might otherwise have upon the fermentations.

The Mash-tun should be capable of being well closed, so as to retain the heat while the converting process is going on, and it should be constructed so as to hold four barrels of liquor to every quarter of malt brewed. Iron is without doubt the best material for the construction of mash-tuns, its durability and freedom from acidity greatly recommending it; but it is necessary that every part of the outside should be well covered with a good non-heat-conducting material, such as most of the compositions sold for the purpose; or perhaps felt is the most suitable material when neatly covered over with wood work.

Underbacks, wherever possible, should be abolished; but, if their use be unavoidable for want of height, then iron is by far the best material for their construction.

Coppers.—It is necessary (excepting in the very smallest plants) to have at least two of these, so as to conveniently boil without waste of time, and although in small breweries various methods are adopted to admit of the work being carried on with one copper, yet it cannot be so satisfactorily performed as with two. We have also to decide whether steam or fire boiling is preferable, and of the two, I consider the latter to be the better, as fire boiling has more penetrating power, or appears to effect more changes in the worts, which are strictly chemical in nature, and of great importance. In some breweries, what is called a "dome" copper is used, but in addition to the waste of time consequent on its sole use, there is also great liability that the worts may be darkened through overheating under pressure of steam, and consequent caramelisation of the worts. For this reason Burton brewers employ open coppers. Dome coppers were originally supposed to prevent loss of hop oil, which passes off with the steam, but they have not succeeded. Open coppers are without doubt the best, providing they are large enough to hold a wort, without fear of loss by boiling over, with ordinary care. In the construction of coppers, the size must vary in proportion to the quantity of malt usually brewed; but bear in mind that increased height will give greater pressure, and consequently more danger of colonration. When we have but one copper it should hold from 4 to 5 barrels for each quarter of malt used, although if we have two coppers they will not require to hold more than from 1½ to 2 barrels per quarter. Coppers should be well scoured each time before brewing, using either sand, fine flue dust, or chain for the purpose, as it is well known that a copper will tarnish on boiling a wort in it, and it will even do so to a small extent simply when exposed to the air. In the former case an acetate of copper is formed, and in the latter an oxide, and if the copper be filled again when dirty, it will appear bright after heating a wort in it, the lactic acid in the wort having dissolved off the deposit that has formed, thus retaining in the wort the poisonous copper salt.

Coolers.—These should be well ventilated to allow free escape of steam, but excessive admission of light must be avoided, and actual sunlight should never be allowed to shine on the worts as it is capable of effecting, and no doubt often does effect, chemical change therein. When coolers are constructed of wood, great loss and inconvenience is found in keeping them in order. Their frail nature and liability to contract under the constant application and removal of lime and water necessary to keep them clean (but which also assists in their decay instead of arresting it) is greatly against their use. There is often a very peculiarly offensive flavour imparted to beer, which is commonly known as the "Fox," and which is caused by the formation of a fungoid growth on the pores of the wood, attributable to neglect in cleaning the coolers. This can only be entirely avoided by discarding the use of wood as a material in the construction of these vessels, and by substituting a less precarious material. The use of glazed tiles, or preferably iron, will be found advantageous for this purpose. Wood is about the worst material that can be employed for coolers, but where they are already in use it may not be convenient suddenly to discontinue using them; and therefore, when washing them, it will be well to remember that *cold* water should be employed for the purpose, and not hot water, as is customary, for the reason that hot water closes the pores of the wood which will inclose any impurities that may be in them, and these will remain there until the wort having been let into the coolers begins to cool—the pores then open and liberate their contents, which, aided by favourable temperature, act as ferments on the wort. Now, although cold water is best for cleansing coolers, yet *hot* water is necessary for finishing off when clean; it will also dry sooner, although it has been advised by some writers to leave coolers wet, to prevent loss of wort by absorption; yet this is false economy, because the moisture thus left in the wood is the very thing necessary for the formation of acidity when in contact with the albuminoid constituents of the wort.

If, after what has been here explained, any one should prefer to construct coolers of wood, first let the moisture be driven out of the pores, and then treat the wood with melted paraffin wax, or enamel. The expansion and contraction of wood coolers create a kind of pump, and as the timber absorbs heat when covered with wort, the pores open, and anything then in contact instantly enters; the timber, contracting as the cooling process proceeds, its fibres assume a more compact position, the pores close, some air containing ferments issue from them, and foxing of the worts naturally results. Again, the albuminous sap contained in the pores of the wood works its decay when in contact with air and moisture; the solvent power likewise of the water draws out the albuminous sap, and the wood becomes like a sponge, absorbing impurities from the worts, which settle in the pores day after day, and act as ferments.

Where a powerful modern refrigerator provided with a good supply of very cold water is in use, large coolers are not only unnecessary, but wasteful and dangerous, by reason of the exposure of the worts to the action of the air; all that can possibly be required being a small iron cooler, large enough to just hold one boiling of wort, and to be used chiefly as a means of settling any deposit which may run out of the hopback.

Hopbacks.—These should always be made of iron, as we always find that in all brewing vessels constructed of wood, and which are liable to excessive changes of temperature, dryness, and moisture, there will be a disposition to form an excess of acidity.

Fermenting Tuns.—In the construction of vats, rounds, and squares, the question of pressure militates against the employment of very deep vessels, attenuation being considerably retarded by the pressure exerted on the lower part of the wort, and the same objection to the use of wood in the construction of coolers applies (although perhaps not so greatly) to its use in mash-tuns and fermenting tuns, or for any utensil subject to changes of temperature. Wood, slate, and stone are used in the construction of fermenting tuns, the last being in most cases preferable; and, if wood is used, it should be treated with melted paraffin wax before making into squares or rounds. They should never be made of iron, and all mixtures of metals should be carefully avoided, zinc and lead being entirely prohibited. They should also be arranged in parallel lines, so that, if necessary, the rousing or pumping may be done by machinery. Plenty of room also should be allowed for the yeast to form, either in large stone backs, as in the stone square system, or by the use of high boarding in the ordinary skimming process. There is one very important point which is but seldom provided for in many breweries, although great care is used in attemperating the fermenting wort itself, yet the temperature of the yeast which rises on the wort is never controlled in the slightest; but we should bear in mind that it is quite as necessary to attemperate the yeasty head as the body of the wort, because the ordinary floating yeast heads are many degrees warmer than the wort below, and, as a high temperature induces unsoundness by favouring the propagation of false ferments in the yeast, it is quite as important to control the temperature of the yeast as the wort.

Fermenting vessels made of stone or slate are free from acidity, require no cleansing agent, and do not need scalding out; in fact, as they are liable to crack and split on the application of hot water, it is imperative that scalding water should not be used in them. Slate being a good radiator of heat is not suited for fermenting tuns, in which any sudden change of temperature is undesirable, although there are many squares made of slate now in use, and giving tolerable satisfaction; but if slate is used in the construction of *settling backs* it will be sweet, clean, and so cold, where coolness is not only welcome but necessary, that in that case its employment is always satisfactory.

The cleansing mains and pipes used for racking and filling should be removable at pleasure, the connections being made by means of unions and screws, thus enabling them to be easily taken down for cleaning at short intervals. A very necessary plan also is to cut off all electrical connection between the tuns and mains by means of short lengths of flexible india-rubber tubing, and the mains should be made entirely of tinned copper; lead being objectionable should be entirely abolished, not only for the sake of cleanliness, but also to prevent the formation of poisonous lead salts in the beer.

Fermenting tuns should stand on brick, stone, or wood, entirely insulated from the mains and earth, and should not on any account be placed under any utensil likely to give off heat, such as an iron hopback or cooler, as it will cause the head to drop, and spoil the beer. In fact the more head room we can get over the tuns the better in every respect it will prove.

Malt-bins should be lined with tiles or galvanise sheet iron, not allowing contact between the mal and brick walls or woodwork—the latter precaution as a preventive against a very common pest in maltings called the weevil. If we cannot conveniently employ tiles or sheet iron to prevent contact between the malt and walls, a good plan is to leave about a yard thick of malt coombs next to the walls or sides of the malt-bins. As malt improves by storing in large bulks, out of contact with the air, it should be shot into large bins directly it is received, and on no account should it be allowed to stand about the brewery in sacks, as it will quickly imbibe moisture, and thus acquire a large excess of lactic acid.

Hop-rooms should always be kept quite dark, as light has a powerful chemical action, and darkens the colour of hops, while currents of air should be avoided, as they carry away the volatile oil of hops.

Cellars should be always kept at an even temperature, and free from air currents. They should also be lofty, and under or above ground, as most convenient.

Tun-rooms are fitted up according to the system of fermentation in practice, but must be well drained. Foul air should be prevented from coming up from the drains, and it is of importance that no stale yeast be allowed to remain on the floors, walls, or any part of the tun-rooms. Nothing is of more importance than cleanliness in every department; all walls should be continually lime-washed, plenty of hot lime should be employed when necessary, and the greatest care should be taken to guard against all likely causes of acidity or putrefaction. If stale yeast or any organic filth in a state of putrefaction is allowed to remain in any part of the brewery putrefactive germs will be given off from it, and these germs, settling on the fermenting worts, will cause failure in the yeast, and unsound beer.

In erecting a brewery the points of prime importance are a water supply free from organic contamination, and good drainage. We also see the advantage of adopting the gravitation system of building, so as to avoid the use of pumps and metal piping. The cost of buildings and utensils can best be arrived at by inviting tenders from several brewers' engineers.

Rotherham. **H. P. Harris.**

ON THE MEASUREMENT OF THE APERTURE OF MICROSCOPE OBJECTIVES.

[14337.]—WE are sorry to gather from the tone of Mr. Wenham's last communication to the ENGLISH MECHANIC (letter 14309, p. 218) that he seems to think us disposed to differ from him for mere controversy's sake, than which nothing could be further from our purpose. We acknowledge, with all men, Mr. Wenham's pre-eminence and our own obscurity in the world microscopical. We merely claim, with all other students of science, the privilege of recording the results of experiments which seem to be at variance with those of another experimenter.

Since reading his letter we have repeated our experiments, in obscuring half the face of the objective, with the same result. We should be glad if any other microscopist, interested in the subject, would do the same, as it can be tried by any one who possesses a microscope and a pocket lens. But we find that the only safe plan of obscuring half the face of the objective is to gum upon it a dark screen which accurately bisects it, as the slightest distance between the screen and the glass gives rise to very erroneous results, especially with high powers.

He is mistaken in supposing us to affirm that "concaves associated with eyepieces" are not apt to elongate the focus. In those experiments of ours, to which he made this objection, the examining lenses were expressly stated to be plano-convex achromatics. **Richd. Nickols.**

Jersey, 11th May. **Martin M. Bull.**

MICROSCOPICAL.

[14338.]—THE most methodical way for me to set about thanking my microscopical friends is to take their letters seriatim, and therefore I commence with "Essex" (letter 13530). I am sorry, as my drawings are not detailed sufficiently, that I occupied space with them; but it is rather difficult (or, at any rate, with my present instrument) to make a better likeness of objects. I assure you, sir, they appear exactly as I saw them.

Would Mr. Walker (letter 13540) kindly say where such a book as he advises me to get can be had? I have "Hogg," "One Thousand Objects," and "Davies on Mounting," also the last two years of the *Microscopical Quarterly*, and still I am, if anything, more puzzled than ever "on what peg" to hang my objects.

Please let none of my friendly advisers get the idea that I know anything about microscopical matters, for I do not; but I am very grateful for all help. In fact, "all contributions thankfully received."

To "Amateur" (letter 13594) I shall say that I *ways my correspondence may seem peevish. The [illegible] of the [illegible] papers yet [illegible] work of the [illegible] [illegible] of very [illegible] and plenty of [illegible].*

As Mr. [illegible] agrees with Mr. Walker (who [illegible] works, in the [illegible] of the [illegible], I feel [illegible] that I am [illegible] of peace between them. [illegible] own "[illegible]" [illegible] I [illegible] like one of [illegible] sent an [illegible] called gyrogrammes [illegible] gentlemen. [illegible] is a compound of [illegible] up of [illegible]. Now, I placed a pane about the size of a [illegible] and put a drop of weedy [illegible] and with a [illegible] objective watched it; two circular currents were immediately commenced, giving me [illegible] of miniature maelstroms. These currents kept up for at least 15 minutes, when they suddenly stopped. Why was it so?

I am very sorry to see the microscopical correspondence dropping off, and feel inclined to wish we were all "Yankees." I was some good and [illegible] hints were [illegible] such as "M. [illegible] C." was doing. His, to me, were really enjoyable, because I understood them. I cannot devote myself entirely to microscopical study for the reason there is so much else to do, and so have not the time to worry out the extreme depths, and I dare say there are many like me.

To finish up, and also "meander" from microscopy, I may state that it is now the middle of March, the thermometer is [illegible] in the shade, and as I sit writing I have a [illegible] mosquito feeding on one knuckle. What do you in England think of that? Any Australian queries I shall be happy to hunt up and answer. **E. C. H.**

THE YEAST PLANT.

[14339.]—In letter 14288 "W. G. P." is under the impression that he has found out a true case of spontaneous generation, because some saccharine liquids will ferment without the addition of yeast, while others will not do so. But his supposition as regards spontaneous generation is erroneous, although he is perfectly right in believing that germs of the yeast plant are continually floating about in the air. I will endeavour to show him why some liquids ferment easily, while others do not. In doing so I shall have to quote largely from Dr. Tyndall's works.

Most people are aware that any liquid containing sugar, either from the fruit of plants or a mixture of honey and water, if left to itself a short time undergoes a peculiar change. No matter how clear it might be at starting, yet after a few hours the liquid becomes turbid, bubbles appear in it, and a dirty looking yellowish foam or scum collects at the surface, and a similar kind also falls to the bottom. During the process the sweetness will have nearly all gone off the liquid, and in its place spirit has formed; carbonic acid gas also is continually given off. Now, these facts have been long known, the process being called fermentation, which we also know is promoted by adding yeast. Yeast germs arising from the abnormal growth or unhealthy formation of yeast, may become dried up, and from their extreme minuteness, are very easily carried about by atmospheric currents. Thus we can easily account for the yeast germs which we know to be very generally in the air; spontaneous generation is out of the question here. If we inquire where the yeast came from we have a problem capable of being easily solved. We see that we have only to expose a solution of sugar, or any syrup or vegetable juice to the air, in order, after a short time, to see all the phenomena of fermentation. The first obvious suggestion will be the same as "W. G. P." remarks that the Torula, or yeast plant has been generated within the fluid, and it seems at first quite absurd to entertain any other conviction, but it is erroneous.

Although yeast Torula cells may be generated from germs in the atmosphere, still that mode of formation would not be sufficiently expeditious for the purpose of raising yeast as a ferment; besides a malt extract submitted to such a process would be sour and unfit for use, long before the fermentation had finished. When abandoned to the contact of our common air beer sooner or later ferments, but the chances are that the produce of that fermentation, instead of being agreeable, would be disgusting to the taste. By a rare accident we might perhaps get the true alcoholic fermentation, but against enormous odds. *Pure air*, acting upon a lifeless liquid, will never provoke fermentation, but our ordinary air is the vehicle of numberless germs, which act as ferments when they fall into appropriate infusions; some of these produce acidity, some putrefaction. The germs of our yeast plant are also in the air, but so sparingly distributed that an infusion like beer wort exposed to the air is almost sure to be taken possession of by foreign ferments. In fact, what Pasteur terms the "maladies of beer" are wholly due to the admixture of these objectionable ferments, whose forms and modes of [illegible] differ materially from those of the true yeast plant. We are therefore [illegible] to promote fermentation by [illegible], or in other words, we [illegible] a sufficient quantity of Torula [illegible] as to produce a quick and healthy fermentation.

But we can [illegible] "W. G. P." remarks that the juice of grapes will ferment readily without the addition of fresh yeast, as [illegible] the fermentation of malt extract or sugar solutions, and this we may attribute to the peculiar fact that [illegible] ferment germs necessary for [illegible] alcoholic fermentation, and this very remarkable fact has been proved by the experiments of MM. Pasteur and Bernard. The germs which excite alcoholic fermentation are very abundant upon the husks of ripe grapes. They lose their fecundity, by drying at the ordinary temperature in a few months, even upon the wood of the branches. For this reason, even perfectly ripe grapes, when crushed in [illegible] in contact with air, frequently do not ferment. Experiments made with strawberries, cherries, and currants show that before maturity these fruits do not exhibit any fruitful germs of alcoholic fermentation. They do not ferment if crushed in contact with air nor even cause the fermentation of sweet juices into which they are plunged whole. But, as with grapes, they ferment when a sufficient quantity of them is employed, and if the experiment be conducted on fruits more or less isolated, fermentation occurs or not, according to the presence or absence of ferment germs. The ferments are more plentiful in summer than in winter, as may be shown by exposing freely to the air for about forty-eight hours a series of basins containing grape juice, and then transferring their contents to bottles with long necks projecting from boiling water. Fermentation will proceed in nearly every case; and a number of different germs may be recognised. In winter the experiment is but rarely successful.

Now, a person not knowing these facts would be inclined to attribute the fermentation of grape juice to spontaneous generation. If we let a quantity of clear filtered must of the grape be so boiled as to destroy such germs as it may have contracted from the air, the uncontaminated must never ferments. All the materials for spontaneous generation are present, but without sowing seed life will not develop, neither will there be any signs of fermentation, which is the concomitant of life. But it is even unnecessary to resort to a boiled liquid. The grape is sealed by its own skin against contamination from without. By an ingenious device Pasteur has extracted from the interior of the grape its pure juice, and proved that in contact with pure air it never acquires the power to ferment itself, nor to produce fermentation in other liquids. In like manner the liquids of the healthy animal body are also sealed from external contamination. Pure blood, for example, drawn with due precaution from the veins, will never ferment or putrefy in contact with pure air. We see therefore, that it is not in the interior of the grape that the origin of life observed in the wine vat is to be sought. At the time of the vintage microscopical particles are observed adherent both to the outer surface of the grape and of the twigs which support the grapes. Now, if we brush these particles into a glass of water it will be rendered turbid by the dust. Examined by a microscope some of these minute particles are seen to present the appearance of organised cells. Instead of receiving them in water, if we brush them into the pure inert grape juice we shall in 48 hours see our yeast plant budding and sprouting, the growth of the plant being accompanied by all the other signs of active fermentation.

The inference which we may draw from this is obviously that the particles adherent to the external surface of the grape include the germs of that life, which, after they have been sown in the juice, appear in such profusion. Wine is sometimes objected to on the ground that fermentation is "artificial," but we notice here the responsibility of nature. The ferment of the grape clings like a parasite to the surface of the grape, and the art of the wine-maker from time immemorial has consisted in bringing, and, it may be added, ignorantly bringing, two things thus closely associated by nature into actual contact with each other. For thousands of years what has been done consciously by the brewer has been done *unconsciously* by the wine-grower.

Rotherham. **H. P. Harris.**

[14340.]—STUDENTS on this subject have microscopically discovered the yeast germ on the skin of the fruit from which the liquor is to be made. I have currant wine made from red currants of last year picked from my own garden. No barm or yeast was introduced for effecting the change called fermentation. This spring we have brewed some ginger wine, adding brewer's yeast to start a fermentation in the solution made from the manufactured material supplied under the name of sugar. If "W. G. P." will only conceive the source or origin of fruit fermentation in wine manufacture to be on the skin of the fruit, and not in the air, it will lead him in the direction for explaining other [illegible] of the subject. Without yeast applied [illegible] we should have, perhaps, to wait [illegible] for some uncertain result. **H. P.**

ZINCOGRAPHY.

[14341.]—If "D'Evlyn" will refer to page 120, and read my letter again, he will see that what I really said was, that the lithographer must undergo an apprenticeship before he can print from gelatine surfaces, and not as he states, from zinc. This little explanation at once quashes the charge of self-contradiction he brings against me. With regard to his second statement that zinc plates require to be moistened with gum water during printing, I am glad to be able to say that it is a fallacy, as it is only used very exceptionally, and even then the rollers are only scraped two or three times a day, when the workmen go to their meals; so the "great hindrance" is disposed of. But in either zincography or lithography, if an ignorant or careless workman swamps his plate or stone in water and then rolls upon it, the roller absorbs it, and, being coated with a slimy mixture of ink and water, refuses to work until it is scraped; but this defect is equally liable (in inexperienced hands) to both processes alike, and the "gum water" cry was charged on zincography to deter novices from attempting it. The process has been in almost constant use at the Government Survey Offices, Southampton, for the past 23 years, for the production of the well-known maps and plans issued therefrom; so it is evident that it cannot have any serious defect.

Surely "D'Evlyn" does not mean what he says when he alludes to the "theoretical" possibility of producing zinc reliefs by etching. All the crayon designs of the *Sporting and Dramatic News*, the supplements to *Engineering*, and the maps of the *Illustrated London News* and *Graphic*, besides illustrations to many other papers, are engraved by this process. In my last, when I mentioned *Figaro*, I merely intended to show the kind of work usually tried by tyros, and not to show the artistic capabilities of typo-zincography. There is a galvanographic process at present in use, but it is by no means a success for commercial work, in addition to which a high tariff is charged.

Ernest A. Nuth.

ROUND v. SQUARE.

[14342.]—I THINK that in the suggested use of Round v. Square—*i.e.*, for shanks of cutter-bars, and consequently for the bed of tool receptacles the present plan is the best for several reasons, but that round might be advantageously substituted for square in some other instances. Any one, for example, who has made a diphthong gauge, or Turner's square, knows the bother of making truly the small mortice in which slides the flat steel blade. This is far easier to make, thus:—File up the gun-metal head, and mark it by means of a square all round, and with a finely-pointed centre-punch make two marks on opposite edges, and drill a hole carefully, half from one mark and half from the other, using a drill that will allow a round steel wire of given size to slide stiffly in the hole, which thus replaces the square mortice, and which can be made in a few seconds. As a gauge the round blade will give as good results as the flat one. In some other similar cases time and need of great skill will be saved by turning and drilling, in place of filing and slotting. **J. L.**

THE ALL-ENGLAND CRANK.

[14343.]—IN reply to "G. L. P." (14307), we beg to say that the "All-England" adjustable cranks are expressly made to fit any ordinary bicycle, and can be fitted by any ordinary maker. It is not confined to any special make of machine, and could therefore be used in the proposed Utopian one of "G. L. P." **Boult Bros.**

IMPROVEMENTS IN BICYCLES.

[14344.]—I HAVE long thought the improvemen advocated and adopted by "Alderley Edge," lette 14274, is a great step for those, at any rate, wh like myself do not look forward to the falls an bruises with the same delight as possessors of bicycle seem to feel when recounting the spills their noviciate. Cannot some of the many make be induced to turn out a bicycle of this descri tion? It seems to me to be the very thing wante as in more senses than one the mounting has to got over first, and if we can only persuade our ste to stand patiently while we get into the saddle, t following steps or rather turns would come mu easier. **B. N.**

MIDLAND ENGINES.

[14345.]—I AM much pleased to see the engravi of No. 134 in the ENGLISH MECHANIC, page 19 kindly furnished by your correspondent "C. E. S Will he please say how it is that the last new Mi land express engines are built without bogies?

ving the details of cylinders and driving of Nos. 134, 96, 1282, 1322, and 1353 "C. E. S." apparently omits those of 1322. mean the "bogies" have cylinders 18 and coupled wheels 7ft. diameter, same as 1,353? not asking too much I hope before long we e in the **Mechanic** elevations of the 800 and asses of express engines; and when we have latter, together with 134, I suppose we shall pretty fair idea of the 1353 class.

ing is believing;" and where we can have an ion (of course, not forgetting to add, where sible) it is so much clearer to the perception, es an amount of writing. I noticed in the ondence on express engines in Vol. XXV., ich lasted so long, there was not one illustra- the subject. That was the reason why I made gestion on page 119.

"C. E. S." kindly say if 899, &c., built in as Mr. Kirtley's or Mr. Johnson's design?

R. N. H.

AL EXPRESS TRAINS ON THE LAND RAILWAY BETWEEN ERPOOL & LONDON—To "E. H. E."

6.]—Very fast runs have been made upon occasions on Sundays and Monday mornings ecial express trains between Liverpool and (St. Pancras). Passengers, before leaving , frequently express their wish to travel in lman cars from Liverpool to London, when ach England. The Pullman company inti- this fact by telegraph to their agent gland. The time the steamer leaves town for Liverpool is also telegraphed, and ber of passengers who desire to travel in the n cars. If it is found that the steamer will ive in time for the 10 40 p.m. express on y night, arrangements are at once made Pullman Company to run a special express to as soon as possible after the arrival of the an passengers. As soon as it is decided that these special expresses is to run, notice is ail the stations and signal-boxes upon the by the most expeditious means, to be pre- or and to insure the line being kept clear for ial train to pass. The actual time of depar- om Liverpool is at once telegraphed to the stations, and the time the train passes all cipal stations is also sent to those in advance. of these special trains ran in the autumn of hen passengers were returning from the lphia Exhibition. One of the fastest runs de with a special train, consisting of two cars and two vans, drawn by engine No. elevation of which I gave upon page 190). The as fitted throughout with the Westinghouse tic brake.

whole journey from Liverpool to St. Pancras omplished in four hours and a half, including three times—namely, at Stockport, Derby, cester, leaving the total running time 4 hours tes. Three of these trains, in the autumn of ar, stopped five times on the journey, and lished the distance in 4 hours 35 minutes. one which is most likely to be that to which E." refers, ran from Liverpool to London in 28 minutes. The train stopped at Marple, r, and Bedford, and ran direct, viâ Chad- sidings, Derby, and the Sheet Stores Junc- ent, without entering either of these stations. sted of three Pullman cars and two vans, s drawn from Liverpool to Marple by an f the 1290 class, and from Marple to London of Kitson's "bogie" engines, No. 1319.

istance, as run by this train, is 225½ miles. ordinary express trains run viâ Derby which slightly increases the mileage. It n often stated, and also published in some ers, that these special expresses run at us speeds of 80 and 90 miles an hour." This e case. These trains run on the level and e banks at a speed slightly in excess of that he ordinary express trains, but as the load hey run at a very high speed up the banks, eby gain a great deal of time.

astest ordinary Midland train from Liver- London performs the journey in 5½ hours, Liverpool at 10.45 a.m., and arriving at St. at 4.15. This train stops at seven stations uding Warrington when required to pick up passengers), and is booked to stop at them f 30 minutes. The fact will therefore be your readers that it is a far greater loco- performance to run the ordinary heavy trains than it is to run these light special s, which have only to stop at three or four

endeavour, at an early date, to give E." the sections for which he asks. At ent I am unable to do so, as I am preparing liagrams upon other subjects for the English nic, and to draw the sections of a hundred line will take a considerable time.

8th. **C. E. S.**

SMITH'S VACUUM BRAKE.

[14347.]—A few facts connected with the Smith's vacuum brake have come before me, which I think might be of interest to some of your readers.

Great Northern Railway.

Experiments on the Smith's vacuum brake, applied to a passenger train.

	Gradient.	Speed in miles per hour.	Distance run after application of brakes.	Time taken to make stop.
Eleven carriages...	Level.	47	244yds.	20sec.
Two vans		56	279	19
6′ 6″ four coupled		42	215	15
Passenger engine and tender ...	1 in 198 falling.	60	320	21
Brake applied to engine & tender				
Ten carriages ...	1 in 1100	60	380	25
Two vans	1 in 440	62	360	23
6′ 6″ four coupled	1 in 198	64	400	25
Passenger engine and tender ...				
Brake applied to engine & tender				

First trial took place July 10th, 1877, between Doncaster and Retford. Second September 4th, 1877, in the same place. **A. D. R. J.**

ADULTERATION OF FOOD DETECTED.
SWEETS.

[14348.]—The adulteration of sweetmeats might be classed under two heads—the first is the colouring matter used, which is sometimes injurious, and the other is the addition of substances to increase the weight and bulk. I will first give a list of colours not injurious, and also a list of colours that are injurious, and ought not to be used under any pretence whatever, especially as they are generally consumed by children.

The following is a list of colours not injurious.

Blues.	*Yellows.*	*Greens.*
Sulphate of Indigo.	Saffron.	Litmus and Saffron.
Litmus.	Turkey Yellow Berries.	Sap Green.
Reds.	*Purple.*	*Orange.*
Cochineal.	Cochineal and Litmus.	Cochineal and Saffron.
Brazil Wood.	Brazil Wood and Indigo.	Brazil Wood and Indigo.

Colours that are injurious.

Blues.	*Yellows.*	*Greens.*
Blue Verditer.	Chrome Yellow.	Emerald Green.
Prussian Blue.	King's Yellow.	Scheele's Green.
Cobalt.	Iodide of Lead.	Rinmans Green.

The substances used to increase the weight and bulk are starch and terra alba. Starch is easily detected by dissolving the sweetmeat in a little hot water, and adding a little iodine, when, if starch is present, it will produce a dark blue colour. But if we want to know the kind of starch employed recourse must be had to the microscope. A little of the dissolved sweetmeat should be placed upon a glass slip, and examined with a ¼in., when the kind of starch used will be plainly seen.

For the detection of the colours dissolve the colouring in some water and apply some chlorine water, when if the colouring matter used be of vegetable origin the colour will be discharged. If it has no effect upon it, evaporate to dryness, add a little hydrochloric acid, redissolve in a little distilled water, and add—if a red colour we are trying—a drop of iodide of potash, when if mercury is present, a bright scarlet colour will be produced; if lead be present, a bright yellow colour will be produced. Colour used red lead or vermilion. Scheele's green, or emerald, or arseniate of copper, Schweinfurt green, are easily recognised as arsenical compounds, by giving off the odour of garlic when heated with carbonate of soda upon charcoal.

Arsenic may also be detected in the following manner:—Take a piece of glass tube about two inches long, free from lead, and draw one end out to a point; a small quantity of the colouring matter is taken, and dropped into the point, and a little charcoal added, when, if the point be now held in the flame of a spirit lamp, the arsenious acid passing over the hot charcoal becomes reduced, and a bright ring of metallic arsenic will be formed upon the cool part of the tube. When examined under the microscope it is found to consist of minute octahedral crystals. The ash should be boiled in sulphuric acid, and tested for copper with potassic ferrocyanide, which produces a brown precipitate, and with ammonia a blue precipitate.

Chromate of lead may be detected in the following manner:—Mix a little of the dry residue with borax, and fuse before the blow-pipe, when, if chrome is present, a bead of emerald green will be formed, and if another portion of the residue be taken, and mixed with soda, and heated upon charcoal in the reducing flame of the blow-pipe, globules of lead will be obtained.

Gamboge.—Dissolve the colouring in rectified alcohol, and add a little water, which will precipitate the gamboge. If a little ammonia be added the gamboge will assume a red colour, which is changed to pale yellow upon adding nitric acid.

Blue Colours.—Litmus is turned red upon adding a little dilute hydrochloric acid. Indigo, when heated upon a piece of platinum foil, sublimes in dense violet vapours, and when treated with caustic potash remains unchanged; while Prussian blue immediately loses its colour, the iron being thrown down in the state of peroxide of iron upon the addition of caustic potash.

Antwerp Blue.—Test the same as for Prussian blue. Cobalt blue, ultramarine, and blue are distinguished from Prussian blue by the ash remaining of a bright blue colour. For terra alba the sweetmeat should be burnt to a white ash, and a little hydrochloric acid added, the sulphuric acid estimated by baric chloride, and the lime by oxalate of ammonia.

Mineral colouring is very seldom used now, and, as a rule, sweetmeats are not much adulterated.

Albert Smith.

NOTES ON CATALOGUES.

◆

American Tools.—Those who are unacquainted with the many useful tools and workshop appliances invented or made by the Americans would be interested in a perusal of the catalogue issued by Messrs. Churchill and Co., of Wilson-street, Finsbury. The machines—such as lathes, shapers, planers, &c.—are those of the Pratt and Whitney Co., but the tools are from different sources, Messrs. Churchill affording anything good and useful a fair chance of obtaining public favour. Many of the more novel and remarkable tools have been illustrated in our pages, but the amateur mechanic cannot fail to be interested in glancing through this catalogue, though he will be at times sorely puzzled as to choice amongst the numerous varieties illustrated.

Printing and Stereotyping Materials.—Amateur printers are now numbered by the thousand, and accordingly we find that those who cater for their wants are competing with one another to produce the best "printing office." The Birmingham Machinists' Co. have forwarded us their catalogue, accompanied by a couple of useful little books—"The Eclectic Handbook of Printing for the Use of Amateurs," and "Stereotyping for Amateurs," by H. P. Trueman. The matter is much better than the execution—the "eclectic handbook," for instance, being a very bad specimen of presswork, and requiring the services of the "reader." In fact, it bears unmistakable evidence of having been printed by an "amateur." Nevertheless, the directions given and statements made are generally correct, and the descriptions of the various amateur presses in the market seem to have been written with a due appreciation of their respective merits. "Stereotyping" is better, and is a clear exposition of the details of the paper process, materials for which are sold by the Birmingham Machinists' Co. Their Simplissimus self-inking press appears to be well adapted to the wants of the amateur.

Steam Pumps, Fittings, &c.—The heading of "steam pumps, fittings, &c.," can give but the faintest idea of the many useful appliances manufactured by the Messrs. Bailey, of the Albion Works, Salford. This catalogue shows, however, that they make all descriptions of pumps, boiler fittings, water meters, valves, turret clocks, and many useful novelties. Their pyrometers are well known, and are used for many purposes where high temperatures are required to be carefully noted. Steam-valves and water-cocks are made by the firm in great variety, and all sorts of gauges, alarms, and fittings for boilers and steam machines are illustrated and described in this catalogue. Amongst these, as worthy of special mention, we notice the adjustable injector, which will feed with a variation of duty amounting to 90 per cent.—a very valuable feature in any apparatus employed for supplying water to steam boilers.

A New Remedy for Diarrhœa in men and animals is said to have been discovered in New Zealand, where it has long been in use among the Maories. It consists in a decoction made by pouring boiling water on the green leaves of a shrub called roromiko by the natives. The liquid, though slightly bitter, is said to be not unpleasant to the taste. It is asserted that two doses of this decoction will always effect a cure even in bad cases.—*Nature*. But what is roromiko?

A New Method of Getting-up Steam.—The St. Louis *Journal of Commerce* reports this:—An Englishman in Nevada proposes, if 250,000dols. can be raised, to bore two artesian wells, eighteen inches apart, the one a 6in. and the other a 4in. bore, to the depth of 6,000ft. Then he will drop into one a powder cartridge wrapped in asbestos, so that subterranean heat will not explode it until it reaches the bottom. The explosion then will unite the two wells, and water poured down one will be converted by subterranean heat into steam and sent out through the other, where the power can be transmitted to any required receptacle.

REPLIES TO QUERIES.

⁂ In their answers, Correspondents are respectfully requested to mention, in each instance, the title and number of the query asked.

[31403.]—**Old Paint.**—The cheapest and best solution I know of I accidentally discovered, and it may be worth while to tell how, though very likely some may know of it. In trying experiments for press-copying some old letters, amongst others I used successfully a solution of one tablespoonful of vinegar and 1oz. of washing soda to a half pint of water. A little of this was spilt on the painted window-sill and in wiping it up the paint came entirely off, leaving the bare board quite clean. Try it; a gallon will not cost 2s.—E. C. H.

[31976.]—**Compound v. Ordinary Condensing Engines.**—The communication on p. 171 from your correspondent, John S. Sunderland, shows clearly that no amount of reasoning can ever alter his conviction on this subject, and, as I can find no time in which to attempt the work which must necessarily be done before he will be willing to comprehend and appreciate the advantages of the king of motors over all other types—viz., clear his mind of that worst of all barriers to the progress of truth—prejudice—I shall be obliged to leave him pretty much as I found him. With the few following remarks, therefore, I shall leave this subject, as it is a hopeless task to endeavour to establish the truth in the mind of your correspondent under existing circumstances:—"J. S. S." asks whether I do not think it advisable to save the "mere trifle" of loss which I admitted took place in the receiver of the compound. He should remember the old golden rule—"Of two evils choose the least!" We cannot have a perfect engine; but pray let us have the best possible. I certainly do not think it advisable to save the "mere trifle" referred to, when that course would entail a hundred times greater losses, and be a decided case of "penny wise and pound foolish." With regard to his next assertion I may say that when I penned my last I was quite aware of what he was talking about in his last letter, and, despite his most dogmatic assertion that his so-called fact about heat lost in the cylinder necessarily performing duty cannot be gainsaid, I most emphatically do gainsay it, because, for the reasons given in my last, a very great portion of the heat lost in the cylinder of any engine does not perform duty; and especially is this the case with the single-cylinder condensing engine. I did not make either a vague or perspicuous attempt to prove that the compound engine absorbs more heat into the metal of the cylinder than the single-cylinder engine. I did attempt, either vaguely or otherwise, to prove that there is enormous loss of heat in the single-cylinder engine through the metal of the cylinder, which metal acts in relation to heat, when there is high pressure on one side of the piston, and a vacuum on the other, very much in the same way that a wicker-work basket or sieve does in relation to fine sand. You may fill the basket with sand much more rapidly than it can run out; but it is, nevertheless, streaming out on all sides all the time. This action goes on in all engines, but it is very materially reduced in the compound, because the temperatures of steam at top and bottom of piston are most nearly alike, and the flow of heat through the metal is thus greatly retarded. This argument, which is the kernel of the whole matter, has been either ignorantly or designedly overlooked by "J. S. S.," and he fancies he has swept all argument out of the way when he tells me that, if I will but think, I shall find that, as the single-cylinder engine must cut off earlier to effect a similar ratio of expansion, therefore less heat must pass into it than into the compound. In this "J. S. S." has forgotten the meaning of the word "capacity;" and, even if his statement were correct, it is altogether beside the argument which it is brought forward to refute. I see, by your review of Mr. Cotterill's book on "The Steam Engine considered as a Heat Engine," that that gentleman explains the advantages of the compound engine on the same principle as that I employed in my last letter. I am glad thus to be able to refer "J. S. S." to so high an authority, although I am sorry to say I have not yet had an opportunity of perusing this work myself.—MARINE ENGINEER.

[32447.]—**Electrical Indicator.**—My only reason for not suggesting an arrangement of current-connector, similar to that described by Mr. C. J. Brown, was a fear that the brass would get oxidised, and so prevent the passage of the current. Whether it would get too much so or not I do not know, and must leave it a question to be decided by one who has more knowledge of electricity than I have. Mr. Brown's arrangement is simple indeed; and, if my fear is groundless, why not adopt it? I think that, perhaps, it would be an improvement to have the board arranged with little strips of brass projecting from each long strip towards one another, and one overlapping the other, but just not touching, as I have shown in my sketches. Fig. 1 shows section, and Fig. 2 plan of board. If the current connector is made of a row of rollers—say 4 in a frame—the two end ones being 9in. apart (see Fig. 3), and the points for the current to be connected at on the board to be 12in. apart, it would make a connection at every 3in. of rise of tide, as each roller passing over the top piece of brass would press it down and make it touch the one under it, and so complete the circuit. By adopting this arrangement the number

FIG. 1.

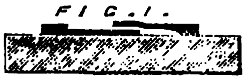


FIG. 2.

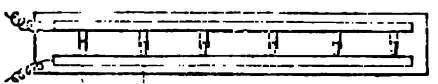


FIG. 3.

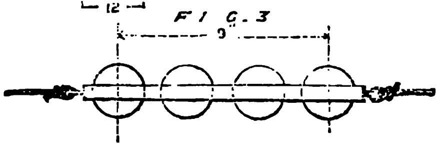


FIG. 4.

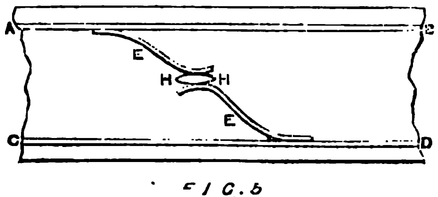
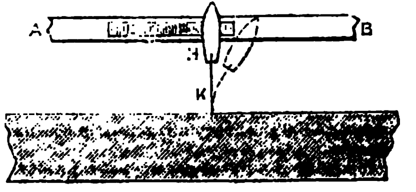


FIG. 5.



of bright parts would be lessened, and yet the reading be quite as fine. If it is necessary to keep the bright parts unexposed to the action of the air, brass strips might be arranged as shown in Fig. 4, which is a plan of a part of the board. A B and C D are the strips of brass, which run the whole length of the board, but instead of being flat on its surface they would lie edge upwards. To each of these pieces small strips would be soldered, E E, so made that they press against one another, unless kept away by a small piece of wood, H H, supported by the spring, K (Fig. 5). As the "current-connector" passed along it would draw this piece of wood aside, and so allow the brass strips, E E, to touch and connect the current, and after passing the spring would drive the piece of wood between again, breaking the current.—A. A. WATKINS.

[32447.]—**Electrical Indicator.**—A. A. Watkins's plan is very ingenious, but it "won't do."

FIG. 1

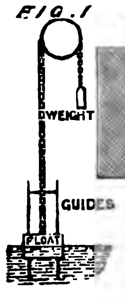


FIG. 2

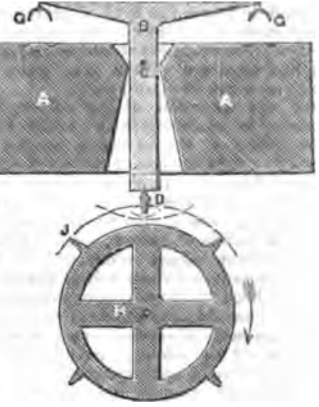


FIG. 5

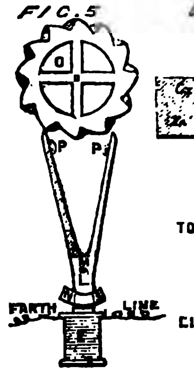


FIG. 3

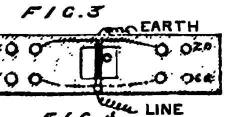
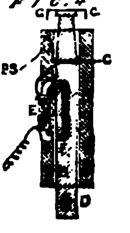


FIG. 4



By reference to his description and diagrams (No. 682) it will be seen that the pointer on the dial moves one notch forward each time the "current-connector" joins a pair of mercury cups. Suppose the tide begins to ebb when the dial pointer p "4, tide rising." The next circuit comple move pointer to "4½, rising," when in reali "3½, falling." As the tide does not rise to t height each time, the indicator would scarc be correct. I think the following plan v Perhaps some of our practical electricians v their opinion about it:—A, Figs. 2, 3, 4, is a l wood or ebonite, in which works a lever, B, on a pivot, C. The bottom part, D, of this attached to the other part by a flat spring, j enough to allow D to move the lever withou ing. On the top of A are eight cups of r connected to line wire, earthplate, and pol battery, as shown in Fig. 3. The line-wire round a small electro-magnet, E, Fig. 4, so pl the side of A that when the lever, B, is ver shall be just opposite a soft iron armature, F lever). The cross piece at the top of the le at each end two staples of copper wire, G G lated from each other. Below A is fixed the H, Fig. 2, so geared with the pulley over wh float-chain passes that the distance from s cog to the next shall be equal to the float ri falling, say 1in. Suppose the tide to be ris turning, H, in the direction of the arrow, the comes against the lever, moving it to th depressing left-hand staples, G, into the n cups, thus connecting Cu (+) pole of bat earth and Zn (−) pole to line wire. This tr a current in the line wire from the office t The instant the circuit is complete the magnet, E, attracts armature, F, causing become vertical. The spring by which D is a to B bends sufficiently for D to pass the cog, cog that passes the lever sends a similar c The falling tide will turn H in the opposite dir The cogs now causing the right-hand staples dip into the cups under them, and connectin earth and Cu to line, the currents will be reve direction. Fig. 5 explains the principle of th indicator. K is an electro-magnet; L is working on a pivot, M, having a permanent n N S, fixed on its lower end, and the upp ending in two arms. A current round K cau arms of the lever, L, to move to the left or th depending on the current's direction. Ther be a spring to bring L back to its original p after each deflection. O are two ratchet- fixed on to the same spindle with their teeth p in opposite directions. This spindle works t pointers, arranged to indicate feet and The ratchet-wheels are moved by the ends lever arms, these ends having joints, P, to them to return without moving the wheels shaded teeth, Fig. 5, represent the hinder r wheel, which is moved by the shaded arm of back for that purpose. The front ratchet-w moved by the unshaded arm. A few more about E, Fig. 4. If the staples, G G′, are a so that on the circuit being completed D is clear of the adjacent cog, the electro-mag pulls D right over, thus preventing the error would result from the tide turning at the ins electric contact, and before D was clear of t —DUDLEY.

[32555.]—**Boiler Scale.**—Mr. Jordan, Guion Line, claims to be the inventor of the a tion of zinc as an anti-incrustator, and, alt none of the readers of this paper may have t there can be no doubt of its efficacy under conditions.—M. S. P.

[32558.]—**G. W. R. Broad Gauge.**—I your correspondent, "H.," p. 222, is under apprehension when he says that the 9.0 p.m. mail runs through from London to Bath. this train start from Paddington a few nigh and I was told that the stops are at Re Didcot, Steventon, Swindon (and, I think, Ch ham). Will some one say why a stop is m Steventon, and also why this train takes 15 m longer in running to Bath than the 9 0 a. 5.0 p.m. (both of which practically take the time when it is remembered that the forme only 5 minutes at Swindon)? The train consi 2 Post-office vans, 1 very ancient first-class c equally ancient second-class, filled with parce and 1 third-class, also filled with luggage. I think the guard had no van, but was accomm in a compartment of the third-class coach; this I am not quite certain. On the whole, before saw such a shabby-looking train start London terminus. The engine was No. 2013, a no name, nor could I see any date. She outward appearance, like those used west of The funnel was of the new G. W. shape. some one please say whether she is new or r —W. E. H.

[32560.]—**The Manchester Bells.**—Perh tower is not considered strong enough; that reason why some other bells are not rung.—Q

[32562.]—**Zinc Paint.**—This can be bough dealers. Quantities of it are used in Lond other large towns. A firm in Lime-street supply it wholesale. "L. S. Y." would scarc to make it or whitelead either.—OBERHOF.

[32566.]—**Naturalisation.**—Mr. Fost erier address his question to the Secretary of State Home Department. If he becomes a natu citizen of Great Britain I presume he would liable to conscription in France, but there (probably is) some proviso preventing the n sation of Frenchmen liable to serve as sol OBERHOF.

70.]—**Model Locomotive.**—The cheapest oil paraffin. Use long flat wicks, and keep them ' from boiler that they do not smoke.—A LLER.

72.]—**Chicken House.**—Lime-wash it. You lour the lime with suitable earths, and it is r and better than paint. If it does require more frequently, so much the better for the ns.—TIBBUS.

76.] — **Dilapidations.** — "A Poor Lease- 's" further communication shows where his lty lies. It is really not a question on the nt to paint, &c., every 7 years, but on the nt to keep in good repair. This the landlord ys able to compel him to do. The real ques- , therefore, "Is the house in good repair or On this point "A Poor Leaseholder" and dlord appear to differ. If the house is not in epair the lessee will be obliged to repair it, t reference to what he has done already. If, onsulting a solicitor or surveyor, he is satis- at the demand now made is oppressive and onable, he may refuse to carry out the repairs the landlord calls for, and leave him to his emedy. If the demand is based on a surveyor's , however, he will probably be better advised nitting to it, or offering some intermediate as a compromise.—SPERANS, Lincoln's Inn.

76.]—**Dilapidations.**—From "A Poor Lease- s" first letter I was under the impression that allowed the house to get out of repair; his had merely called on him to paint, which he ne; and that the lessor afterwards (finding defects) had sent in a list of repairs to be which, if carried out, would most probably tate re-painting, and that his query was to ect whether, having painted as required, he e called upon to repair, and possibly re-paint; herefore suggested that he was so liable. It s now, however, that he has kept the premises ir. If this is the case, I cannot see what he lessor can require; but "A Poor Lease- " must remember that a landlord's and a 's ideas of good repair are very often widely nt. The construction put by the courts upon rds he quotes is, that the tenant is not bound ild an old house on account of its becoming ated from merely natural decay, but that he o his best by timely repairs to postpone that as long as possible. If from neglect or care- in doing other repairs the brickwork he to has sunk, he must put it right again, not se. He had much better get advice on the B. H., Solr.

3.]—**Boiler Incrustation.**—The following the *Brewer's Guardian*:—"The Minister of vorks in France recently ordered an inves into Lesueur's method of preventing boiler ations. This method consists of introducing e boiler some small ingots or clippings of is then observed that the usual earthy sub- instead of forming a hard and adherent form a non-coherent crust, which can be emoved. If the water be very strongly impreg- ith lime salts, the deposit, even if coherent d, does not adhere firmly to the boiler plate. c is converted into a white earthy mass, lly oxide of zinc. No trace of zinc can be in the water, and there is very little in nary incrustation, as the oxide of zinc forms rate deposit. Experience has shown that b. of zinc per horse-power is sufficient. The of the zinc, being in contact with the iron late, is probably electrical, and if hydrogen ed in small bubbles it would be sufficient to for the deposit being non-adherent and '—H. P.

.] — **Eucalyptus Globulus.** — Only an ished botanist or a specialist well acquainted e seeds of Eucalyptus could answer the , even on inspection of the seeds; but accord- looker's "Le Maout and Decaisne," Euca- a genus of Leptospermeæ, and the "seeds etimes dimorphous." Sow them sepa- S. R.

.]—**Fancy Cloth.**—Clean with carbonate nia and water, and fetch up a surface with By the way, can teazles be had in London? FAX.

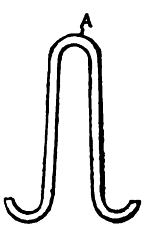
.]—**Indigo.**—Does Mr. Moore want to test as in the dye-house, or scientifically, for cial purposes? I doubt whether there is a od process for ascertaining the dyeing power les of indigo. But probably the best for the se is to dissolve indigo in fuming sulphuric ute with plenty of water, and then test with g powder. Of course the tester should have rd indigo for comparison. The quantity of equired will be an indication of the amount ing matter present. See Slater's "Manual" od) or Napier's "Manual" (Griffin).—

.]—**Light for the Lantern.**—W. J. Lan- under this head, says the "Wheel of Life" lure with the lime-light. If properly con- it is a most satisfactory and amusing slide, have shown constantly, and it is always ted.—A. PUMPHREY.

.]—**Model Trunk Engine.**—The following ions will be of use to "Amateur Trunk:"— about making a perfect model of a marine o put in a glass case I advise him to make or procure a correct drawing of a trunk engine and faithfully work to that drawing in all its details. But if his intention is to make an engine that will respectably drive a boat of moderate dimensions, say 4ft. long, then he must adopt a very different course as regards pattern, for simplicity and lightness are the elements of success. I advise him to discard the trunk pattern (because of the excessive friction of the trunks) and stick to the simple high-pressure oscillating engine, in appearance like Penn's engines in the river boats, only omitting the centre crank, air-pump, and condenser, and their accompanying complications; or, in other words, let him copy those he sees in the shop windows, but—and herein lies a grand secret—it must be made very much lighter in weight. Nearly all models that I have seen are far too heavy for the boat they are intended to drive, seldom allowing any lead to be placed on the keel, and without which they are always liable to share the fate of the Captain. In order to reduce the weight let "Amateur Trunk" use as little cast work as possible. I have made cylinders of "triplet" drawn tube, the top and bottoms only being cast, and snaped on to the tube like the lid of a box—no screws. If the cover and bottoms fit properly a little white-lead wiped in before closing makes a perfect and simple joint, and no pressure of steam that he can put on will blow them asunder. The steam passages and valve boxes may be made of thin metal and soldered on—the top frame and bed plate cut out of sheet metal and connected by columns. For reversing gear I use a four-way cock, inclosed in the steam chest of the boiler. With respect to the size of his boat he could not get his cylinders into a less width than 8in., and as the length is eight times the width, and the depth two-thirds of the width, he will have rather a large model. The boiler should be made of copper the full width of boat, but not to touch the sides, as this would conduct away the heat. The length in models is usually twice the breadth. A drawing of a boiler, with internal fire-box fitted to burn charcoal, I published in one of the earlier volumes of the ENGLISH MECHANIC.—E. PARR.

[32631.]—**Amateur Printing Press.**—I am extremely obliged to those gentlemen who have replied to my query. Will they further enlighten me as to the reason why lithographic and copper-plate printing require a rolling pressure, and why the bed and platten press will not do for all three? Is it that lithography and copper-plate require much greater pressure than ordinary type? I have the "Eclectic Handbook of Printing," also "Printing for Amateurs," by P. E. Raynor.—GALVANO.

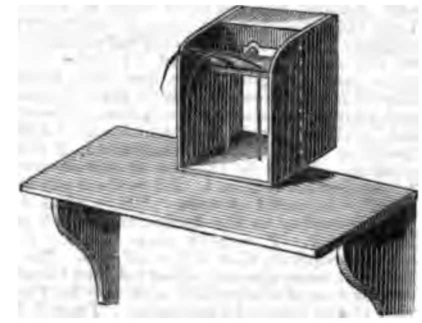
[32665.]—**Siphon.**—I send a rough sketch of what is known as the Wurtemberg siphon, hoping it may be useful to "Aulos," or some of our readers. The siphon when once filled remains full so long as it is kept perpendicular, and is set to work on the liquid rising above the one end. The siphon may be filled through a tap in the top at A, by first corking up both ends while filling.—GEAR.



[32680.]—**Foul Closet.**—I thank "G. L., Southend." In reply to his questions, the closet is an ordinary pan closet; the air-pipe was fixed on the closet soil-pipe, and is 20ft. long, and of 1in. steam tube. The plumber was supposed to have thoroughly examined the joints. I am also obliged to "J. A. P." and "Yorkshire Yeoman," and on getting "G. L.'s" instructions I intend to have something done. I have been told that the bore of the pipe is too small; it should be 2in. or 2½in.—J. H. S.

[32681.]—**The Rhine.**—It is not easy to answer J. Taylor's query. I will do my best; but beg J. T. not to be guided by "Dane" or "P. T. Otto." I have lived for 21 years three miles from the Rhine, and know the manners, customs, and localities well. Don't go in the summer to stay at Heidelberg, which is about twenty miles from Mannheim, on the Rhine; though very beautiful it is very hot, and not a desirable place for an invalid. The villages on the river are most of them hot, but the heat is compensated for by the cheerfulness and by the coolness of the mornings and nights. If J. T. is bent on the Rhine he need not settle, but change his quarters. The steamboats pass constantly up and down, and the fares are low. I may name Lorch, Boppard, Oberwesel, as charming places; St. Goar, some years ago, I did not like. If J. T. is not bent on the Rhine let him go by s.s. to Ober-Lahnstein, thence, by rail, to Nassau, where he will find pure air, beautiful scenery, pleasant people, and moderate prices. The best money to take is English money—gold and circular notes (£10). The gold will pass at the exchange of the day everywhere, and in the towns bankers exchange the notes willingly. It is not true that J. T. will make on the exchange. What "Otto" means by saying Hamburg is the best place to change I don't know, unless J. T. is to take a three days' voyage, viâ Southampton, to obtain German money. Lombard-street is nearer! A knowledge of German is not indispensable, for on and in the neighbourhood of the Rhine English is spoken. J. T. need not fear heat before the middle of July; August is usually intensely hot—is called the Koch, or boiling month, as the heat then is looked to for ripening the grapes—for developing the grape-sugar. —N. SIRCH.

[32704.]—**The Cats and Pigeons.**—Many thanks to the correspondents who have answered my query, most of whom have made the difference of weights of a cat and a pigeon the basis of their calculations. My contrivance, which in many years' experience has proved most effectual, is based on the difference of their lengths. The accompanying drawing will almost tell its own tale. The device is a very simple one. A common bob-wire is placed about half-way in between the two cheeks, and from the front of the cylinder (which must turn easily on two firm wire pivots in its ends) two sharp iron prongs project forwards, which must be counterpoised by a small lump of lead behind the cylinder. When the vertical wires are pushed inwards by a cat trying to enter the sharp points of the curved prongs descend with proportionate force on the animal's back, and an immediate retreat is the result. When a pigeon enters, the prongs merely comb the tip of its tail, which, consisting only of feathers, is invulnerable. This admits of a fixed and firm alighting board, which is a great advantage. The box should be fixed in the brick-work from the dotted line backward, and open head-room should be left over the prongs, to allow of their tilting upwards, when a pigeon, coming out, pushes the vertical wires forward. Make your pivots, vertical wires, and prongs, of strong iron wire, about one-seventh of an inch thick. The measurements of mine are: Height of box, 9in.; width between cheeks, 4in.; length of vertical wires, 5½in.; straight distance from point of prongs to the cylinder, 7in.—WILLIAM WILSON, Chester.



[32720.]—**Canvas Canoes.**—I cannot give any particulars of canvas canoes, never having had any experience in them. With regard to price of one built of wood, they may be bought second-hand at considerably less than £10, or, when built at home, a very good one may be made for from £4 to £3. I do not consider a canvas one suitable for sailing on such a river as the Mersey. Great strength is required in a sailing canoe, as when under sail a great strain is put on the deck and keel, which I am afraid one made of canvas would not stand.—E. H. J.

[32741.]—**L. C. & D. Railway Engines.**—

	ft.	in.
Diameter of cylinders...	0	17½
Length of stroke	0	26
Lap of valve	0	1
Lead of valve, front port	0	$\frac{3}{16}$
Lead of valve, back port	0	$\frac{3}{32}$
Length of connecting-rod between centres	5	10
Diameter of bogie wheels	3	6
Diameter of driving and trailing wheels (coupled)	6	6
Distance between bogie wheel centres ...	5	9
Distance from bogie pin centre to centre of driving axle	9	10
Distance between driving and trailing centres	8	4
Length of boilers between tube plates ...	10	3
Diameter of barrel inside	4	2
Length of fire-box inside	4	11
Width of fire-box inside	3	5
Height of fire-box inside	4	10

No. of tubes, 200; diameter of tubes, 1¾in.

Heating surface in tubes	962 sq. ft.
Heating surface in fire-box	107 „
Area of fire grate	10·6 „
Diameter of safety valves (Ramsbottom's) ...	3½in.

Boiler pressure 140lb. per square inch.

Two Gresham injectors (Nos. 8 and 9) fixed one on each side of the ashpan. A steam brake on the engine only, with cast-iron brake blocks fitted on the driving and trailing wheels. Capacity of tank, 2,500 gallons.—H. L.

[32742.]—**£5 Telescope.**—The diaphragm's being out of place causes extraneous rays to illuminate the field. £5 3in. telescopes have been denounced in these columns by "F. R. A. S." and many other correspondents, including myself, over and over again. The powers are generally vastly exaggerated. Browning mentions a case where an eye-piece engraved 70, magnified B. I certainly do not think I should go to the expense of a Barlow and astro eyepiece for it. An astro eyepiece should contain two lenses, except for very high powers, when one double convex is sometimes employed. Am sorry not to be able to answer more satisfactorily.—F. C. DENNETT.

[32749.]—**Nautical Astronomy.**—(1.) The two bearings or azimuths are taken, as their difference is used in the calculations. If the absolute azimuth of one observation is known, then the question is much simplified, either in observing the sun or a star. But in observing a star we really only require the difference of azimuths—nothing else. But with the sun we at least require the approximate (if we cannot get the true) azimuth of one observation from the meridian, in order to correct the declination to the time of observation; or, instead of the azimuth, we may use for this purpose the approximate local mean solar time given by an ordinary watch not more than 5′ wrong. From these data, together with the corrected altitudes of the two observations (and the approximate longitude of the place of observation of the sun is observed), we may find both latitude and the exact times of observation (and thus also find the error of our watch). An ordinary watch does not do for observations of stars, as sidereal time is required for these. (2.) The accompanying figure shows how from a point, P, above the earth less of the earth than a hemisphere, and more of the heavens than a hemisphere, is seen. (3.) Let P be the pole, Z the zenith, and P Z M E the meridian of the place of observation, E being the equator. Let S be the sun or star observed at a known instant of time, *t*. Z S = the zenith distance = 90° − corrected altitude. P S = 90° ± declination, according as the declination (*d*) is S or N of the equator. P = hour angle, Z P S. Let φ = latitude required, then Z P = 90° − φ. The declination, *d*, when the sun is observed must be corrected for the time of observation, and also for the longitude of the place of observation. Draw S M perpendicular to P Z M. Then—

$$\cos.\ P = \tan.\ PM \cot.\ PS;$$

$$\therefore \tan.\ PM = \cos.\ P \tan.\ PS;$$

$$\text{or } \tan.\ (90^\circ \pm EM) = \cos.\ P \tan.\ (90 \pm d).$$

The + sign is used when declination is S, and the − sign when N. Then—

$$\tan.\ EM = \sin.\ P \tan.\ d;$$

Hence E M can be found, and

$$PM = 90^\circ \pm EM \text{ according as declination is S or N respectively.}$$

Again, $\cos.\ PM : \cos.\ ZM = \cos.\ PS : \cos.\ ZS$, and $ZM = PM - ZP = PM - (90^\circ - \phi) = -\{90^\circ - (PM + \phi)\}$,

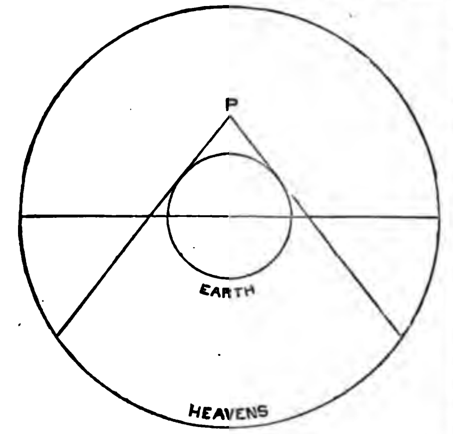
$$\text{and } \cos.\ -\{90^\circ - (PM + \phi)\} = \cos.\ \{90 - (PM + \phi)\};$$

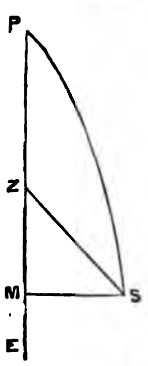
$$\therefore \cos.\ ZM = \sin.\ (PM + \phi);$$

$$\therefore \sin.\ (PM + \phi) = \frac{\cos\ ZS \cos.\ PM}{\cos.\ PS}.$$

Thus $(PM + \phi)$ is known, and P M is also known; ∴ φ or the latitude is determined.

We must remember that $\sin.\ (PM + \phi)$ is equal to $\sin.\ \{180^\circ - (PM + \phi)\}$ so we must use which of these two values is the most appropriate. If the sun is observed, mean solar time must be taken, and if a star, sidereal time. In the latter case no correction for declination for time of observation or for longitude need be made, as the declination of a star does not appreciably alter. (4.) N L means nearest (or adjacent) limits. As this is an example to find longitude by a lunar distance the *Nautical Almanac* for 1873 is required, which I have not got. But should the inquirer have it, and will give me his address in these columns, I will borrow it from him and return it with the example worked out in full.—C. B. M.





[32753.]—**Bird's Eggs.**—A little white wax could be put into the holes of eggs after blowing, and the whole shell may have a coat of mastic varnishing put on thinly with a camel's-hair brush, or if the egg be of a blue or green tint, as many are, a solution of very pure white gum-arabic is best, as the varnish is apt to injure those delicate colours.—X. Y. Z.

[32756.]—**British Wines.**—Parsnip wine may be made by infusing 5lb. or 6lb. of the chopped stem in 1 gallon hot water till cold; strain, and add to each gallon of the infusion 3lb. or 4lb. white sugar, 1oz. cream of tartar, and about 2 to 5 per cent. brandy. When well made and strong, this wine is of rich and excellent quality, especially after fermentation. Rhubarb wine: Infuse 5lb. or 6lb. of the best selected chopped stems in 1 gallon of water, add 3lb. or 4lb. sugar (or to taste).—NO NAME.

[32766.]—**Stopwork.**—Having obtained a small pamphlet descriptive of the patent "stopwork" referred to by "A Lover of the Art," with much pleasure I reply to his query. The watch being wound up until resistance arrests the further winding must produce a strain upon the coil which is next to that which is on the barrel-arbour; but, when the pressure is relaxed, the slotted stick allows of a small quantity of unwinding of the mainspring, and then the inner coil is not so much "on the strain" as one would be with an ordinary going barrel without a stopwork. At the same time there is the same risk of breaking a mainspring with one arrangement as with the other, inasmuch as the mainspring is fully wound and on the strain, while the pressure by the act of winding remains. I cannot see any other than that the spring is wound to its fullest tension, and that the value attached to the patent click is more ideal than real. —SECONDS' PRACTICAL WATCHMAKER.

[32776.]—**Vienna Flute Organ Stop.**—I feel much obliged to C. E. Sheppard and S. Taylor for their kindness in answering my question. A short time after I sent off my inquiry it struck me I had seen a diagram of a round-mouth wooden pipe in a previous number of the MECHANIC, and on looking back, as I fortunately possess a good many volumes, I came upon the very thing I wanted in No. 254, by "Adept." I made one of the description recommended by him as an improvement on the original—viz., the semicircular-mouthed one, and I found it a very fine pipe—indeed in my opinion an improvement on the old flute, I believe called the "Suabe flute." I would like to know what pipe Mr. Taylor refers to, which, he says, surpasses the Vienna.—MUSICUS.

[32783.]—**The Moon.**—Of course Mr. Robinson is aware that the light which renders the dark hemisphere of the moon visible is earth-shine, or the light reflected from the earth. The variations in the brilliancy are due to different causes. 1. The amount of land on which the sun happens to be shining, because the land reflects more light than the sea. 2. The state of the earth's atmosphere over a large extent. 3. The state of the atmosphere at the place of observation. Clouds reflect much more light than either earth or sea; so that, if there was a great conglomeration of them on the portion of the earth illuminated by the sun's light, and visible from the moon, the dark side would be more visible than in the absence of the clouds. With respect to the other reason mentioned the vast difference in the state of the air may be pointed out. Sometimes the minutest details of a distant object can be easily seen with attention, whilst, at another time, the object itself is scarcely visible; so with the dark hemisphere of the lunar world, if our atmosphere is thickish it cannot be so easily seen as when it is clear; though the stars may be seemingly bright, still there may be really a thickness in the atmosphere.—F. C. DENNETT.

[32800.]—**Grating Noise in Telephone.**—If you use earth plates of different metals, or of the same metal, and in different kinds of soil, there may be a galvanic action at them producing a current in the wire. Any sudden and quickly repeated variations in the strength of this current would cause a grating sound. Such undulations in the current might be caused by variations in the insulation of the line wire, possibly due to shaking of the wire by the wind, &c. If this be the cause of the defect the remedy is to abolish the earth plates, and use a return line wire instead.—J. BROWN, Belfast.

[32801.]—**Peculiar Action of Glycerine.**—No action takes place between the two salts, but if the solution be strong, on heating, vapours of acrolein (acer, sharp, oleum, oil) are given off, recognised by their peculiar smell. The acid carbonate of potassium absorbs the water, and sets free the acrolein:—

$C_3H_8O_3 - 2H_2O = C_3H_4O$.—NO NAME.

[32803.]—**Organ Wind Chest—No Springs.**—To construct a soundboard as described by "F. M." would cost more than the safe plan, where springs are used for closing the pallets. A thrust action never works so freely as the ordinary pull-down action. Stout wire should be avoided whenever it has to pass through a brass plate. The channel would not be required larger on account of the turning. By no means try the experiment.—S. TAYLOR.

[32804.]—**Olbers' Theory of the Planetoids.**—The explosion theory is itself exploded. If the elements of the orbits of the planetoids had always been what they are now, it would be very easy to show that they could not all of them have ever passed through the same point; yet some of them, such as the eccentricities, are subject to secular variation, owing to the action of the planets—most likely, however, in some instances, not to a sufficient extent to admit of some of the orbits ever having had a point in common. The limits of the variation of the eccentricities have not been calculated, and, therefore, until this is done, it can hardly be said that the theory has been rigidly disproved. It is evident, however, that the tension of the crust of the supposed planet which burst must have been, just previously to the explosion, something inconceivably great in order to resist an internal force which was sufficient to cause them to move in independent orbits instead of returning again towards their common centre of gravity—far greater than would have been possible if the crust had been like that of our own earth. It must have have been of extreme tenacity, like metal, and would have split into irregular fragments, which would retain their form. The theory, however, is so highly improbable that it is not worth being at much pains to see whether powerful telescopes give any signs of such irregularity.—W. G. P.

[32818.]—**Gallium.**—The prediction of the existence of gallium by Mr. Newlands and Mr. Mendelejeff was based upon the "periodic law," which was discovered by Mr. Newlands, and published by him in the *Chemical News* nearly fifteen years ago, but the importance of which has only recently been generally recognised. The periodic law reveals some curious relations among the elements, and I cannot do better than give the following quotation from the last edition of Fownes' "Chemistry:"—"A very remarkable relation has been shown to exist between the quantivalence of the elements and the numerical order of their atomic weights. Arranging the elements in vertical columns according to this order, as in the following table, we find that, with the exception of certain metals belonging to the iron and platinum groups, they all arrange themselves in such a manner that the first horizontal line is occupied by the monad elements, the second by the dyads, the third by triads, &c., as indicated by the composition of the chlorides in the last column of the table, where R denotes a metal or hydrogen. Hydrogen itself stands alone, there being no known element between it and the monad metal lithium. This relation of the elementary bodies, which is called the 'periodic law,' was first pointed out by Newlands in 1864, and afterwards developed by Odling and Mendelejeff.

ARRANGEMENT OF ELEMENTS IN THE ORDER OF THEIR ATOMIC WEIGHTS.

H 1	Li 7	Na 23	K 39	Cu 63	Rb 85	Ag 108	Cs 133	—	Au 199	—	R Cl
	Be 9·4	Mg 24	Ca 40	Zn 65	Sr 87	Cd 112	Ba 137	—	Hg 200	—	R Cl_2
	B 11	Al 27	—	Ga 68	Y 88	In 113	Di 138	Eb 178	Tl 204	—	R Cl_3
	C 12	Si 28	Ti 48	—	Zr 90	Sn 118	Ce 140	La 180	Pb 207	Th 231	R Cl_4
	N 14	P 31	V 51	As 75	Nb 94	Sb 122	—	Ta 182	Bi 210	—	R Cl_5
	O 16	S 32	Cr 52	Se 78	Mo 96	Te 125	—	W 184	—	U 240	R Cl_6
	F 19	Cl 35·5	Mn 55	Br 80	—	I 127	—	—	—	—	R Cl_7
			Fe 56	—	Ru 104	—	—	Os 195			
			Co 59	—	Rh 104	—	—	Ir 197			
			Ni 59	—	Pd 106	—	—	Pt 198			
			Cu 63	—	—	—	—	—			

The blank spaces in the preceding table indicate the places of elements which probably exist, but have been actually discovered. An anticipated y of this kind has, however, been actually When the table was drawn up a blank, in e now occupied by gallium, indicated the existence of a trivalent element inter- in atomic weight between zinc and arsenic. nent was provisionally designated chalumi- Mendelejeff, who predicted, from its posi- he series, what its chief properties ought to discovery of gallium, with the atomic &c., has verified this prediction." Dr. in his late lecture on gallium, at the Royal ion, alluded to Mr. Newlands as having pre- n general terms the existence of gallium years before M. Mendelejeff's prediction of rties in such an explicit and extraordinary —A FELLOW OF THE CHEMICAL SOCIETY.

.]—**Legal Question.**—The death of B. has he only trustee. Her trusteeship will not ı her marriage, but her husband will be into the trust, and all dealings with the operty will be complicated by the difficulties ttach to such transactions by a married B had no power of nominating a successor was given him by the settlement, and this y unlikely. For the convenience of the trust advise, presuming there is such a power in ement (and if the settlement be well drawn that C at once before her marriage retire trust, and appoint two men trustees.— s, Lincoln's Inn.

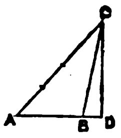
.]—**Suspension of Ultramarine.**—It is le to dissolve ultramarine without destroy- ıpairing its colour, but it may be suspended ally by thickening with starch.—H. B. F.

.]—**Unfermented Bread.**—If "A Would- r" will add the following quantities of nts to each pound of the flour he uses in he will find them to be within a very small of the formula given by "A Physician":— onful of hydrochloric acid; 1 teaspoonful of ate of soda (not heaped, but level); ½-pint of The acid and soda, measured in this way, just the proportion to form common salt. nt of water is a trifle in excess, being 10 fluid whereas the recipe gives 9½oz.; but this, I ıd, is sufficiently exact for the purpose, espe- the quantity of water required varies a little erent samples of flour. Speaking from my perience I have found these proportions ery well.—GEORGE TOMMY.

.]—**Unfermented Bread.**—I fear that I at "A Would-be Baker" into the way of unfermented bread without measures, and scales. The process requires accuracy rtion, I therefore specially addressed my the subject to such of "ours" as had a turn. But if our friend merely wishes to experimental loaf let him procure 80 grains onate of soda and 106 minims of the pure loric acid of the Pharmacopœia from a mix the soda well with 1¾lb. of flour, and acid into four-fifths of a pint of water, in has dissolved a teaspoonful of salt. Put the d flour together, mix quickly, no kneading , and bake the resulting loaf in a quick oven our.—A PHYSICIAN.

.]—**Carbonate of Soda.**—1. The lime is ted as carbonate, while the soda becomes bicarbonate, or sulphate, just as the lime inally hydrate, bicarbonate, or sulphate. 2. of soda is produced, and if the tartaric acid uicarbonate of soda have been used in equi- roportions, chlorate of potash will more or mpose the resulting tartrate of soda into of potash and chlorate of soda.—H. B. F.

]—**Trigonometry.**—The solution of the ies by "Anxious" is as follows:—Let the *a b c*, represent the second query, whose



to be $ab = 2$, $bc = 3$, $ac = 4$, with the bc, obtuse; produce ab to d, then, by a wn formula in trigonometry, we have—

$$bc^2 - ac^2 = 2\,ab\,.\,bc\,.\ \text{cos. angle}\ abc,$$

$$\frac{ab^2 + bc^2 - ac^2}{2\,ab\,.\,bc} = \text{cos. angle}\ abc.$$

substituting the numbers 2, 3, 4, we have—

$$\frac{2^2 + 3^2 - 4^2}{2\,.\,2\,.\,3} = \text{cos. angle}\ abc;$$

$$\text{or, } \frac{4 + 9 - 16}{12} = \text{cos. angle}\ abc;$$

$$\text{or, } \frac{-3}{12} = \frac{-1}{4} = \text{cos. angle}\ abc;$$

$$\text{or, } \tfrac{1}{4} = -\ \text{cos. angle}\ abc,$$

ws angle abc to be obtuse. Hence bd is hich, by construction, finds the angle cbd, plement, abc; and by referring to a table l sines and cosines I find it to be a few arger than 75° 31′. Again, by using the (8, 15, 17) in the first query in like manner, is only asked to find the angle, we are not to know whether it is right, acute, or obtuse; but it will be determined by trial, for by substituting the numbers 8, 15, 17 in the above formula we have—

$$\frac{8^2 + 15^2 - 17^2}{2\,.\,8\,.\,15} = \text{cos. angle}\ abc;$$

$$\text{or, } \frac{64 + 225 - 289}{240} = \text{cos. angle}\ abc;$$

$$\text{or, } \frac{0}{240} = \text{cos. angle}\ abc = 0.$$

Therefore, angle abc is a right angle, since cb coincides with cd.—C. J.

[32830.]—**Trigonometry.**—1st (see Fig. 1), A B − A C, or 17 − 15, gives C E, or versed sine = 2. 2nd. $\sqrt{BC^2 + CE^2} = \sqrt{8^2 + 2^2} = \sqrt{68} = 8{\cdot}246$ for chord, B E, of half the arc, B E D. 3rd. "Nesbit's Mensuration of Superficies," Prob. 14, $\frac{8\ \text{times BE} - \text{BD}}{3}$, or $\frac{65{\cdot}968 - 16}{3} = \frac{49{\cdot}968}{3} = 16{\cdot}656$, gives the length of arc, B E D, very nearly; and 4th. As 17 radius = 34 dia. = 106·8144, circumference = 360°. Then, $106{\cdot}8144 : \frac{16{\cdot}656}{2} :: 360° :$ 28°·4′ nearly for length of arc, B E, or measure of the angle, B A C, for first answer. And in reply to the second question, where the sides of triangle are

FIG. 1

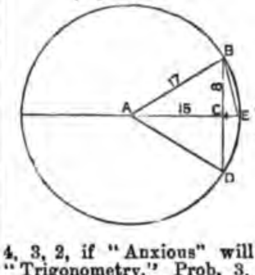
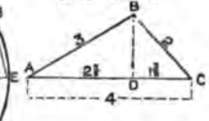


FIG. 2



4, 3, 2, if "Anxious" will refer to the article "Trigonometry," Prob. 3, Part 9, in "Nesbit's Mensuration"—1st. (See Fig. 2). As base 4 : 3 + 2 or 5 :: 3 − 2, or 1 : 1¼ for the difference of the segments of the base, A D and A C, made by a perpendicular from its opposite angle, B. Then—

$$\frac{4 + 1\frac{1}{4}}{2} = 2\tfrac{5}{8} = \text{AD},$$

$$\frac{4 - 1\frac{1}{4}}{2} = 1\tfrac{3}{8} = \text{DC}.$$

Or, the figure, A B C, is now resolved into two right-angled triangles, two sides of largest being 3 and 2⅝, of smallest 2 and 1⅜, from which the perpendicular, B D, common to both is obtainable by Prob. 6; the respective angles, A and C, are obtainable like the answer to question 1st; and, lastly, 180° − (angle A + angle C) = obtuse angle, B, or answer.—BUTTERSHAW, near Bradford.

[32835.]—**Organ Matters.**—If "Storace" puts in a large wind trunk the concussion bellows may not be needed. I would recommend the concussion bellows, because a steady wind can be insured if the bellows be in proportion to the size of bellows and wind chest, say 18in. by 10in., hinge at one end—*i.e.*, diagonal. The pressure of wind is in a great measure a matter of taste. The height of mouth should be regulated somewhat by the pressure of wind employed. I like a low pressure for diapasons and dulcianas, which gives a free breathing kind of tone, having, as it were, the dew upon it, while reeds and other stops require a heavy wind, not because power is aimed at. The stops supplied by a heavy wind are not necessarily loud, but great individuality and character can be given. A stouter tongue can be used in the reed stops on a heavy wind, which enables the voicer to obtain a firm, full, and lasting tone. Reed stops on, say, 2in. pressure are worthless. Hear some of the old organs for example. If "Storace" is not thinking of having reed stops I would say employ 2in. wind; but with reeds 2⅝in. would do for the chamber organ. The other stops can be plugged to reduce power.—S. TAYLOR.

[32845.]—**Brakes on the L. C. and D. R.**—In answer to "G. L. P.," the London, Chatham, and Dover Railway Company was one of the first to reply to the Board of Trade circular dated August 30, 1877, in which the essential conditions of an effective continuous brake were laid down. On the 30th of September, 1877, the Chatham and Dover Company had 6 engines and 20 carriages in use, fitted with the Westinghouse automatic brake. They consider it the most efficient continuous brake, and intend to fit it to several more of their trains. It fulfils all the Board of Trade conditions. A short time ago an experimental train was fitted with "Smith's vacuum brake." The trials which followed confirmed the fact that the Smith's vacuum is far inferior to the Westinghouse automatic, and also that it does not fulfil the Board of Trade conditions. Those carriages which have Smith's vacuum brake will be used when it is required to send through carriages from Dover, and other stations on the Chatham and Dover line, to stations in the North, viâ the Great Northern line, and to stations on the Midland line by the three Manchester and Liverpool expresses, which are fitted with the vacuum brake. This arrangement will, to a certain extent, avoid the inconvenience which has been caused through the difference of brake systems, and it also gives further proofs of the necessity of unanimity of brakes. The Chatham and Dover Company point out that their choice must be in opposition to either the Great Northern or Midland Railways, and that to use two systems will cause great inconvenience to themselves.—C. E. S.

[32847.]—**Transparent Varnish.**—H. Allingham should get 1 pint of methylated spirit, 4 ounces of bleached shellac, and 3 ounces of sandarac. He should put the shellac and sandarac (powdered) in a bottle with the spirit, occasionally shaking it till all is dissolved, then apply the varnish with a camel-hair brush.—F. A.

[32850.]—**The Separation of Manganese.**—Powder the ore, and dissolve it in hydrochloric acid; filter off; neutralise the filtrate with ammonia; add ammonic sulphide. A black precipitate is obtained, consisting of the sulphides of the three metals, Mn, Ni, and Co (and several others if present in the ore); filter off. Digest the precipitate with acetic acid, and manganic sulphide is decomposed, while nickelic sulphide and cobaltic sulphide are unaffected; filter. You have now got the Mn in solution as acetate, separate from the Co and Ni, which remain as sulphides. I should be glad if "T. G." would forward me a specimen of the ore for analysis. E. WALKER, 7, Exeter-street, Otley-road, Bradford, Yorks.

[32851.]—**Bicycle Wheel.**—Various methods have been adopted for fixing gun-metal hubs to steel spindles, such as shrinking, casting, keying, and screwing on with right and left-hand threads. Many of these methods have failed, the gun-metal being softer than the keys, &c., and gradually working loose. I would not recommend "Mechanic" to cast the hubs on spindle. Probably the best way of fixing them is as follows: First bore a true and parallel (not taper) hole in centre of hubs, and turn the spindle to suit in length, &c., but leave it about 1-64″ larger in diameter than the holes in hub, also leave a shoulder for the hubs to come up to. Now heat the hubs to, say, 300° or 400°, and they will go easily on to the spindle. When cold turn and drill the hubs, and to make all secure drill one of the holes deep enough to go about half through the spindle, drive in a steel peg, leaving it long enough to touch, or almost touch the end of nipple, after the latter has been finally screwed up. Thus the peg cannot come out. For the spokes it is best to buy the wire in straight lengths. Recently wire, headed by machinery at one end, has been introduced, and this saves much time and labour; moreover, the head is better than when made by hand. After measuring the rim and hub calculate as nearly as possible the length of spoke required, and cut off 8 to this length; put a nipple on each wire, and put the plain end of spoke through the rim and rivet it. Screw the nipples into hubs, and you will see if the wires have been cut to the right length; if so cut off the remaining spokes, and finish the wheel. I think instructions have been given before for trueing the wheels. The head should be bought ready forged (stamped) also the neck. There is no difficulty in fitting up the head. Any mechanic would see at once how to do it. I ought to have said that the spindle should be of good tough steel. Some prefer iron case-hardened, as it does not go out of shape so much in hardening. Steel, however, if hardened in oil will not "warp" very much.—WM. GRANGER, Birmingham.

[32857.]—**Stearine.**—"Soap Maker" can make stearine on a small scale—say from 10 to 300 gallons—upon the following principle:—A wooden tub must be made of 2in. thick boards, 5ft. high, 3ft. diameter, the bottom of it to be 1½in. thick, and in it make five holes, one in the centre of the other four, the size of broomsticks, which must be the same length as the height of the tub, which must be fixed into those holes air-tight. Then place the tub over a smaller one upon two beams across the lower tub, which must be made about 4ft. diameter, so that the top tub is suspended over the lower one. When this is done heat your tallow (Russian or any other) to a boiling point, so that you may perceive sparks over its surface, then put it into the large tub, taking care to cover it with sacking and matting, that no draught or cold comes near it, and to be kept so till the liquid is separated from the solid. This is generally in from 10 to 18 days effected; and, when the whole mass is thus, loosen the sticks one by one a little, so as to allow the liquid to drop through those holes at the bottom into the lower tub, not all at once, but very slowly, from each stick. The matting must not be removed until all the liquid has passed through. If the weather is hot at the time that "Soap Maker" is making this preparation, it will take a longer time to stand. However, he will be able to judge as to time.—CONSTANT READER.

[32859.]—**Microscopical.**—For the information of "Diatomaniac," it affords me pleasure in adding my testimony in favour of Lord Osborne's "Exhibitor," having used one of them for the past eight months, with perfect success. To microscopists who have no sub-stage appliances, and cannot afford to purchase the more expensive illuminators, the "Exhibitor" is particularly well adapted. It can be used on any ordinary microscope stage, and with a little practice will be found to give most perfect oblique illumination, and, moreover, with very little trouble and excellent dark ground, illumination may be obtained. Last July Lord Osborne very kindly invited me to witness the working of "Exhibitor" on his own stand. In his hands it proved a most perfect illuminator, and with Swift's ½ and Zeiss $\frac{1}{12}$, it gave most perfect resolution of N. Rhomboides, P.

Angulatum, and many other diatom tests. His lordship showed me his numerous and large number of microscopical accessories, reflex illuminators, &c., at the same time expressing that with the assistance of his own simple invention he could do all that an objective was capable of doing with much less labour than with the more costly apparatus, which be only used in exceptional cases. I may add that his lordship, with his usual liberality places this invention in the hands of the public, having no pecuniary interest further than the gratification of those who take an interest in microscopy.—HENRY MUNRO, Lynn Regis.

[32860.]—**Black Stain for Table.**—H. Allingham should wash the surface of his table with liquid ammonia, applied with a piece of rag; the varnish will then peel off like a skin; afterwards smooth down with fine sand-paper. He should then mix ½lb. of lampblack with 1 quart of hot water, adding a little glue size; rub this stain well in; let it dry before sand-papering it; smooth again. Mind you don't work through the stain. Afterwards apply the following black varnish with a broad fine camel-hair brush:—Mix a small quantity of gas-black with the varnish, given in reply 32847. If one coat of varnish is not sufficient, apply a second one after the first is dry. Gas-black can be obtained by boiling a pot over the gas, letting the pot nearly touch the burner, when a fine jet black will form on the bottom, which remove, and mix with the varnish.—F. A.

[32861.]—**Removing Cement from Iron Pipes.**—This has been asked several times lately, and I have not seen it satisfactorily answered. I would suggest tapping round the joint with a small hammer—using, of course, a large hammer under the joint to receive the blow—and afterwards a few smart blows on the end of joint; but if the joints have been long made, it is probable they are now part of the metal.—OS.

[32861.]—**Removing Cement from Iron Pipes.**—In the "trade" iron cement is generally "picked" with a hammer and chisel; but as it is nearly as hard as the solid metal itself it is a tedious job. Very frequently it is cheaper to cut the spigot end off level with the socket, so that it is more convenient to get at. The spigot end, thus cut, if used again, should have a wrought-iron ring shrunk on, to take the place of the bead usually cast on.—NOVUS HOMO.

[32863.]—**Electro Magnet.**—You should state what resistance your circuit offers, and what battery-power you intend to use. If the resistance is considerable use wire No. 26 silk-covered, or finer wire still.—WIESENDANGER.

[32864.]—**Gold.**—If there is nothing in your gold but copper, melting will remove it. Half an hour's roasting will make it tolerably pure.—OS.

[32875.]—**Hooks and Eyes for Catgut Band.**—I think that the method adopted, if done carefully, is not to be beaten. In the first place screw the catgut into the hooks and eyes very tightly, and leave the end projecting well through, then singe this end with heated wire until you have riveted it over, as it were. You will find that the individual fibres will curl over and swell, so as to effectually prevent it pulling through. Another way is to splice the catgut; but it requires practice and care to accomplish neatly and well. This is described in Prof. Willis's book on "Mechanism."—NOVUS HOMO.

[32875.]—**Hooks and Eyes for Catgut Bands.**—If the gut is the right size for the hooks, it requires nothing but screwing well in. The ends do not even require burning. I cut them off with a sharp knife, and I find they require nothing else.—OS.

[32875.]—**Hooks and Eyes for Catgut Band.**—Hooks and eyes are made of steel, and carefully tempered. By burning off the ends you spoil the temper, and make the hook or eye soft. It is very important that you should notice this. When the hook or the eye comes off the internal screw-thread is filled with particles of gut, and you never can fix it on again successfully before having carefully cleaned it. Do it in this way: Take a brass pin, turn the point to a small hook, hold it into the thread of the hook or eye and turn the latter round until the thread is quite clean; then screw it on to the gut. Take a hot iron and hold it into the hook or eye itself. The fatty matter in the gut will melt and fill the interstices. After this, plunge the hook or eye and end in cold water; you thus temper the steel again.—WIESENDANGER.

[32876.]—**Cutting Gauge Glasses.**—These are best cut with a small emery-wheel, and afterwards ground flat on the face of wheel. You might manage it with an ordinary grindstone, by using the corner or edge of the stone to cut the glass.—OS.

[32877.]—**Indian Ink.**—Mix lampblack with ten times its weight of sulphuric acid (specific gravity 66 degrees B.), and after standing 24 hours wash it free from acid. It becomes easily mixed with water, and is as good as genuine Indian ink.—ADYE DOUGLAS.

[32881.]—**Gas Holder.**—A zinc-worker would make you a gas-holder for a few shillings—two cylinders, one inverted in the other; two uprights, with pulleys at top, and weights to counterbalance the inside cylinder. A zinc pipe attached to the outside cylinder should reach the top of the machine (when empty). If you merely want a reservoir, without any pressure, a large closed cylinder of zinc would answer your purpose, and would cost very little.—OS.

[32885.]—**Canoe.**—In reply to "Temeraire," if your canoe is 16ft. long, the seat aft should be about 5ft. from the top of stern-post. The canoe would be better 17ft. for two men—the distance for the after seat would then be about 5ft. 6in. from the stern; but, if you require her for your own use occasionally, 16ft. would be better. The anchor should weigh about 12lb.—not more. If you will write me direct, I will send you tracing full size of the best anchor for a canoe, folding stock, &c. The following is the best arrangement for anchoring a canoe:—The painter is rove through a hole in the stem-post (not the stern). On the end, instead of a knot, splice a strong brass ring or thimble sufficiently large to allow the cable to slip through easily, the other end of the painter being made fast to a cleat on the right-hand side of the canoeist, within easy reach of the hand. To anchor, haul the end where the ring is aft by a small line, at the same time slacking out the painter; pass the cable through the ring, haul on the painter, and when fully out make fast round its proper cleat; throw over the anchor—which will now hang from the bow—pay out the cable the required length, and make fast to a cleat on the left. The boat will now lie at anchor, head to stream. To get in the anchor, haul on the cable until the anchor is chock up to the bow, slack out the painter, and haul on the cable, when the anchor may be taken in at the well. Afterwards haul the painter to its proper position. Having tried various plans, I find this answers admirably. The painter and cable should be made of half-inch woven cord, which runs easily. With regard to the mizen, the sheet should not work on a horse, but through a block on the after-deck about 8in. from the stern-post; thence to a cleat on the left-hand side of well.—E. H. JONES, Monmouth.

[32885.]—**Canoe.**—1. In a canoe I am about to build of the same dimensions as "Temeraire's" I propose to place the after-seat (for the heavier person) 4 5ft. from stern, making the well long enough for the forward sitter to trim her by sitting a little more foward or aft. 2. The proper-sized anchor can be got at the corner of Arthur-street and King William-street, City—Monument side. Get a strong painter, with thimble turned in the outer end; reeve it through a ring near the stem. Pass the cable through the thimble, and by slacking the inner end of the painter the cable will come as far aft as you please. 3. The mizen sail should have a boom, and the sheet may be rove through an eye on the after-deck, and may be made fast to a cleat on the deck near the well.—GIMCRACK.

[32891.]—**Treatise on Comets.**—I beg Mr. Salburgh will accept my best thanks for his very courteous expressions. There is no prospect of the publication of a treatise which the subsequent advance of astronomy has rendered of very little value.—T. W. WEBB.

[32894.]—**Canaries.**—I don't think there is any cure for what affects your canary. It is a very common thing with foreign-bred birds. I have known many people to have birds go in the same way, which leads me to believe it occurs through the birds being bred in a much warmer climate, and when they moult here it is so much colder, and they thus lose their voice. It may very likely occur in another way—viz., the bird is an old one that has been used for breeding, for they generally are not much good after they have once been put up to breed. You had better get one from a home breeder, as they are best. I have one myself of my own breeding which sings the same every year, being now six years old.—H. A. WRIEDEN.

[32894.]—**Canary.**—I had a similar case of a canary entirely losing its voice after moulting, and it did not sing for quite a year. I put a small piece of mutton suet between the bars for it to eat, and I found that in about three months it had quite recovered its voice, although it song was not quite so strong as previously. Give it also a small quantity of cayenne pepper occasionally, for most canaries are very fond of it.—ADYE DOUGLAS.

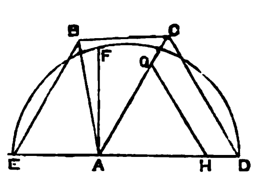
[32895.]—**Bicycle.**—With regard to the first part of "Tangent Amateur's" query I may say that I have been using a front wheel pull brake lately, and find it very efficient, and, with moderate care, quite safe. The brake is pulled on by the fingers, and not pushed on by the thumb. I have not seen the sliding saddle clip in use.—53IN. INVINCIBLE.

[32895.]—**Bicycle.**—A friend of mine, a captain of a large bicycle club, bought a new machine lately with a screwdown brake on the front wheel, and as I told him would one day happen, he tried to stop suddenly when going fast down hill, and was thrown right over the handles, and very severely injured. The machine also turned a complete somersault, and was bent out of shape.—ADYE DOUGLAS.

[32896.]—**Reversing Gear.**—This is "Waelschertz' reversing gear." (Have I spelled it right?) The advantage in it is, that it gives a quicker cut-off than if worked by the eccentric alone, as then the links, H and D, are moving in opposite directions, causing the velocity of G to be the result of the motions of the crosshead and eccentric. It will be seen that the travel of the valve is greater than that of the eccentric, the amount of which is determined by the proportion of the links. On constructing a diagram some time ago I came to the conc
that its advantages were more imaginary tha
although the simplicity of the curved reversin
is to be admired. I believe it is used on man
tinental locomotives of German make, and I
recollection of its being illustrated in *Engin*
some months back, but am unable to find
NOVUS HOMO.

[32900.]—**Attraction.**—The attraction of a
upon a particle on its surface is the same as
whole mass were collected in the centre, as is
in mathematical treatises on the subject.
being so, "Volvox" will have no difficul
answering his own question.—W. G. P.

[32903.]—**Geometry.**—Given △, A B C.
A C D equilateral; draw B E ∥ C A; A F ⊥



A G = A F = A H; then △ A G H = △ A
H. F. L. MEYER.

[32905.]—**Pumping Engine.**—Theoreticall
diameter (I suppose you mean diameter) woul
to be about 28in. In ordinary pumps the deli
probably one-fifth less than the calculated qua
in well fitted-up sets from one-tenth to one-twe
less.—ROSCOE.

[32606.]—**Oval Measure.**—The oval taken
ellipse, the area is [illegible] . [illegible] . 3¼ square inches =
= 109¾ sq. in., or 1[illegible] sq. ft. 1¼ sq. in.—H. F. L. M

UNANSWERED QUERIE

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The numbers and titles of queries which remain
secred for five weeks are inserted in this list, and
unanswered are repeated four weeks afterwards. W
our readers will look over the list, and send what infor
they can for the benefit of their fellow-contributors.

32300. Soap Substitute, p. 635.
32307. Induction Coil, 635.
32309. Dissolving Tap.—To Mr. Pumphrey, 635.
32310. Organ Pipes, 636.
32313. Microscopical.—To Mr. Allen, 636.
32316. Gold Shell, 636.
32323. Herapathite, 636.
32326. Pigments, 636.
32350. Traction Engines, 637.
32354. Colouring Fern Leaves, 637.
32357. Paste Blue, 637.
32358. Coal Tar and Chemicals, 637.

32534. Organ, p. 101.
32536. Moulding, 101.
32537. Stern Post, 101.
32538. Tellurium, 101.
32553. Coils, 101.
32563. Flutina, 101.
32571. Fingering (Flute), 101.
32577. Chicory in Coffee, 101.
32579. Pullman Car Trains, 101.
32586. Black Patches on Oak, 102.
32589. Electric Controlled Pendulum, 102.
32597. Flies' Eggs, Mounting, 102.
32605. Prout's Brown, 102.
32606. Small Organ, 102.
32607. "Blacks" from Kitchen Chimneys, 10[illegible].

QUERIES.

◆ ◆ ◆

[32908.]—**Refractive Power of Water.**—
seen the following statement in a recently publish
and would feel obliged if any of your readers would
me of its truth or otherwise, and quote any autho
the subject:—"In the raising of the temperat
water from 0° Cent. a very remarkable exceptio
otherwise universal law is observed. All bod
pand when heated; but upon heating water at 0°
contracts until it reaches 4° Cent. and from this
again obeys the law." I am perfectly aware th
phenomenon takes place, but I understand that b
behaves in a similar manner when a temperatu
above its melting point is reached, and that water
therefore a solitary exception. But the statement
follows is the one I more particularly wish to ha
firmed or confuted:—"When light passes thro
transparent medium it is refracted. If the density
body be increased, its power of refraction increase
should expect, therefore, that as water increases
density from 0° Cent. to 4° Cent., its refractive
would likewise increase, but such is not the case."
correspondent will, perhaps be able to state the ref
power of ice and of water at 0° Cent. and 4°
respectively at any given angle?—H. B. F.

[32909.]—**Paper Canoe.**—How could I mak
frame of a paper canoe, intended to be made by p
sheets of paper on the frame and then oiled?—Aus

[32910.]—**Japanning Clock Dials.**—How
enamelled surface produced on three feet dials?
what black is used for chapters, &c.?—AUSTRALIA.

[32911.]—**Fuller's Battery.**—Will "Sigma,"
other electrician, kindly inform me if this batt

equally useful and as durable as the Léclanché for bell-ringing, also if it is applicable to any other purpose? In its construction would it not be better to put bichromate solution and carbon in porous pot, and to have a bent sheet of zinc surrounding the pot in the outer cell, instead of the reverse as mentioned by a recent correspondent?—AMATEUR.

[32912.]—**Mustel Organ.**—Will "Eleve" or some of our friends give extreme treble end of mustel organ, of which "Eleve" gave two sections in Vol. XXIII., No. 577?—ANXIOUS ONE, J. S.

[32913.]—**Model Cutter.**—I am anxious to make myself a model cutter or schooner about 3ft. or 3ft. 6in. long. Will you kindly tell me in your answers to correspondents how to set about it, either to build or cut it out from the block? Can you give me any idea of the shape at top, midship section, and stern?—POOR JOE.

[32914.]—**Hair Dye.**—(See reply of "A. L.," 31390). Will any brother-reader who has tried this, kindly report result? I have advertised twice for some of it, but cannot get a reply.—DOLOMITE.

[32915.]—**New Zealand Railways.**—How can I obtain an appointment on the New Zealand railways before leaving England, and what are the salaries for station masters and higher officials on those railways?—A STATION MASTER.

[32916.]—**Wing or Throttle Valve.**—Can any reader inform me of the best method of finding the centres of wing valve so that when it is turned in the lathe and put into the valve-box with the spindle through the wing it will be steam or water-tight as the case may be?—THORNHILL.

[32917.]—**Romping Twist.**—Will "Concoil," or any other subscriber, oblige me with a simple rule for finding the twist of the coping of a winged wall that would enable me to work the same? I am not acquainted with orthographic projection but know a little of the elements of plane geometry.—APPRENTICE MASON.

[32918.]—**Electric Pen.**—I wish to write simultaneously 10 or 15 copies of a notice I have frequently to send out, and I want to employ electricity. My idea is a metallic plate connected with one pole of a battery, a metallic style in lieu of pen, connected with the other pole, and a number of sheets of paper soaked in some chemical which will be decomposed by the passage of the current. If this is correct will some of our electrical authorities kindly say what solution the paper should be steeped in and what battery power would be required?—WALLASEY.

[32919.]—**Hot-Air Engine.**—Would some correspondent oblige by giving me information how to make a small engine of about ¼ horse-power, the motive-power to be hot air? Drawings will oblige if convenient.—A COUNTRY READER.

[32920.]—**Capillaire.**—Will any reader oblige by informing us how capillaire is made, and what of, and for what it is used?—Z. D.

[32921.]—**Noiseless Gear for Lathes.**—Would Mr. Jewsbury please inform the readers of the E. M. where, in the neighbourhood of Birmingham, the above gear may be seen in motion?—ANXIOUS.

[32922.]—**Repairing German Concertina.**—Will some one tell me how to repair a German concertina which is out of tune, what kind of metal the reeds are, and how to replace a bad one?—E. W.

[32923.]—**Scarlet Tunic.**—I have one soiled with [illegible]-gum. Any information as how to clean it or restore it to its original colour will be gladly received.—J. J.

[32924.]—**Telescope.**—Like "Telescope Tele" I too have bought one of the noted £5 telescopes, but with brass body and finder, and (in maker's words) with "3in. achromatic O. G. of superior qualities," making the real cost £12 18s. 6d. Since Mr. Dennett kindly answered my query, when, anticipating my disappointment, he feared my "telescope was not achromatic, and the O.G. one of the cheap ones," and since "F.R.A.S." advised me to sell it straightway for old brass and glass," I have given it another trial. With the terrestrial eyepiece I can read the letters to the editor at forty yards, and the signatures of the writers at fifty yards' distance, and also many stars clearly and well defined. But as soon as I use either of the celestial eyepieces (180 and 250) the bright stars appear to be covered with a mist, sometimes made up of two or three colours. Will Mr. Dennett or some friend kindly tell me if I am right in attributing the fault to the eyepieces and not the O. G.? The information will be interesting to amateurs, and some of us would like to know if "Telescope Tele" finds his "noted £5" glass a [illegible].—TOTHAM.

[32925.]—**Hjorth's Magnet.**—What kind of thing is a magnet on Hjörth's principle?—SITIENS SCIENTIÆ.

[32926.]—**Red Colouring.**—What is the colouring [illegible] employed to make strawberry and red currant [illegible] when these are simply sugar and water, flavoured [illegible] appropriate ether?—SITIENS SCIENTIÆ.

[32927.]—**Mensuration.**—In "Templeton's Workshop Companion" I find the rule to find the solidity of a cylinder: "Multiply the area of the diameter by the length." I also find, "Multiply the square of the diameter by ·7854, the product is the area;" also, "A cubic [illegible] equals ·02909 cylindrical feet." Then follows an example. Required the number of cubic yards in a well [illegible] diameter, and 35ft. deep. The answer is given

$$4·75^2 \times 35 \times ·02909 = 22 \text{ cubic yards.}$$

This is simply multiply the square of the diameter by the length, but I, in working it out, made it

$$[illegible] \times 4·75 \times ·7854 \times 35 \times ·02909 = 18 \text{ cubic yards.}$$

Will some one kindly explain to me how I am in error? [illegible] in the formula area of a circle to diameter [illegible] ·7854 what is the meaning of "to diameter 1?"—[illegible].

[32928.]—**Pastry Oven.**—Will any reader inform me how to build a small brick oven about 20in. square inside? I want to bake a little pastry and tea cakes in it. Also will any reader say what is the cause of the blistering on the top of the tea cakes?—J. B. N. H.

[32929.]—**Cement for Aquariums.**—Will some [illegible] kindly give me a receipt for a good cement to make my aquarium waterproof? I have tried a good [illegible] and have entirely failed, so far, to make it hold water. Cement that sets quickly preferred.—F. A.

[32930.]—**Pipe Angles.**—Wanted to know how to cut ends of two pipes so as to form any given angle or elbow. I asked a nearly similar question lately, but it has received no reply.—JOHN.

[32931.]—**American Dried Apples.**—Can any one tell my wife how the sliced dried apples from America are prepared? They are done in some similar way to pippins, and merely require soaking to swell up.—JOHN.

[32932.]—**Bird Lime.**—Will any of your readers inform me of the best way of making bird lime?—W. B. A.

[32933.]—**Legal Question—Tithes.**—Would one of your legal correspondents inform me whether it is obligatory on a person to take the tithe to any place in the parish the incumbent or his agent may appoint? Cannot they be compelled to call for the money at one's domicile, as they do for income tax, poor rates, &c.? Who has the power to let the churchyard to be grazed (it is often done in Wales)? Would it be the parson or churchwardens?—KAIKORA.

[32934.]—**B.Sc. London.**—I am desirous of obtaining the degree of Bachelor of Science at the University of London. I have procured and studied carefully "Pinnock's Science Catechisms," and I consider I understand them. How ought I to proceed to obtain this degree without subjecting myself to the unnecessary and troublesome previous examinations?—W. H. ESCOTT.

[32935.]—**Grinding Glass Tube.**—I want to grind a glass tube inside; the hole is ¼in. diameter and 7in. long; it wants to be very correct inside. I want, if it is practicable, to run the tube in a wooden chuck in the lathe, and have a long spindle with a small grinding stone screwed on the end to grind inside the tube, but I want to know what kind of stone will be the best, also what speed it should run at, and how to polish after it is ground true, because I think the stone will leave it very dull. I believe there are some level tubes sold in London that are ground inside and out, but by what process I should like to know, and also how they blow the ends up without contorting the tube?—J. K. N.

[32936.]—**Bicycle Construction.**—To MR. STRIFFLER.—Will Mr. Striffler, who, in bicycling matters, really seems omniscient, kindly supply answers to the following string of questions? 1. Are charcoal-iron spokes preferable to steel, and, if so, why? 2. Do steel spokes require tempering, and can they be headed up cold like the iron ones? 3. What would be the proper diameter of steel tubes for hollow front fork and hollow handle bar, and could they be worked as received from manufacturer, or must they be tempered? 4. I intend making my bearings after the fashion of those used on the "Premier," but with the addition of a glass hard renewable steel-bush to spindle, hoping thus to obtain the maximum of simplicity and durability. I shall be glad of Mr. Striffler's comments on this. What should be the thickness of the bush? 5. Would it be practicable or advisable to put 1in. rubber on ⅞in. U-rims? U-rims do not appear to be made larger than ⅞in. 6. What would be the probable cost of fitting up an amateur bicycle maker's workshop? What size lathe, what cutting tools, drills, taps, &c., are necessary? If Mr. Striffler would specify all the appliances, with their probable cost, absolutely necessary to bicycle-making, I am sure he will receive not only my grateful thanks, but also those of many others who, like myself, may wish to construct a bicycle after their own "heart's desire," but who have not the means or who may not, for other reasons, wish to place themselves in the hands of a manufacturer.—PHŒNIX.

[32937.]—**Le Floral.**—There is a form of concentrated manure sold under this name by a well-known firm of seedsmen, for which almost magical properties are claimed. Can any one give an idea as to the ingredients of this?—R. G. L.

[32938.]—**Fireworks.**—How are the daylight fireworks made, and what of, such as those manufactured by Hirayama Jinta, pyrotechnist to the Mikado of Japan, and exhibited at the Alexandra Palace?—GOLD STAR.

[32939.]—**Glass Staining.**—Could any reader enlighten me as to the technical part of glass staining (for church windows, &c.) or recommend a book?—PERDU.

[32940.]—**Plaster of Paris**—Will some reader of the ENGLISH MECHANIC kindly inform me how plaster of Paris could be reduced to powder after being burnt in the kiln? Would a pair of crushing rollers do? or would a mill with edge runners be preferable? A machine capable of grinding 300 bushels per day would be sufficient for my purpose. Are such machines made to be worked by hand power?—ETNA.

[32941.]—**Powerful Telephone.**—I copy the following extract from the *Birmingham Post* of May 3rd:—"At the annual soirée of the Royal Society, held at Burlington House, London, on Wednesday evening, one of the most notable items amongst a very interesting collection of scientific objects and works of art was a musical telephone, said to be the most perfect yet produced, and instructive also in the novel scientific results obtained with it. It is the invention of a young American, Mr. Gower, of Boston. Its remarkable feature is the way in which the transmitter is strengthened by battery currents, so that the electrical waves conveyed to the receiving instrument, which is the familiar Bell's telephone, have such power as to produce an amplitude of vibration in the iron plate that will yield musical sounds perfectly audible in a large room to the whole audience." Would some of your electrical correspondents kindly explain in what manner the battery currents are applied, and also the general construction of such a telephone?—J. W. O.

[32942.]—**Interest.**—A person borrows £40, for which he agrees to pay £50 by weekly instalments of £5. What per cent. per annum does he pay for the loan? Again, a person borrows £175 from a society, to be paid by monthly instalments of £1 6s. 9d. for a period of 21 years. What per cent. per annum does he pay for the loan?—J. W. B.

[32943.]—**Rose Colour.**—I wish to colour a compound a delicate rose colour. The colour must be added whilst the material is pretty hot, which seems to destroy the effect of various substances which I have tried for the purpose; in fact, the heat appears to burn the colour out. Will any of "ours" advise me what to use, and give me any other information on the subject which they may deem useful?—APOTHECARY.

[32944.]—**Musical Telephone.**—I am about to make a musical telephone to transmit vocal and instrumental music. I have seen one of the sort that appeared like a large inverted helmet, but I have no idea of its construction. Will some telephonic correspondent kindly give me details of a transmitter and receiver capable of rendering a distant concert audible to all in a room 25 feet square.—SINCUB.

[32945.]—**Reducing Aperture of Quarter-Inch O.G.**—Will any of our correspondents on microscopical matters kindly give me their advice and suggestions? I am in possession of a ¼in. objective of about 100 angle, which resolves diatoms to perfection, crossing angulatum without the least trouble; but unfortunately it lacks penetration. I have been recommended to reduce the aperture with a stop, but that does not seem to have the necessary effect. I have placed a piece of black paper with pin-hole over front lens, which certainly improved the definition beyond the exact focal plane; but what I require is to be able, for instance, to see the whole of a small creature, such as a water flea or cheese mite, at one instant without altering the focus. Is it possible with an eyepiece to get that depth, and how are the stops to be arranged? My glass in its present state gives exceedingly sharp definition, but there is so very little of the object in perfect focus at the same time that it spoils the effect, giving the object a misty appearance. Any remarks on the above will greatly oblige—H. R. HERBERT.

[32946.]—**Telescope.**—Having lately made an eyepiece with ¼in. focus and ⅜in. focus lenses for a 2¼ O.G., I shall be thankful if any of ours will tell me what lenses to get and what distance apart to mount them; also how to make the dead black which sticks so fast to the brass; that which I have made is not satisfactory in either manner.—RAILROAD.

[32947.]—**Blacking.**—Will some qualified reader of the ENGLISH MECHANIC favour me with the ingredients and proportions, and how to manipulate them, to make a first-class blacking?—IVORY BLACK.

[32948.]—**Preserving Caterpillars.**—Could any correspondent give me some directions as to preserving caterpillars and chrysalides in a dry state, as I am going to try this year to get up some life-histories of British butterflies and moths?—WALTER A. PEARCE.

[32949.]—**Great Northern Engines.**—When in London a few days ago I heard that the G. N. R. were building express engines with 9ft. driving wheels. Will "C. E. S" kindly say whether such is the case or not?—T. G. S.

[32950.]—**The Phonograph.**—To MR. SHELFORD BIDWELL.—May I ask Mr. Shelford Bidwell whether he considers it would be worth my while to proceed with the construction of my phonograph, which, owing to the lucid description of his own, No. 683, p. 157, I have so far matured as to obtain, upon rotating the cylinder at a speed of about once in a second, well defined pits on the foil—speaking meanwhile, distinctly and rather loudly into the mouthpiece of the instrument? What rather puzzles me, however, is this: the pits appear to be exactly similar in size and distance apart; whereas, I expected to have found them varying in distance and size, as shown in the actual impression, in ink, from pieces of foil, in various papers, illustrating the phonograph. My thin iron disc appears to be sufficiently sensitive to vibrations. I find that a single distinct sound such as "ooo" will produce a well-pronounced deep pit, whilst the cylinder is stationary, or three distinct pits, varying in depth and size, if the word "Pho-no-graph" is spoken, moving the foil a little for each syllable. When the cylinder is rotated about one turn in a second, and I say, pretty loudly, "How do you like the phonograph?" pits are made all round, but they appear to be at equal distances, and of equal size. A clean groove is made when the disc is not agitated by the voice. I have insured great accuracy in the mounting of the cylinder &c., and, having applied very closely to the work in hand, now feel inclined to delay proceeding further, until I may receive encouragement or otherwise from the above gentleman, who has added so materially to my desire to construct a phonograph by his exhaustive and excellent article in "our" journal. I may say, that I do not expect any difficulty in the arrangement of the reproducing diaphragm, &c.—GEO. FOX.

[32951.]—**Organ Orchestrion.**—I have one of these instruments standing 10ft. 6in. high, with barrels 4ft. 6in. long. Each barrel has 128 bars of music, and compass of instrument is 6 octaves. I want some more barrels making. Will "Fiddler" or some other musical friend tell me how to arrange the music, dances, overtures, &c.?—UNION JACK.

[32952.]—**Photographic.**—I have lately been varnishing some negatives, but fail to get a nice clear face to the plate. I apply moderate heat before and after applying varnish, still I cannot obtain other than a dull ground-glass-like surface. Can some one set me right? I use Cox's negative varnish.—J. S.

[32953.]—**Indian Museum.**—Do the authorities of the Indian Museum have stalls at public meetings for the sale of Indian articles I have been told so, but I think it very doubtfull; and also are the officials allowed to have a stall on their own account? Would some one kindly inform me?—RED INDIAN.

[32954.]—**Old Music.**—Will any reader of the ENGLISH MECHANIC tell "Hosnikos" whether there is any hospital or charitable institution that would like a quantity of old music sent to them?—HOSNIKOS.

[32955.]—**Moths.**—Would some of "ours" give me some information about catching night-flying moths, the names of some of the commonest, and how to distinguish them?—X. Y. Z.

[32956.]—**Highest Power for Object Glass.**—I should like to ask "F. R. A. S.," Mr. Birt, or one of the gentlemen who kindly answer so many questions on the subject, as to what is the highest power I can put on my object-glass of 2¾in. aperture. I should like to get 200 or 250 on the moon, and would like to know if it is advisable; also what would the eyepiece cost. Would it be practicable to put in the paper weekly, a map of one or more of the constellations for the use of such contributors who cannot afford to buy a map one of whom I am. For instance, I want to find Uranus, and cannot tell which is ν Leonis—the only assistance I have being Proctor's "Half Hours with the Stars," and though this is an exceedingly good book, I could do with one showing smaller stars, but cannot afford.—A POOR STUDENT.

[32957.]—**Loco. Notch.**—Thanks to C. J. Bonser for his reply to my former query. Will he or any other correspondent tell me whether it does any good to locomotives notching them back, and would he prefer them notched back at the start or in full motion?—APPRENTICE FIREMAN.

[32958.]—**Weak Part in Cylinder.**—I have got a small cylinder, 3½in., which has been cast with weak side on part near to the top flange of cylinder. I will feel obliged to any of the readers who could suggest a plan to strengthen the weak parts.—TURNBULL.

[32959.]—**Incorporation of Building Societies.**—The shareholders of a building society are about to consider the desirability of applying for a certificate of incorporation under the Building Societies Act, 1874. I find from a return published some six months ago that upwards of 200 societies have become incorporated under the Act. Will some one conversant with the matter inform me the advantages attaching to incorporation; and the probable cost of obtaining a certificate? Any information on the subject will be gladly received by—AN ANXIOUS SHAREHOLDER.

[32960.]—**Lamp for Burning Tallow.**—Will any one be so kind as to give me a description of what they think will be the best kind of lamp for burning tallow?—SAILOR.

[32961.]—**Excise.**—Can any reader inform me what are the subjects for examination for the above branch of the Civil Service? Please give limits of age, pay, and in fact all particulars.—R. S.

USEFUL AND SCIENTIFIC NOTES.

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A Real Insecticide.—We are repeatedly receiving queries asking for information as to the best means of getting rid of beetles and other insect pests that infest our houses and gardens. Three or four years back we stated in these columns that we had found the liberal application of gas-tar a good antidote to the presence of black beetles and cockroaches. Recently, however, we found ourselves again obliged to wage war with our old enemies, and sought to disperse them by the same means which had before proved successful, but in vain. We tried over again all the poisons and pastes we could get hold of, but the beetles still remained masters of the situation, and our kitchen. Just as we were at the point of despair a friend sent us a box of Vesper's Insect Destroying Powder, which has effectually rid us of the enemy, and we recommend it to all similarly plagued. It is perfectly harmless to human beings and domestic animals, and is clean and inoffensive in use, which is more than can be said of some of the evil-smelling compounds we have lately been trying. Unless we are mistaken it is a preparation of Pyrethrum Roseum; or, Russian Tansy—a plant which is well-known abroad for its deadly effect on insects, but which, when grown in England, loses its properties. Whether our surmise is correct or not the value of the powder is beyond question. Having disposed of the beetles, it occurred to us to try it on some rose trees badly infested with green fly. We applied it liberally—until the trees looked as if it had been raining Scotch snuff—and awaited the result. One of the heavy downpours we have been favoured with recently came down in the night, and in the morning the trees were clear alike of powder and green fly, and the latter have not been seen since. We are assured that it is equally efficacious with ants, fleas, and other tormentors of the tribe, and have little doubt that such is the case.

The Bahama Pine-Apple Trade.—A large proportion of the area of the Bahama Islands is devoted to the cultivation of fruit, of which oranges and pine-apples are the principal; and at the present time the fields in the estates on which the pine-apples are growing form a peculiar feature in the landscape. The appearance of the broad expanse of young fruit, with its clusters of delicately-tinted, but sharp and serrated leaves, rising only a short distance from the ground, and covering the undulating fields, produces a very remarkable effect. In no other branch of agriculture can so curious a picture be produced as in the growth of these vast numbers of pines. As many as a million and a half of the fruit have been collected from a single acre at one crop. The appearance of these pine-apple estates has as little in common with the sugar plantations or paddy-fields of the tropics as with the corn-fields or vineries of Europe. In a few weeks these pine-apples will be making their appearance in the English markets. They are shipped in an unripe state, and mature during the voyage, and hence are not so excellent in quality as the English hot-house fruit, or as if they were properly ripened in the ground. The pine-apples of New Providence, however, are superior to any other variety, and often attain an enormous size. One, grown in Pembrokeshire, weighing 10½lb., and measuring 10½in. in height, exclusive of the stalk and crown, and 22in. in circumference, was served up at the Coronation banquet of George IV., and since then the improved modes of cultivation have greatly increased the size and quality of the fruit. There is an enormous demand for the Bahama pine-apples both in Europe and America, and a new industry has lately sprung up in the island in preserving the fruit in tins when they are fully ripened; one factory in Nassau alone exports annually a million tins, valued at £16,000. These fruits are superior to those sent away earlier in the season, as they are ripened naturally and packed in perfect condition instead of being gathered when only half ripe.—*The Colonies and India.*

CHESS.

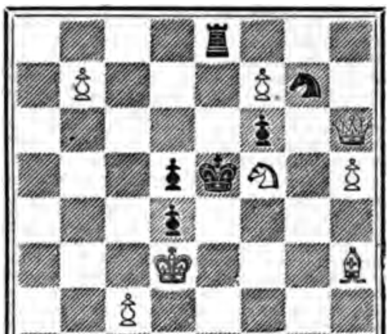
◆

ALL Communications intended for this department must be addressed to J. PIERCE, Copthill House, Bedford.

PROBLEM CCCCXXIII.—BY BLAIR ATHOL.

(One of the competing problems in the British Chess Problem Association Tourney.)

Black.

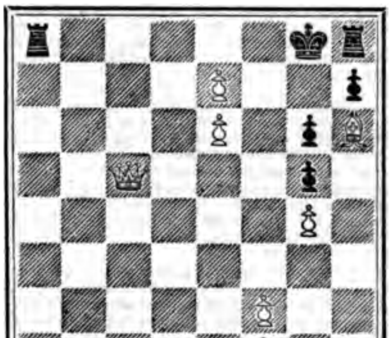


White.

White to play and mate in three moves.

PROBLEM CCCCXXIV.—BY J. G. FINCH.

Black.



White.

White to play and mate in three moves.

SOLUTION TO 421.

White.	*Black.*
1. R to Q B sq.	1. K to K R 4 (*a*).
2. R to K Kt sq.	2. K to K Kt 5.
3. K takes P.	3. K to K R 4.
4. P mates.	
	(*a*) 1. P to K Kt. 3.
2. R to K Kt sq.	2. P takes Kt.
3. Kt takes P at K B 5.	3. K takes Kt or moves.
4. P mates.	

NOTICE TO CORRESPONDENTS.

J. THURSBY.—Thanks for the problems. In the two-mover how do you mate if 1. $\overline{\text{K to Q 3,}}$ if 2 B checks, P covers.

J. FOXELL.—Scarcely up to mark. Try again.

C. A. L.—Your solutions of 419 and 420 are correct.

SPEED.—If in 418 Black takes Bishop, White moves Kt to Q B 3 and discovers mate.

H. HELLEWELL.—Solution to 420 correct.

CORRESPONDENTS are requested to send solutions of Tourney Problems (which will be published from time time) with comments.

To Destroy Blackbeetles, Fleas, Bugs, and all Insects, use VESPER'S WONDERFUL INSECT DESTROYING POWDER, which is sold in Tin Boxes 6d. and 1s. each, or post free for 8 or 14 stamps, from the sole proprietors, G. and T. VESPER, 423-5, Commercial-road, London, E. The name of VESPER is stamped on top of every box; otherwise none are genuine.

Lamplough's Pyretic Saline is refreshing, most agreeable, and the preventive of FEVERS, BILIOUSNESS, SMALL-POX, SKIN DISEASES, and many other spring and summer ailments. Sold by chemists throughout the world, and the Maker, 113, Holborn Hill. *Use no substitute.*—[ADVT.]

ANSWERS TO CORRESPOND

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HINTS TO CORRESPONDENTS.

1. Write on one side of the paper only, and
ings for illustrations on separate pieces of pap
titles to queries, and when answering queri
numbers as well as the titles of the queries to
replies refer. 3. No charge is made for insert
queries, or replies. 4. Commercial letters, or
replies are not inserted. 5. No question askin
tion or scientific information is answered t
post. 6. Letters sent to correspondents, und
the Editor, are not forwarded; and the name
spondents are not given to inquirers.

The following are the initials, &c., of letters
to Tuesday evening, May 14, and unacknowl
where:—

J. B. DANCER.—Rother Ironworks Compan
Espin.—E. Broderip, Fournier, and Co.—W.
General Knox.—Capt. Boileau.—J. Bourne
G. Tolman.—W. K. Fergusson.—P. Harris
Bulger.—Henry T. Vivian.—Theo. Izod.—F.
field.—Adolf Schulze.—W. C. Lockerby
Gauge.—Adye Douglas.—J. N. B.—E. M.
vator.—Discord.—B. J. S.—F. Piper.—J. A
—Daghbert.—"One who has Often Helped
Help."—Bothwell.—A Dusty Miller.—G. L.
—C. H. Smith.—Telescope Tele.—L. and Co
leod.—C. R. M.—New Zealand.—S. W. Bur
Moore.—Bachelor.—W. Burns.—One in
Pumper.—J. H. Stephenson, New Zealand.—
Theo. Pitt.—Photo Cymraeg.—C. C. C.—G. P
—L. Newton.—J. R. W.—Mapplewell.—Blac
J. A.—H. E. H.—Vercingetorix.—Cornishma
W. J. Grey.—Mechanic.—Robertson.—E.
A. C. R.—J. Stewart.—J. L.—T. Wilson.—
F. Bottomley.—Sea King.—Hyperion.—Al
E. J.—XXXX.—Herbert A. Stevens, Japan
An Old Subscriber.—Clarence Sterling.—A.

SOUTH AMERICAN EMIGRANT. (We know no
tively, but should hesitate to advise you to
an American trade journal just perused w
the United States Consul at Buenos Ay
American workmen against proceeding to t
search of employment.)—R. C. P. (We publi
tions for making modelling clay on p. 643,
and on pp. 381 and 408, Vol. XXII.; and f
modelling wax on p. 413, Vol. XVIII., a
Vol. XXII.)—J. E. B. (Please send.)—ONE
(The misspelling of the name will not affe
riage, provided, of course, that no intenti
was practised. It is a matter of some d
arrive at the correct orthography of some
One very uncommon one that we know is spel
of ways in the registers of the native pari
who bore it, and it is by no means certain th
accepted spelling is the correct one. This i
the case with many families.)—W. H. B
have several times given directions for ma
balloons; the querist referred to the i
balloons and the machinery used in their ma
—W. S. (Nothing can be done with the bir
at all an unusual occurrence. 2. Any dealer
specimens will be able to sell you a piece of t
loadstone; third query inserted.)—J. A. (Se
editor of the "Sphinx.")—BOPEG. (Apply
motive superintendent of the line.)—SEMIBR
letter was in type, and would have appeare
as we go to press we notice it has been sent
journal. It is therefore not inserted.)—A
WIFE. (We have often published directions
ing and polishing shirts and collars; amon
and clearest are those given on p. 445, Vol.
p. 401, Vol. XII.)—BOOKWORM. (A good s
ters on bookbinding appeared on pp. 67, 28
418 of Vol. XXV.)—W. J. TREWS. (A review
book on St. Alban's Abbey, with illustratio
in to-day's *Building News.*)—A. P. (We are
of organ matter just now, but should have n
to look through your treatise and, if acceptab
lish it in the same way as we have similar
cations.)—RAVEN. (A solution of diluted
will remove the rust and stains.)—BEGIN
cannot advise as to makers; you can hardl
by dealing with those who advertise in these
to choice of apparatus, read the letter fron
"on the choice of a microscope," p. 12, Vol.
625.)—L. MORELAND. (The Lapideon was
instrument, contrived by M. Baudry, made o
schist, suspended from an iron frame, and
a flint hammer to produce the notes. The
about forty in number, elongated, and of vari
and thicknesses. They were, of course, arra
order of their tone, and much labour and tim
sumed in obtaining the desired result. We
of no attempt to repeat M. Baudry's exp
S. T. W. (We know that, as you say, mor
historian has asserted that music was u
ancient Egypt; the statements quoted fron
Siculus are, however, altogether disprov
results of modern explorations. Bruce f
painted on a tomb near Thebes, so superio
instruments of his own time that doubts
tained as to the accuracy of his sketche
Gardner Wilkinson and Rossellini have lon
the matter beyond all question. With reg
names and forms of musical instruments
the Jews, authorities differ. The general
that the "psalter" was a species of harp, an
asserts that it was an instrument of twel
played on by the fingers. That historian,
remarkably circumstantial about many m
garding which he could have had no positive
and this may be one of them. Many musi
suppose that the psalter was not an instrum
but that the term was applied merely to th
produced by the voice in conjunction with in
—APPRENTICE. (A perpend is a term used
for a header stone which passes through
thickness of a wall.)

AN ENGINEER, C. C.—Your queries are advts.

P. C., G. Dashwood, Union Jack, Perdu, and
replied to queries already similarly answered

e English Mechanic
AND
ORLD OF SCIENCE AND ART.

FRIDAY, MAY 24, 1878.

ARTICLES.

SOME DIFFICULTIES IN THE STUDY OF CRYSTALS.—III.

By J. H. Collins, F.G.S.

ry *Secretary to the Mineralogical Society of Great Britain and Ireland.*

SUMING that the student of crystals has made himself acquainted theore- y with the forms usually occurring in x crystalline systems, and that he is s guard against being misled by pseu- rphs, and by what I have called *decep- orms*, there are still many difficulties way when he transfers his observa- from drawings and models to the als themselves. I will now proceed to e *seriatim* some of his chief difficulties.

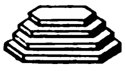
Rarity of certain crystals. — Many al and some artificial bodies, although n to crystallise in definite forms, do ery rarely, so that a student ordi- situated has but few opportunities of ning acquainted with them. *Graphite,* nstance, crystallises in well-defined gonal tables, but so rarely that a stu- well acquainted with ordinary graphite t readily suppose that he was dealing some totally new substance if a well- d crystal presented itself to him—if, stance, he should be fortunate enough d such a crystal in a cavity of an us rock.

writer has in his possession well- d octahedrons of cast iron—formed in ty of pig-iron while cooling. So rare ch octahedrons that, but for the kind- f the discoverer who presented him *wo*, so that he was enabled to sacrifice r the purpose of making a chemical sis, he would have been disposed to l it as some unknown alloy due to the ities of the cast iron.*

mallness of Crystals.—This will be a difficulty to students who have dealt with comparatively large models or gs. The best formed crystals are large, and many which the student determine will not exceed 1-30th to of an inch in their largest dimen- Of course, the pocket magnifier or croscope must be used in the investi- of such crystals, but here new diffi- come in. If a low power be used, nt amplification may not be obtained; on the contrary, a high power be ed, only a small portion of the object in focus at any one moment.

n, many crystals are opaque, and e viewed as opaque objects, and icroscopist knows the difficulty of ating very small opaque objects in manner as to avoid distortion. In nstances the Lieberkuhn mirror will d extremely valuable in such observa- ut, unfortunately, few modern micro- re supplied with these mirrors. Of too, they would be useless for ex- small crystals in the interior of in a large mass.

comparatively large crystals deter- s may be made in doubtful cases urements of the angles formed by faces, with the reflecting or even e common goniometer, but this is out of the question with very small crystals. Such measurements may sometimes be made by means of a microscope provided with a circular graduated revolving stage, but in many instances the practical difficulties in properly placing the crystals for measurement are insuperable.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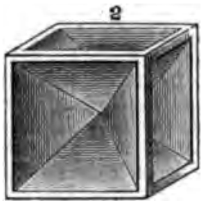
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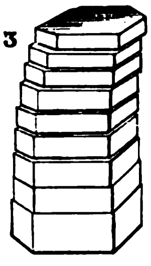
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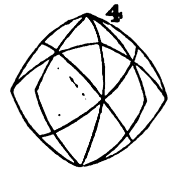
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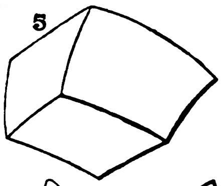
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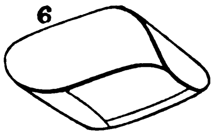
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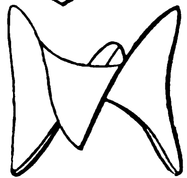
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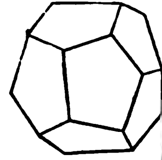
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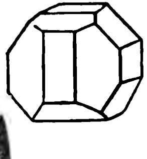
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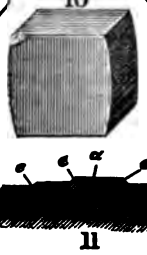
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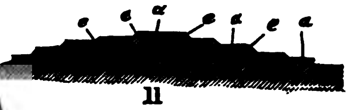

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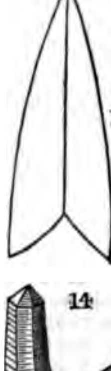
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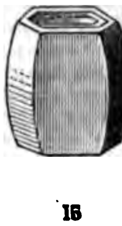
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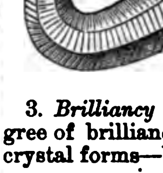
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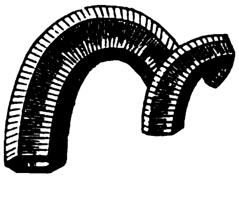
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3. *Brilliancy of Faces.*—A moderate degree of brilliancy is an aid in determining crystal forms—but some small crystals are so overpoweringly brilliant as to dazzle the eye. This is often the case with small crystals of *Pyrites, Leucopyrite,* &c. The difficulty is usually greatest with minerals possessing brilliant *metallic* lustre, *i.e.,* opaque minerals; but it is sometimes experienced with transparent minerals also. When the mineral happens to be a good conductor of heat, and in cold weather, the true form may sometimes be made out by breathing upon it, when the breath will be condensed upon the planes in a thin film having little lustre. This effect, however, at best is very transient, and the process is often quite impracticable.

4. *Aggregation.* A great many bodies of a highly crystalline character are so gregarious in disposition that only a small portion of any individual crystal can usually be seen. Crystals belonging to the *rhombic* system are especially liable to this habit—so much so that they often appear as fibrous radiating masses, externally bounded by one or more minute terminal planes of prisms, none of the lateral planes being measurable or even visible.

The aggregation of crystals is probably produced by many distinct causes acting separately or together—rapidity of formation, sudden changes of temperature or pressure, galvanic or magnetic action, &c.; but in many cases it seems to be due, in great measure at least, to what we may call peculiar idiosyncracies of the molecules themselves.

5. *Roughness of Planes.* A great many crystals, instead of being bounded by true *planes*, have rough irregular surfaces, which are only called planes for convenience. Sometimes they are made up of a multitude of individual facets, apparently indiscriminately mingled together; at others, the face of the crystal seems covered with irregular depressions or small prominences. This condition entirely prevents anything like accurate measurement of angles, and it is sometimes so great that the "edges" between contiguous faces, forming large angles with each other, are entirely obliterated.

Roughnesses, however, are sometimes of advantage in the determination of crystal forms, as they are often constant to the same planes in the same minerals. Thus, the basal planes (001) in *Cassiterite* and in *Calcite* are usually rough, and in Zircon the faces of the pyramid (101), &c. In complex crystals of tourmaline, again, when the planes of the positive rhombohedron are smooth, those of the negative rhombohedron are often rough, and vice versâ.

6. *Striations.* Every observer of crystals must have noticed the frequency of striations on certain faces. These are very often so deep and irregular as to utterly prevent anything like accurate measurements, and so far they may be numbered among the difficulties. Even more than the roughnesses just referred to, however, these striations aid the student who is once acquainted with the peculiarities of different minerals. Thus, the merest tyro in mineralogy will recognise *quartz* crystals by the striations on the prismatic faces which run *across* the prism (parallel to 001), while in tourmaline and topaz the striations are longitudinal, parallel to the principal axis of the crystal. The "Babel quartz," formerly found at the Tamar mines in Devon (Fig. 1) is, perhaps, merely an exaggerated example of this striation, although it differs in some particulars. Of this nature also are the hopper-shaped crystals (Fig. 2) frequently found in *rock-salt*, and occasionally in *fluor*. In the beryl (Fig. 3), the interrupting cause seems to have acted *per saltum*, or at least its effects so appear, but always in one and the same direction.

7. *Curvature.* Many of the so-called "planes" of crystals are curves of single or double curvature. The *Diamond, Chalybite,* and *Dolomite* are particularly apt to exhibit this peculiarity. In so far as it prevents anything like accurate measurement it is, of course, a difficulty, but as certain curvatures often (not always, however,) characterise certain minerals, it is to some extent also an aid.

In the natural diamond crystal a true plane is a great rarity. Fig. 4 represents a form which makes a considerable approach to the sphere.*

Fig. 5 is a curved form which has often

---

ese interesting specimens he is indebted to daley, Esq., of Grange, Ulverston.

writer has prisms of tourmaline less than of an inch in thickness.

* The figure is slightly incorrect. An equator line should be drawn across.

been observed in *Chalybite* and also in *Dolomite* (Pearl Spar), and Figs. 6 and 7 have both been met with in Chalybite. In the instances already given the curved surfaces are perfectly smooth and regular, but in others, as in certain well-known forms of iron pyrites, the curved faces are really made up of a series of little steps. Fig. 8 represents a common form of iron pyrites, bounded by twelve pentagons, and called the pentagonal dodecahedron. Fig. 9 is the combination of this form with planes of the cube; and Fig. 10 a curved form apparently different from either.

The explanation of its form is as follows:—

Fig. 11 represents a section of one of the curved planes on an enlarged scale. Here it will be seen that the apparent curve is really made up of a series of little steps—the parts, *a a a*, being successive small planes parallel to faces of the cube, and the parts, *e e e*, planes parallel to the pentagonal dodecahedron. On examining the curved crystal, Fig. 10, it will always be found to be striated, and these striations merely indicate what we may call the alternate efforts of the crystallising force in these different directions. These curved pyrite crystals sometimes exist in mineral veins by millions, embedded in soft chloritic schist, and it is then easy to collect a series of specimens showing every stage, from the perfect cube or dodecahedron to the perfect curved form. In a similar way the barrel-shaped crystals of arsenio-phosphate of lead (*Camphyllite*) from Cumberland, Fig. 12,* and the arrow-headed crystal of *gypsum* from Montmartre, Fig. 13, have been formed.

Fig. 14 is a crystal of quartz, figured by Dana, in which the interruptions appear to have been stronger on one side of the crystal than on the other, the result being a curved form. In the crystal of prochlorite, Fig. 15, the interrupting cause seems to have travelled round the principal axis in a spiral direction.

It is not improbable, however, that curves in crystals do sometimes indicate a real plasticity of material at some stage in the history of the crystal. This seems especially likely to have been the case with the bent prisms of *Vivianite* and of *Tourmaline*, which are found in almost all extensive collections. A great many curved crystal surfaces seem to be immediately related to a peculiar internal structure. This is the case with the curved crystals of dolomite, Fig. 5, where the cleavages are curved as well as the "planes."

METALINED BEARINGS.

IT is a remarkable instance of the indifference with which really useful improvements are treated in this country, that metaline has not been more generally adopted for bearings than it has at present, although it is now about ten years since it was invented by Dr. Stuart Gwynn, of New York. During the last five years it has, however, been brought into more prominent notice, and in the United States may be said to be steadily gaining favour amongst engineers and machinists. In Vol. XIX. we alluded to a new material for the bearings of machinery, which was exhibited at the Vienna Exposition by a Mr. Cohné, and which had already found its way into some of our factories, notably in Manchester and its district. Whether or not that is metaline we have no means of knowing, but it was applied in the same way, and dispensed with the use of oils or grease. Metaline is usually described as an anti-friction alloy, capable of being reduced to a powder so fine that it will pass through a sieve with 15,000 meshes to the inch. By hydraulic pressure it can be consolidated into plugs, or other shapes, which are fixed in the ordinary "brasses." If we are not mistaken, the use of metaline in this country will date its most rapid increase from the time when Mr. A. H. Bateman, F.C.S., read a paper on the subject before the London Association of Foremen Engineers and Draughtsmen. The practical and scientific manner in which Mr. Bateman treated the question commends itself at once to the attention of the thoughtful engineer and mechanic, and, when the arguments are backed up by experimental facts, critics are disarmed until they have themselves tried the new material and found it wanting. The bearing surfaces of machinery have always received the most careful consideration of makers; fit, material, and the means of lubrication being each the subject of anxious thought. The fit must be accurate: there must be no shake; it must be close to exclude dust, and yet not so close that a film of lubricating material cannot be introduced between the surfaces; and, lastly, as no mechanical skill can produce such a surface as a few weeks of actual work will, the skilled artisan endeavours to leave the bearing in such a state that it will most surely and speedily run into its best possible condition. As to material, the machinist discovered long ago that rubbing surfaces, when formed of the same metal, had more cohesion or friction than when the moving part was of a different material to that in which it rested. Iron and steel run well on brass, cast-iron on wrought-iron, and any metal on the alloys known as white, Kingston, and Babbit metal, and phosphor bronze—the latter being a very remarkable alloy in many respects. For special purposes special alloys are employed, but when the machinist has done all that his skill can accomplish, and carefully guarded every weak point by the aid of experience, the user of the machinery has a difficulty in discovering the best lubricant. An oil or grease well adapted for a heavy bearing is not suitable for a light one, and the lubricant that answers excellently for a fast speed is, as likely as not, all but useless for a slow speed. As a rule, factories and workshops have a surplus of power, but Mr. Bateman puts the lubrication question well when he points out that where the power is sufficient only to meet the requirements the difference between a suitable and an unsuitable lubricant means an inability to drive the machinery at all. In factories, where there are very large numbers of bearing surfaces in the machinery, the slightest excess of friction at each bearing involves a very serious expenditure of extra power. Thus, to take Mr. Bateman's example of the moderate excess drag of one pound on each of 20,000 spindles through gummy oil, we have a driving power equal to not less than ten tons to provide beyond what would be sufficient if the oil were good and adapted to its purpose. "What wonder," he says, "that on a Monday morning in cold weather it is a difficult thing to start the machinery at all, and that this ten minutes is the harvest-time of the belt-makers?"

It is a remarkable but, nevertheless, well-known fact that when hard steel runs in a brass bearing it is invariably the harder metal that wears, unless, indeed, the steel journal is brought with great force upon the brass. A familiar instance of steel giving way when rubbed by brass is seen in the pallets and escapement-wheels of a clock, though in this case it may be that the pallets betray the wear more than the teeth of the wheel. It is obvious, however, that in the majority of cases it is better for the brass to wear than the steel or iron journal, because the former is more easily replaced; but that, after all, is a mere detail of the workshop, and what we are more interested in is the cause of the wear and the effect upon it of lubrication. Examined under a microscope, the surfaces of both journal and bearing, even when old and apparently smooth, are seen to be composed of projecting points and hollows; it follows that, unless there is a film of oil to bear the journal off the brass, the action will be similar to that of, say, a dead-smooth file. If the lubricant is absent, we get first "cutting" from the accumulation of fine particles of metal, and subsequently "firing," which involves the destruction of the bearing. All, then, that oil or grease does is to form a thin film between the two rubbing surfaces—a sort of skin which prevents the contact of the microscopic points on the journal and the bearing, and enables the moving part to run in its stationary rest with the minimum of friction. The object of the metalined bearings is, instead of placing a film between the two surfaces, to smooth off the points and produce such a degree of uniform smoothness that contact between the journal and the bearing is complete, over at least half the circumference of the journal. The greater the amount of surface in actual contact the better, because then there is less likelihood of dust or dirt getting in. According to the only analysis of metaline with which we are acquainted a sample was found to contain lead 32·40, zinc 20·07, copper 27·5, tin 1·55, carbon 18·89, silica 6·44, lime 3·96, ferric oxide 3·94, alumina 2·53, magnesia 1·99, paraffin 4·98, and a little moisture. Some of these substances may be, no doubt are, accidental ingredients; but in the process of manufacture the alloy is reduced to a very fine powder, and then forced into small steel moulds so as to form plugs of a quarter of an inch in diameter by the same in length for use in large bearings, but only about an eighth of an inch in diameter for small bearings. These plugs are inserted in the face of the bearings by sinking holes of the exact size, so as to insure a tight fit without damaging the plugs. The holes are bored by means of a "tit-drill," which leaves a flat bottom, and the plugs are left standing up slightly above the surface, being set in by a tap from a jeweller's hammer. They are arranged in lines so as to break joint, and so thickly that about 10 plugs, ¼in. in diameter, will be put into a square inch of surface. The projecting ends are then roughly filed off, and the journal left with a loose fit at starting. At first the brasses will heat, but as the plugs are worn the powder rubbed off polishes the surfaces of the steel and brass, producing a truly accurate fit, so that there is nothing left to tear or cut, and no dust can find its way in between the moving part and its seat. As soon as such a surface is produced the bearing, if it has heated, will soon cool down, provided it is properly proportioned; but on no account must oil or water be permitted to touch the metaline, nor may the brasses be opened after starting, or while hot. It is certainly eight years ago since metaline was introduced to the notice of British machinists, but so conservative are they that most machines are still made in the old-fashioned style. The first cost is about 6d. an inch of surface, but that sum, large as it may seem, is soon recouped by the saving of oil and labour, and the avoidance of the danger from fire which is believed to appertain to the use of oily waste. Mr. Bateman stated that he knew of main shafting (3½in.) which had been running at 150 revolutions a minute, and a lathe head at 2,000, for some months, without a drop of oil or other lubricant. But in the United States, a speed of 4,800 revolutions and upwards per second has been run for a long time with satisfaction to the owners of the machinery; and in the neighbourhood of Manchester there are several calender rolls with pressures ranging up to 30 tons, and many hundred feet of large fting, which have for some three years been running on metalined and Mr. Low, during the discus- ed that a lathe head-stock with bearings had been running con- r at Woolwich for nine hours per the rate of 2.000 revolutions per or a total of 320 hours. With the 1 of a slight heating at the start, or a quarter of an hour, it has been perfectly cool without any lubrica- tever; for, as explained above, the is not a lubricant in the sense in e apply that term to oil or grease. aline was some years ago exhibited offices of the company in High , but it can be obtained of the n Metaline Company, New York. teman has done a service to ts, mechanics, and manufacturers cent papers on emery-wheels and , inventions which, however slowly, ope steadily coming into use.

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* The engraver has represented the shading as vertical; it should be horizontal.

GUNPOWDER.—II.

· John Joseph Lake, F.M.S.

ormerly of the Ordnance Department.

omposition of gunpowder varies in rent countries and with different urers, and also according to the use it is intended to be applied. The are atomic and theoretical propor- t come the nearest to its composition:

	Atomic.	Theoretical.
etre	74·6	75·00
hur	11·9	11·77
coal	13·5	13·23
	100·0	100·00

llowing is the composition of several gunpowders:—

	Saltpetre.	Sulphur.	Charcoal.
esumed 18th August, 1808 ...	75·0	12·5	12·5
... ...	62·0	20·0	18·0
	65·0	20·0	15·0
Ancient d'Essone	74·0	10·0	16·0
Of M. Champy, by order of Committee of Public Safety A ...	76·0	9·0	15·0
B ...	77·0	7·0	16·0
C ...	80·0	5·0	15·0
s' powder	62·0	18·0	20·0
Au Pilons	78·0	10·0	12·0
Angoulême et le Bouchet ...	76·9	9·6	13·5
d'Esquerdeo	76·0	10·0	14·0

osition of the gunpowder of various :—

	Saltpetre.	Sulphur.	Charcoal.
ates...	75·0	12·5	12·5
... ...	76·0	12·0	12·0
for muskets	75·6	11·3	13·1
Government	75·0	10·0	15·0
Dartford	79·7	7·7	12·6
Curtis and Harvey	78·1	9·2	12·7
... ...	75·0	11·77	14·4
	61·5	15·4	23·1
sporting	73·2	8·6	18·2
... ...	76·0	13·0	11·0
Government	75·0	16·0	9·0
rtillery	69·8	13·9	16·0
... ...	70·6	11·7	17·7
	70·0	11·5	18·5
	73·78	12·63	13·59
... ...	76·0	10·0	14·0

products of gunpowder on combustion onsiderably, and are more complicated eory would indicate. The late Sir John me gave the following as results of the s of eleven samples of merchants' blast- wder:—

	Saltpetre.	Sulphur & Charcoal.	Loss.
id to be of same manufacturers, t procured from different dealers	72·5	25·0	2·5
	66·0	32·5	1·5
... ...	66·0	32·0	2·0
id to be from same manufacturers, t procured from different dealers	66·5	32·5	2·0
	75·0	24·0	1·0
	73·5	25·5	1·0
me manufacturers	73·5	24·5	2·0
	66·0	32·0	2·0
me manufacturers	73·0	25·5	1·5
	73·0	25·5	1·5
	73·0	25·0	2·0
eod Government powder	75·0	25·0	—

Karolyi obtained the following gaseous products from Austrian small-arm powder:—

	Combustion. By weight.	Combustion. By volume.
Sulphate of potassium	36·17	—
Carbonate ,, ...	20·78	—
Hyposulphite ,, ...	1·77	—
Charcoal	2·60	—
Sesquicarbonate of ammonium ...	2·66	—
Sulphur	1·16	—
Nitrogen	10·06	35·33
Carbonic anhydride	21·79	48·90
Carbonic oxide	1·47	5·18
Hydrogen	0·14	6·90
Sulphydric acid	0·23	0·67
Marsh gas	0·49	3·02
Loss	0·68	—
	100·00	100·00

ANALYSIS OF WALTHAM ABBEY POWDER.

—		Pebble.	Rifle.		Fine Grain.
			L G	F G	
Saltpetre		74·67	74·95	75·34	73·55
Potassium sulphate		0·08	0·15	0·14	0·36
Sulphur...		10·07	10·27	9·93	10·02
Charcoal		14·23	13·52	14·09	14·59
	Carbon	12·12	10·86	10·67	11·36
	Hydrogen	0·42	0·42	0·52	0·49
	Oxygen	1·45	1·99	2·66	2·57
	Ash	0·23	0·25	0·24	0·17
Water		0·95	1·11	0·50	1·48

The pressure under which the products are developed affects the results. Carbonic anhydride increases when the pressure is increased and carbonic oxide decreases. The solid products show greater variation.

The weight of a grain of gunpowder, according to Gay Lussac, is equal to 0·9 of an equal bulk of water. This, however, varies according to quality.

Observers differ very much as to the amount of heat resulting from the combustion of gunpowder. According to Bunsen and Schinschkoff one grain of sporting powder evolved sufficient heat whilst burning to raise the temperature of an equal weight of water to 619·5° C., after allowing for corrections. The same give the temperature of the flame at 2,993° C.

There is also a great divergence as to the space occupied by the gases resulting from the combustion of gunpowder.

The quality of gunpowder is tested various ways. Place a dram on a piece of clean writing paper, and fire it with a red-hot wire. If the powder be good the flame will ascend quickly with a good report, the paper will be free from white specks, and no holes will be burnt in it. When fired on a clean sheet of copper no foulness should be left. These are good tests in skilful and honest hands, but by manœuvring or unskilfulness will not yield a correct result. Good powder is of a dark slate colour, the grains do not cohere, and possess a certain firmness well known to the practised examiner when it is rubbed between the thumb and finger. Old and deteriorated powder becomes brown, and bad powder a decided "foxy" colour. It should not absorb more than 12oz. of moisture per 100lb. when exposed to the atmosphere, and should be condemned if this absorption reaches the extent of 1 per cent. Hardness increases the durability of gunpowder. Glazing is not necessary, but protects it from damp.

The projectile force is proved by means of a 8in. Gomer mortar, which has a conical chamber. Great nicety is required in placing the bed horizontal and laying the mortar at an angle of 45°. From this a nicely turned 68-pounder shot is propelled by 2oz. of powder, placed carefully in the bottom of the chamber by means of a funnel, and fired by a piece of quick match in the vent. The average of three discharges is taken to indicate the force of the powder in this respect. Care must be taken to observe that the mortar does not get materially heated, otherwise the proof will be too high. New large-grained powder should give about 270ft. The force of gunpowder depends on the elasticity of the gases, and the greater or less rapidity with which these are developed.

When powder is thus proved there are some precautions to be observed. The mortar must be well sponged after each round, and well washed out and dried after the proof of each sample. The temperature of the metal must be also attended to, for I have witnessed it rise so irregularly and rapidly that the business has had to be stopped until the piece cooled. The reason of this will be seen by placing a board a short distance in front of the muzzle. When the piece is cold a considerable quantity of unconsumed grains will be found to have been discharged; but, when the mortar has become heated, the quantity of this unconsumed powder is materially lessened, and with sufficient heat disappears altogether.

When we speak of "strength" as regards war powder, the power of discharging a projectile a distance is meant. There is another kind of strength that is quite different, resulting from the too rapid evolution of the gases. Hence the necessity for having it of a larger grain, known as L G, for cannon, and our new monster guns have compelled the manufacture of pebble or prismatic powder, to reduce the rate of combustion whilst the enormous projectiles employed are moving out of the piece. The effect of a too rapid evolution of the gases may be exemplified by the case of fulminating silver, two or three grains of which will burst an ordinary gun-barrel, flatten the leaden bullet as with a hammer, and yet project it a very little distance, so that the power of the gases is spent in overcoming the inertia of the ball, and very little remains for the projection of it.

The "agneeaster" of the Hindus, a kind of rocket, has already been referred to, and we cannot leave this subject without some further remarks on these missiles. Congreve's rocket is the one most prominent in the British service, but Sir William never laid claim to originality in the matter. They were well known in Hindustan, and in the "Memoirs of Eradut Khan," a Hindu nobleman, translated by Captain John Scott, of the Company's Service (London, 1786), "a rocket's flight" is frequently given as a measure of distance. The translator, in a note at page 36, says:—"The rocket in India is used in war, and the chamber being made of iron does execution wherever it strikes, but cannot be sent in true direction; it will reach from 300 to 400 yards."

The rockets used in the service do not at all come up to the ideas formed of them by Congreve, but they are so erratic that larger ones are at present impossible. Should any means be discovered by which their flight can be controlled, other results might be obtained.

But what Congreve contemplated as regards size has, according to Colonel Symes, been far exceeded. At p. 173 of his "Embassy to Ava" he says:—"The display of rockets was strikingly grand. The cylinders of the rockets were trunks of trees 2ft. or 3ft. in circumference; these were bound by strong ligatures to thick bamboos, 18ft. or 20ft. in length. They rose to a great height, and, on descending, emitted various appearances of fire that were very beautiful." At p. 432, referring to yet larger rockets, he says:—"The trunks of trees, bored in the manner of a pump, were used: the cavity of the cylinder 9in. or 10in. in diameter, the wood 2in. thick, and length from 12ft. to 20ft." Some of these rockets are said to weigh from 1,000 to 2,000 pounds.

In Siam such instruments are used as means of execution. The criminal being bound to one it is discharged perpendicularly, or along the ground, and the unfortunate creature is thus put to death in a most cruel manner.

It is not intended to enter upon the consideration of fire-arms, but one or two curiosities in ordnance may be mentioned, as the "organ gun" of the fourteenth century, constructed in three tiers to throw 140 balls at once; steam guns, alluded to by Denys Papin in 1688, and a revolving "portable gun or machine, called a Defence." It was mounted on a tripod, and had a single barrel and a rotating chamber-piece containing six or more chambers for charges. When these were all discharged the chamber-piece could be unscrewed and removed, and a charged one put in its place. The patentee provided chambers and bullets of various shapes, some "for shooting square bullets against Turks," and others "for shooting round bullets against Christians!"

PROF. HUGHES' TELEPHONE.

In the annexed sketches we illustrate some of the apparatus employed by Prof. Hughes in his recent experiments on sonorous vibrations. His paper (see p. 235) will have made our readers familiar with the principle of his discovery, so far as it is understood, and we have now only to give a brief description of the simple apparatus he employed, which, it will be seen, can be readily made by any one. In his first experiment Prof. Hughes took a piece of glass tube and nearly filled it with "white silver powder," a mixture of fine zinc and tin; the ends of the tube were stopped by plugs of gas carbon long enough to slightly compress the powder, and kept in place by means of sealing-wax. Wires from each make a circuit with a battery and a galvanometer, which latter is found to be deflected when a strain is put on the glass tube, either tending to elongate or to compress it. The deflection is, of course, in opposite directions. We need not here inquire whether or not the explanation suggested is true, for, as a matter of fact discoveries follow one another so quickly nowadays, that the hypothesis of yesterday is frequently destroyed by the facts of to-morrow. Prof. Hughes seems to have very quickly appreciated the importance of his discovery, and accordingly laid one of the tubes of "white bronze" over a simple resonant chamber (a child's money box with one end knocked out). The apparatus is represented by Fig. 1, in which the glass tube (about 3in. long by ¼in. in diameter) is seen affixed by sealing-wax to a resonating chamber made of thin pine. One wire leads through a battery to one pole of the telephone, and the other goes direct to the other pole. Speech and song uttered at the mouth of this resonating chamber are delivered with surprising volume by the Bell telephone. Such a result having been obtained, it becoame advisable to ascertain what was the best material, and then Prof. Hughes discoveres that almost anything, not homogeneous in its nature, would answer the purpose; but as explained on p. 235 the greatest success was attained by means of willow charcoal, the pores of which contained mercury in a state of fine division. As a matter of fact, however, any mechanical structure containing a good many joints would appear to be capable of becoming a transmitter, and in Fig. 2 we illustrate perhaps the most amusing of the discoveries made by Prof. Hughes. Two of the common wire nails secured by sealing-wax to a piece of board, and connected by wires with the battery and the telephone, from a resting place for another nail, which when in the position indicated is a sensitive transmitting telephone, the little rail communicating to its fellows the vibrations it receives from the words or the notes it bears. The very simplicity of this apparatus gives the subject an air of ridiculousness, which, however, is speedily suppressed by one of astonishment when the effects are appreciated. The effect is improved by the use of 10 or 20 nails built up log-hut fashion, as Prof. Hughes explained, but after all, the material for further experiment will undoubtedly be gas carbon, because it does not oxidise. In Fig. 3 we illustrate a microphone of the simplest kind. F is a baseboard, to which a thin soundboard, S, is glued. C is a stick of gas carbon, about one inch long and a quarter of an inch thick in its greatest diameter, resting by a point in a cup hole made in the lower block, B. These blocks are of gas carbon, and are attached to the soundboard, S, through which the wires pass and enter their substance. The gas carbon is preferably tempered in mercury, but it is not absolutely necessary: so that with a few bits of retort scale and two pieces of wood those who have a telephone and a battery may make the most sensitive acoustical instrument yet invented, not excepting the human ear, for the microphone renders audible sounds that would be inappreciable by the ear, and, in the words of Prof. Hughes, we may now hear the "beating of a pulse, the ticking of a watch, or the tramp of a fly" a hundred miles away.

FIG. 1

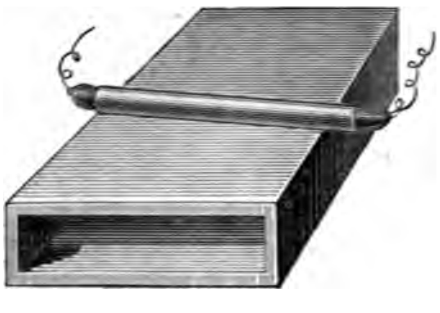
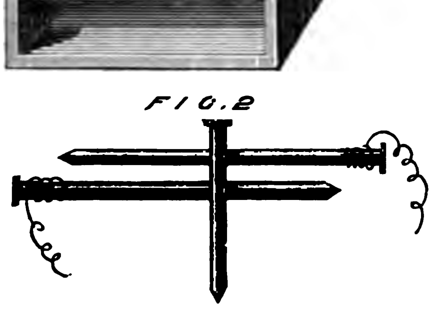


FIG. 2



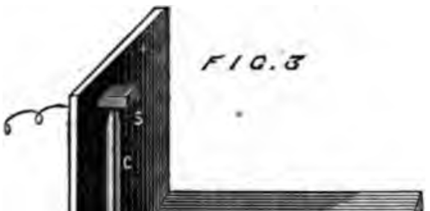
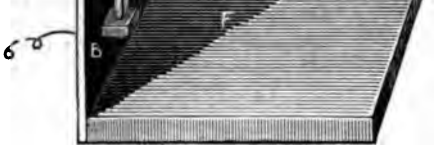


FIG. 4



The above form of microphone is, however, too sensitive for ordinary use, as it takes up every sound, producing a pandemonium of sounds in a comparatively quiet room.

In order to hear the tramp of a fly, the microphone is constructed as in Fig. 4.

A, stick of carbon (preferably the round compressed pencils used for electric light), pivoted on its brass support at C, and resting by the slight pressure of its weight upon a small block of metallised charcoal (blow-pipe, box wood, or any hard conducting charcoal will serve); the wires are connected to the pivot support at C, and charcoal B. This structure is fastened to any small board, D, of pine, ¼in. thick, 3in. or 4in. square. This will also transmit perfectly articulate speech if spoken to not closer than 1ft.; if louder tones are desired put a small weight on A, and speak within a few inches of the microphone.

The telephone transmitter is a very similar arrangement, except the lever, A, has a justable spring to increase or decrea pressure, according to its uses; and the B, consists of two separate pieces of pine coal, the upper one simply attached t lower one by a hinge of paper. With latter arrangement the finest inflexions human voice become perceptible. Indi voices are clearly distinguishable, a becomes an absolutely perfect reproduct the sounds spoken in its presence.

ERUPTIONS AND EARTHQUAKI THE YEAR 1877.

While the advantage in statist volcanic phenomena fully appea where the data of several years are con a survey of the phenomena of one ye presents many points of interest. In a number of *Naturforscher*, M. Fuchs such a survey for the year 1877, from we take the following:—Five erupti different volcanoes occurred during the The eruption of the South American v Cotopaxi, lasting from 25th to 28th Ju a regular, and (for this volcano) very teristic course. From the phenomena be designated as an ashes and mud er Though the opinion of Humboldt, that the American volcanoes produce no lava, h been shown to be erroneous, and Cotop gave a large stream of the substance i there are still large quantities of ashes out by this volcano without lava. Mud s are frequently associated therewith, a due to various causes. They wrough devastation, especially in the valleys of and Tumbaco, and in the former hundred men perished; the ashes sprea the air changed the day into dense nig even penetrated into the interior of rooms.

A most remarkable eruption of 187 place on the island of Hawaii. Twic rupted, it found a path for itself i different places—thereby shewing that the same source of eruption may, accor the time and circumstances, use any numerous channels present in Hawaii burst. The first portion of the erupt peared for 6 hours on the 14th of Febru small secondary crater, near the top Mauna Loa, and was distinguished magnificent pine-like form of the col smoke, which was estimated to ris metres. On the 24th of February the act occurred in the bay of Kalukeakua, as the scene of the murder of Captai There was also a submarine eruption two days, in the middle of this bay, surrounded by pre-historic volcanic p On the 4th of May, the eruption agai its ordinary outcome through the long s lake of lava of the Kilauea. Then a once more the grand spectacle of loft tains of lava, which has only been witn this giant crater. In the space of si fountains of lava sprang up, now he there, out of the large cauldron, numerous were they that at one time mo fifty were observed in action at once, them being as high as 30 metres.

The third eruption was that of the Japanese island volcano, Ooshima, fr January to 6th or 7th February. noises and dreadful earthquakes accon especially the large eruption phenomen 20th January and 4th and 5th Februa

On the 11th of June an outburst occur hitherto almost unknown volcanic re Colorado, South California, about 60 miles from Fort Yuma. As little know submarine eruption which took place 15th of June on the coast of Peru.

The number of earthquakes in 1877, M. Fuchs had information, was 109; thi about the average number obtained observations, extending over thirtee They are distributed as follows o seasons:—Winter (Dec., Jan., Feb.), 3 quakes; Spring (March, April, May), 3 quakes; Summer (June, July, Aug.), 1 quakes; Autumn (Sept., Oct., Nov.), quakes. On fifteen days several eart occurred in different places.

ain regions, such as Peru, Bolivia, Tokio ın, and the island Ooshima, were visited :thquake-periods, consisting of a large r of shocks and concussions, now weaker, tronger, while other places were re- ly visited by earthquakes which were ted by long periods of rest. Among the nay be specified the following:—Western ald, 2nd and 10th Jan.; Judenburg, 4th 7th and 28th Dec.; Forest in Steiermark, an., 5th Sept.; Rattenberg in Tyrol, 8th 11th Oct.; Bad Füffer in Steiermark, 4th, th and 25th April, 12th Sept.; Callao, pril, 14th May, 9th Oct.; West Switzer- nd May, 8th Oct., 30th Nov.; Lisbon, 1st h Nov., 22nd Dec.

earthquakes in Switzerland had a re- ble extent; the first of them, on 2nd May, s to have passed outwards from the lake rich, and to have reached eastwards l Glarus and St. Gallen, westwards as Mühlhausen in Alsace, northwards into ck Forest. More violent, and still more ve was the earthquake on 8th Oct, which ongest in Geneva (so that *e.g.* chimneys hrown down), and which passed from r the Cantons of Geneva, Waadt, Wallis, atel, Freiburg, Berne, and Baselland.

nd Switzerland it was traced in the departments of Drôme, Isère, Rhone, Aix, Jura, Doubs, and in the Belfort , as also at Mühlhausen in Alsace. The on westwards was thus much further stwards, where the Alps seem to have d it, for only the flat and hilly canton s were affected by it, and the movement ted only in the broad Rhone valley into pine region proper, as far as Sitten. the more remarkable, because the Jura offered no obstacle to the extension rds. The greatest width of the strip of ffected between Lyons and Sitten was 00 kilometres, the greatest longitudinal on from Valence to Mühlhausen 337km.

extensive earthquake-regions of lands ave few earthquakes belongs the shock pril, in the eastern Alps, which reached wer Steiermark to the lower part of the

most violent earthquake of the period d on the 9th May, on the west coast of merica. Both in its course, and in the anying phenomena, it had a remarkable ty to the great earthquake of 30th Aug., the same region. The centre of the ion lay in the desert of Alkama, where ll harbour towns of Cobija, Autofagarta, la, and others, were almost entirely de- . The movement was propagated over the greater part of Bolivia. The ion of the ground was followed by a of the sea, a so-called earthquake-wave, wrought great devastation along the South America. In Chanavaya the sea ck at first—in all other places, the high some cases reaching 20 metres) seems been first observed. This hill of water over the flat coasts, and left frightful its track. In Iquique 600 men perished nundation. In Chanavaya the majority inhabitants saved themselves by flight igher points, but even there, through of the water to the ridge of the hill, st their lives. The ships in the different s were partly driven against each other, tered or torn away from their anchorage, led by the wave on to the sand. At y, far inland, half-buried in sand, h American steamer, Wateron, which n carried thither by the earthquake 1868; the wave of 9th May, 1877, lifted in, and carried her 2½ km. further. Mejillones, Tocapilla, Sampoca (70 rom Iquique), and Arica are almost destroyed. Huaxillos, Iquique, Mol- nd the Chilian harbours of Chero and suffered much. The action of this ended from 12° to 32° south latitude.

arthquake-wave was propagated over n, and especially affected the Sandwich where the town and bay of Hilo, on coast of Hawaii, were most devastated. the sea drew back, and then, about an er, rushed far inland, as a steep hill , 5m. high. The wreck of the destroyed of Waiakea, the magazine and harbour ali, is still to be observed.

THE LATHE.—V.

By Fred. Hoffmann, Engineer.

THE handle, to reverse the saddle, should be plenty long enough, as the saddle often gets stuck so fast from rust that it is next to impossible to move it. If there is a gap in the lathe, care should be taken that the rack comes out so far that the pinion does not come off the end when the saddle is moved up next to the faceplate. Of course, the leading screw must be outside the radius of the gap. As regards the saddle, it should have plenty of room for fixing on stays, for sliding long shafts, and should have gutters for clamping, and for what is, perhaps, more useful, for putting the end of the carrier in. (See Fig. 1.) A word about carriers in passing: the screw should be steel, with an eye for a steel tommy-bar. Although it is very awkward to have the screw too long, yet it should be long enough to take up any diameter, however small. They are very good when made of malleable cast iron, or cut out of the solid in wrought iron, but when they are forged they often appear with a crack at the top and bottom (see Fig. 2), which looks very bad. Sometimes carriers are made square inside, for driving mandrels with square ends, and tops for making chasers. As a general rule, small work that has a hole in the middle (see Fig. 3) is turned best on a mandrel—such as brushes, glands, flanges, &c. The mandrel should, of course, run true, not merely to turn out work true, but because in turning flanges and glands, it is impossible to turn the work clean and not leave a fin (if the mandrel is not true) without sending the knife tool right into the mandrel (see Fig. 4); and any one that has handled much machinery knows the value of "*harageing*" or taking off the fins and burrs to prevent them scratching the hands, and in the case of glands cutting the piston-rod, and, in oil-cups and bearings, the finns finding their way in. A mandrel table is a very useful thing. It is a cast-iron table, with a round hole at the top, which may be filled up with cast-iron bushes till the hole is a little larger than the mandrel. A wooden mallet should be used (Fig. 5) for driving in mandrels, and to save using very large mandrils for flanges, a dummy flange is hammered first on to the mandrel, which in its turn is fastened into the bore of the flange. In turning such things as crank-handles (see Fig. 6), if the tool is not quite sharp, a ridge of little dents will appear where the tool enters the work. The same thing happens in turning oval glands, where the corners must generally be left quite square. In turning brass, if the tool (see Fig. 7) is at all blunt, the rubbing of the tool will produce heat enough to turn the copper in the brass quite blue. Brass-turning should not have that leaden bluish tint, but should be clear cut all over. Brass has more of the nature of cast iron in turning, and as it is very soft, can be turned at a high speed. Of course, any brass casting, such as valve seatings, &c., that must be hard at a particular place, necessitates having the whole casting of yellow brass. In turning brass the work often gets very hot, and it is necessary for the turner to use gloves (see Woolwich Arsenal). Brass also flies more than cast or wrought iron, and is apt to get into one's eyes and blister them—that is, leave a small raised blister in the eye-ball that feels for some time as if the turning was still in. Most lathesmen keep their tools in the inside of their bed, but a good plan is to have a little wooden shelf put up to hold the articles to be turned. Everything in the lathe should be placed so as to be handy, especially the handle for pulling the strap on and off—that is, the handle or cord should be able to be reached when the turner has his face close to the work. As to whether a cord, or handle, or loop of chain is best, the fixed handle has the advantage that it does not so often get out of repair as the cord, and is always in its place when wanted, which cannot be said of the cord, which swings about. In small plain lathes for turning and chasing half a dozen may conveniently be driven off an auxiliary shafting, and the lathes turned on and off by merely pulling off the belt. If in this case there is any danger of the lathe (see Fig. 8) going on from the strap always turning round, the nuts of the bearings, or the back centre pin, must be screwed up, which will soon stop it. At first sight it might be thought that shifting the strap would take longer than moving a handle, but the reverse is actually the case. The centres of a lathe cannot be made too hard, and there is plenty of body in them to prevent them snapping in half (as of course in hardening anything it does not matter how hard you make it if it is not likely, from its shape, to break when hardened), and the angle of the point should not be too small, or the point of the centre will ride on the bottom of the centre punch hole, whereas the point of the centre should be clear (see Fig. 9).

FIG. 1

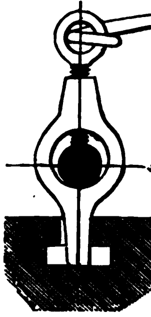


FIG. 3

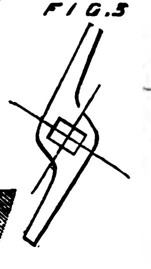


FIG. 2

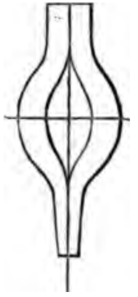


FIG. 4

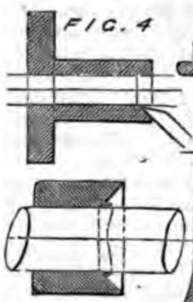


FIG. 5

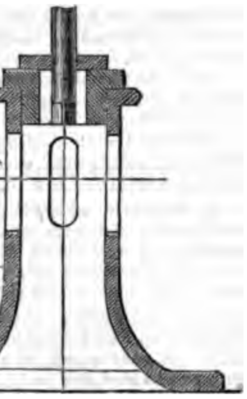


FIG. 6

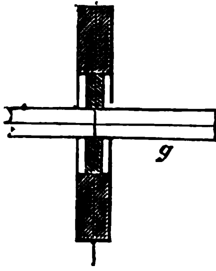


FIG. 9

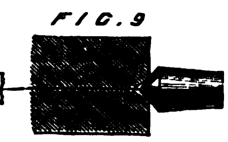


FIG. 7

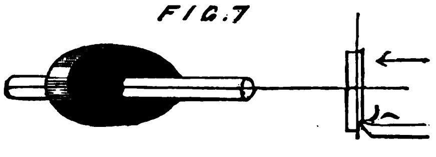
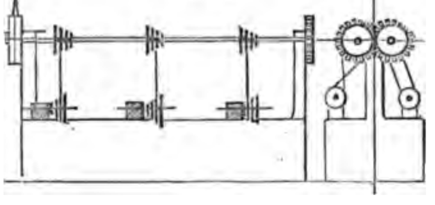


FIG. 8



(*To be continued.*)

The Brazilian Government has removed its interdict against the employment of coloured labourers on the railway in that empire, and a large number will now be sent there.

It is said that the German Government has given a secret but general order that all articles used in the Government establishments must in future be of home manufacture.

THE ORGAN: A COMPREHENSIVE TREATISE ON ITS MANUFACTURE, PROCURAL, AND LODGMENT.*

BY JOHN WATSON WARMAN,
Associate of the College of Organists, London.

PART I.—GENERAL TREATMENT IN MANUFACTURE.

e. IT may, I think, be safely laid down that Light pressures will be more agreeable to persons stationed near—at the same time they will make less of the Organ. Heavier pressures will often be unpleasant to the player if he be close, but at same time will assuredly make the Instrument much more valuable as a controlling power. Act, therefore, according to circumstances. Thus, imagine such a building as All Saints, Margaret-street, London, which will seat only about 500 or 600 persons, and has an organ, placed on ground, of four Mans., how very unwise would it be here to employ heavy pressures; 2½—except for the Solo, and, perhaps, part of Ped.—would obviously be ample. On the other hand, suppose a mounted Instrument of, say, two Manuals and 20 Stops, in such a building as the Agricultural Hall, Islington—a 2½ pressure would be here almost *worthless.* The Organ in the Parish Church, Faringdon, Berks—by Nicholson, of Worcester—presents an example of *insufficient* pressure. The church is of large and much broken plan, and has a heavy central tower carried on three huge piers and a corner: the Instrument has a 2½ wind throughout, and being placed in a chancel chapel or large mortuary chamber, can hardly be heard by the congregation unless they keep tolerably quiet; the workmanship is excellent throughout, so it cannot be there the fault lies.

f. Bear, also, carefully in mind that the heavier the wind the more the touch will be imperilled. There are, it is true, Compound and Balanced Pallets, which may be employed when desirable, but the former do but *diminish* the pack or pluck, and the latter, though they nearly or quite get rid of it, yet are not adapted for general purposes; besides, all are more expensive than the ordinary (*see* fully in *Depart.* of PALLETS). Remember, also, that the touch resistance must be calculated from the *Sounding-size*, and this is affected by the *Couplers*; thus an Instrument with Great, Choir, and Solo, might have a 4in., or even stronger wind for latter, so long as there existed no Coupler Solo to Great; the Great and Swell, say, of 10 and 8 stops respectively, to admit of uniting, would be kept to not over 3in.; the presence of Solo to Great would *at once involve* Pneumatic action, or at least Balanced Pallet.

g. I will now give a few examples which I think likely to be practically useful. First, however, look carefully at BORROWING (from one Clavier to another).

h. CHAMBER ORGANS. These do not require much consideration; from 2in. to 2½in. may be considered their best pressure; the former may be used in usual cases, but if the Instrument have two or more Manuals, or be in a fairly large room, the 2½ may be employed either for the whole or a portion. A very excellent little practice Chamber Organ might be made with Choir, Great, and Ped., on 2in.; Swell and Solo on 2½. The presence of a Reed need not necessarily here involve the use of heavier pressure; a very satisfactory *quiet* Oboe or Clarinet can be obtained with two inches of wind.

h. h. As Organ enlarges, say beyond nine Registers, of course treat with respect to pressure more and more as a Concert Instrument, provided the size of room or hall in which placed be commensurate.

i. CHURCH ORGANS. These demand more consideration; their normal pressure may be considered as ranging from 2½in. to 3in.; this is exclusive of *Pneumatic* Action or other Motors, of *Solo* Organ, and in some cases of *Reeds* generally, and of *loud* portion of Pedale.

j. *One Manual.* Very great latitude may be allowed here. A "one-row" Church Organ is always more or less of a makeshift and rarely large; its pressure may easily range from 2½in. to 4in., or even more, according to size or acoustic qualities of building, size and location of Organ, character or intelligence of congregation, &c.

k. *Two Manuals.* More caution must be exercised here; as a rule, if there be no Pneumatic it will not be advisable to go higher than 3in. (average) here, for the two Mans. must admit of being united, and it is hardly worth while to have anything heavier for the Pedale. If two pressures be employed, the Great might have 2¾, and the Swell 3¼, the Ped. having its Reed-and-Chorus portion on the heavier, and the remainder on the lighter. Also, if the Organ be small, say 6 to 8 Stops on Great, and 4 to 6 on Swell, the whole might, perhaps, be on 3¼. I should not recommend heavier than these, for either special Pallet or Pneumatic will become desirable, and, as a rule, these are not much worth while for no more than two Manuals. *See* also BORROWINGS (26 e. to end).

l. *Three Manuals.* Church three-Man. Organs, perhaps, require more care in the pressure than any others, for on the one hand there will be a desire to do without Pneumatic if possible; on the other it will be incumbent to make the most of the Instrument. There can be no doubt that very satisfactory results may be obtained with a light wind; thus Green's organ in Salisbury Cathedral had 24 Sounding Stops in three Manuals, all admitting of being united, and yet the touch quite free from heaviness; the secret was, of course, the light wind—I believe 2in. This pressure was often used by that, in many respects, most admirable maker. As a rule, however, such is not recommended, except in a good-sized organ in a small church, and even here the Choir to Great might be dispensed with to allow of greater pressure, for the sounding size would be commensurate without the use of the Choir Organ.

m. As a rule, where it is wished to avoid the Pneumatic, the best pressure will be 2½ for both Great and Swell, the *Choir to* Great or to Swell (not *Swell to Choir*) being dispensed with; the pressure in this case for the Choir will be immaterial—it cannot well be lighter for there will be no lighter pressure present. It might, if very small, share the heavier pressure of the Pedale should latter have such; but, generally, in such an arrangement as this, one pressure of 2½ throughout will be best. This is assuming the Gt. and Sw. of say 12 or 13 stops each, where they are less a little increase may be allowed the Swell, say 2¾, and this may be shared by the Ped. or a portion of it. With a Gt. of 10 and a Sw. of 8 stops, and no Ch.-to-Gt. Coupler, 3in. may be used for the whole of instrument, or 2¾ Gt. and Choir, and 3¼ Swell; Ped. shares the two winds, as already laid down (10, e.).

n. When Great and Swell smaller than preceding (this, however, is not advisable) either pressure might be still further augmented, or Choir-to-Great introduced. When the foregoing pressures and number of stops will not be commensurate, Pneumatic Action must be insisted on: in such case the Swell or portion of it (see INSTANCES, 11 *a*), and part of Pedale also may rise, as a matter of course, to 3in., or from that to 4in.; the remainder of Ped., the Gt., and the Choir, taking say 2¾ to 3½. These pressures are, however, often exceeded, even with only this number of Manuals. A 3 Man. Organ (by Harrison, of Rochdale), at Morpeth, has its heaviest wind 5in. St. John's, Bethnal-green (by A. W. Coleman), has its Ped. at 6in.—quite too heavy in this case in author's opinion. St. Peter's, Eaton-square, London (by Lewis), has Ped. 4 and 5¼, and Great 3½ and 5¼. The Parish Church, Ryde, Isle of Wight (Willis), has Ped. and Gt. Reeds 10½, Swell and remainder of Gt. 7in., and Choir 3¼in.

o. The foregoing are large Instruments, though of only 3 Mans.; still I cannot help thinking they must be over pressed. St. Bartholomew's, New York, by Odell, of that city, has 44 Sou. Stops, on 3 Mans., and is at 3½ throughout: this, by account, is a thoroughly effective Organ. St. Alban's Abbey, by Hill, furnishes an excellent specimen of an effective Organ at low pressure: the Great has 13, the Swell 13, the Choir 7, the Pedale 5 S.S.; the whole of the Mans. are at 2½: there is no Choir-to-Great. The Swell and Great united do not involve a very unpleasantly heavy touch.

p. *Three Manuals, consisting of Gt., Sw., and Solo. See* CONCERT INSTRUMENTS (14, a).

q. *Four Manuals.* These being hardly, strictly speaking, Church Instruments, are treated of more fully in CATHEDRAL ORGANS, next.

r. CATHEDRAL ORGANS. *Three Mans.* will be the smallest that ought ever to be allowed in a Cathedral. Study all that has been said with respect to Church Organs, *ante*; the same general rules applying in most cases, except that Pneumatic Motors and large Pedales ought now to be freely granted. It might seem that in Cathedral Organs, the building being so much larger, great increase of pressure will be required. In practice, however, it is found that this is not so, provided the Inst. be well placed: thus, the Salisbury Organ on the screen proved itself adequate to the Choral Service for very nearly a hundred years. The secret lies in the good acoustic qualities of most of our cathedrals, and the absence of the untutored roar of "congregational singing;" the trained Choir, to whom the services are usually committed, being perfectly under command even with a very few Stops. But it must be carefully borne in mind that, as these buildings become more utilised for Diocesan Festivals, "popular" services, and the like, the necessity for both larger and a more heavily-winded Instrument becomes imperative. *See* more fully in next.

s. *Four Manuals.* Here we are, or at least ought to be, at once in full latitude; Pneumatic, Tubas, &c., being now matters of course. Even here, however, there will be no necessity for running riot among heavy pressures; *See* preceding. The Tubas and Solo generally must, of course, speak out; but the complete Organ obviously requires its delicate as well as its heavy effects, and this must not be lost sight of.

t. For a Cathedral of moderate dimensions, with few occasions on which other than trained singers are employed, and these not in large numbers, and assuming the Organ well placed, the foregoing treatment laid down with reference to Church Instruments will suffice for the softer portions; but there remain here the Solo, the Heavy Reeds, and the Motors. The Solo itself is, or should be, divided into two portions—viz., the Tuba Organ, comprising from one to four Reeds on a very heavy wind; and the remainder, consisting of Flue, and *softer* Reed work; the pressure for the former will, of course, vary with circumstances, though it must never be other than strong, or the pipe ceases to be a "Tuba."

u. The Organ (by Bryceson) in Mr. Holmes's concert-room at Regent's Park, of 65 Sou. Stops (contraction of *Sounding*) has its Tuba on 6in.; this may be considered as light a wind as should be allowed for this Register. Next comes the Organ (by Hill) presented by Mr. Houldsworth to Manchester Cathedral, of 40 Sou. Stops, which has its Tuba on 8in. The Leeds Town Hall Organ, 93 S. S. (Gray and Davison), has 10in. for this Register; and the Crystal Palace Festival Organ, 65 S. S. (by the same builders), has its single Tuba on 11in. In a Stock Specification, printed by Lewis, he names 18in. for "Trumpet Organ" of a large Instrument. The chief Tuba at the Liverpool Hall is 20in.; the Albert Hall is, I believe, still heavier (both sets by Willis).

v. 9in. may be set as a useful Tuba pressure; use lower in a small place, may use higher in large; where Tubas are few (as only one Stop, as is often the case) may also use higher, when very great power is wanted higher still, say 18 inches.

w. With respect to the remainder of the Solo, a very good rule will be from half to two-thirds that of the Tuba, according to the relative sizes of the two portions of the Solo. Thus, a 6-stop Solo, with only one Tuba, might have the five at 4½ to 5, and the one at 9; with a very small Solo, as—say, 4 Stops—the three might be on 6in., the Tuba as before: but, as a rule, better keep to the half, unless more than two pressures used for Solo. The Solo Organ at Manchester Cathedral aforesaid is given as same as remainder of Instrument—viz., 2½, which is certainly too low for a Solo; (I cannot help thinking the account is in error):

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this excludes Tuba and Harmonic Flute, which are the only two on a heavier—viz., the 8in. aforesaid. The Leeds Organ just mentioned has this portion of Solo on 6in. for the Bass and 7 for the Treble. The specification, by Lewis, just referred to, gives 9in. The Liverpool Organ has 15in.; at least, such seems the case from the account.

x. It is, however, on occasions when a large Cathedral is filled with a huge miscellaneous congregation—not only undisciplined and comparatively ignorant with reference to musical matters, but totally heterogeneous as regards such qualifications and experience as they do actually possess (as well as not a little excited)—that the capabilities of heavy pressure are most severely drawn upon, and it may perhaps be laid down that then, and then only, may excessive weighting become legitimate, or at any rate desirable.

y. Even here, however, great caution and reserve must be used. It is quite out of question to transform the Instrument for the sake of occasions that may occur perhaps once or twice a year into a mere power-machine almost unbearable at close quarters. The obvious course is to increase the size of the Organ rather than the pressures, for sound will inevitably travel far enough, even at the lightest pressures, if only the volume be sufficient. In such cases as this, therefore (say in such a Cathedral as St. Paul's), a Choir of 3½in., a Great of 5, a Swell of 6, a Solo of 8 and 12 inches, will give good results, the Pedale shared between the 5 and 8.

(*To be continued.*)

EXPLOSIONS IN COAL-MINES.—I.

BY T. WILLS, F.C.S.

THE following is an abstract of the lectures delivered by Mr. Wills before the Society of Arts:—The gases found escaping from the coal in coal-mines, as would naturally be expected from the chemical changes through which the coal has passed, and is at the present time slowly passing, are marsh gas, or light carburetted hydrogen or fire-damp, and carbonic acid gas. These are found mixed with variable small quantities of sulphuretted hydrogen, nitrogen, and oxygen. The marsh gas or fire-damp is by far the most important of these, amounting as it does to from 75 to 95 per cent. of the escaping gas.

The following table gives the analysis of four samples of pit-gas:—

—	Marsh Gas. CH_4.	Carbonic Acid. CO_2.	Nitrogen. N.
Barleith, Ayr	75·86	1·31	22·83
Hepburn*	85·22	3·27	7·98
Llwynpia, S.W.†	94·78	0·72	8·60
Dunraven, S.W.	97·65	0·50	1·85

* Contained a trace of olefiant gas, carbonic oxide 1·30, and oxygen 2·17.

† Contained ·90 hydride of ethyl.

These gases escape directly from the face of the coal, also through fissures which communicate with hollow spaces containing pent-up gases, which may cover large areas, and which empty themselves into the mine until an equilibrium of pressure is established; also, though more occasionally, the gas issues from the floor or roof of the coal. Apart from the occurrence of such liberated compressed gas, the coal contains within itself a quantity which has been absorbed or occluded; this occluded gas, so long as the coal is out of contact of air, and under a uniform pressure, will remain within it; but, on exposure, the tendency is for the larger part of the occluded gas to diffuse out into the atmosphere; at the same time an absorption of atmospheric oxygen and nitrogen takes place. The composition of the gas so contained within the coal is of very much the same nature as that issuing from undoubted reservoirs of compressed gas near the same district—a fact which would rather tend to indicate that it is not a case of true occlusion, but that the gas is hold compressed within the interstices of the coal, as true occlusion would be selective rather than general, each gas being condensed in a different proportion to the others.

The amount of gas contained in this way is a very variable amount. Some coals are found to give off very little marsh gas, but more carbonic acid, while in others the marsh gas is more plentiful. Accordingly we have the difference between fiery coals and non-fiery coals. The coals which contain the least amount of condensed gases are the bituminous coals, in some specimens of which won from near the surface no marsh gas is to be found at all. The greatest amount of condensed gas is obtained from the anthracite coal from a considerable depth. The following table represents a few of many analyses of such gases made recently in the course of a valuable investigation of the subject by Mr. J. W. Thomas.

The results represent the total volumes of gas obtained, in many cases after several times heating, and, moreover, after the coal had been some time out of the mine, but the amounts given off under the circumstances would be nearly proportional to the above, so that the relation of the coals in this respect would remain the same:—

Analysis of the Gases evolved from 100 grammes of Coal heated to 100° C. in vacuo.

Sample.	Total Vol. c.c.	Composition of Gas p. c.			
		CO_2	O	CH_4	N
Merthyr Bituminous ...	55·9	36·42	0·80	—	62·78
Rhondda Semi-bit. ...	73·6	12·34	0·64	72·51	14·51
Aberdare Steam... ...	250·1	13·21	0·49	81·64	4·66
Pembroke Anthracite ...	555·5	2·62	—	93·13	4·25

Mr. Thomas points out that in the South Wales district seams of bituminous coals are continually worked in safety with naked lights, while the seams of steam and anthracite coals are of a much more dangerous nature; also the character of the coal, whether compact or porous, will largely influence the evolution of gas; thus the steam coals, although containing less condensed gas, being more porous than the anthracite, the gas escapes from the former in much greater abundance than from the latter.

Looking at the successive changes through which the woody fibre has passed, in its conversion into coal, in the light of the above fact it would appear that in the earlier stages the formation of carbonic acid and water was the principal action, while in the later stages the formation of a greater amount of marsh gas occurred.

The quantity of gas issuing into a mine from the coal itself is dependent upon the extent of fresh surface which is from time to time exposed, and this quantity is found to vary according to the nature of the coal and the depth below the surface. The effect of the exposure of fresh coal surfaces upon the amount of gas issuing into the pit is well illustrated by the remarkably rapid falling off in the amount of fire-damp which occurs when the coal is not being worked; but, in addition to this source of gas, which is tolerably constant, there is the further source in the issue of gas from fissures and hollow spaces, forming what are termed "blowers;" the amount of such gas is obviously likely to be very variable, and admits of little or no calculation, but it is found that its composition is approximately the same as that of the gas condensed within the coal of the seam from which such blowers proceed.

In many cases, in addition to the marsh gas, small traces of a more condensed hydrocarbon are obtained, which makes the marsh gas burn with a slightly more luminous flame than the pure gas would do; probably this hydrocarbon is hydride of ethyl, C_2H_5H. The amount of gas escaping directly from the substance of the coal is, as has been already mentioned, approximately constant, and the necessary calculations for the proper ventilation of the mine under ordinary circumstances may be made. The fire-damp, to be safe, requires to be diluted with at least from 30 to 40 times its volume (mines with less than 1-40 of fire-damp in the air may be considered safe) of air, and no less than this amount must be provided wherever the gas issues. It must be remembered that an air current once vitiated cannot be purified, but can only be diluted. The gas coming from "blowers," on the other hand, is quite uncertain. A fissure containing gas may be tapped at any moment by the stroke of a workman's pick, or through the movement of the coal, and the gas that forthwith issues may do so with great rapidity or more slowly, according to the difference of pressure, and it may be exhausted very speedily, or may continue to give off gas for long periods, sometimes even for years. There is especial danger when, in the process of removing the coal, "faults" or breaks in the strata are arrived at, as under these circumstances there are to be found, generally, in the neighbourhood of such "faults" large hollow spaces, which are usually full of gas. Practical workmen state that occasionally a space within a mine, normally perfectly free from fire-damp, may within less than two minutes, become full of explosive gas. On sinking a shaft at Whitehaven in 1733 at a depth of 42 fathoms a considerable amount of fire-damp was set free, a tube was carried from the pit, from the top of which the gas was burnt continuously for more than two years, the flame being some yards high. A jet of this gas was evolved at Wallsend, which likewise continued burning for some years, giving off the gas at the rate of 120 cubic feet per minute. In some cases, which are somewhat rare, the irruption of a blower into a mine takes place with considerable violence. The following is a description of the issue of a blower into a colliery adjacent to that of Lundhill, near Barnsley, Yorkshire:—"The fireclay floor of the seam was seen to heave at different points along the face, and presently large fractures were made in it, through which gas was ejected with great violence, and with a sound similar to the issue of steam from a high-pressure boiler." Sometimes, when the coal between a large fissure and the seam becomes thin by working, the intervening wall gives way, at other times the issue of gas will be accompanied with a noise, as of the explosion of artillery; the pressure under such circumstances must be very considerable. Subsequent to an explosion at the above-mentioned Lundhill Colliery, the pent-up gas, still issuing into the mine in the higher parts of the workings, supported two columns of water 30ft. high, one 10ft. and the other 11½ft. in diameter, corresponding to about 11lb. pressure per square inch. When such large volumes of gas issue suddenly into a mine, even supposing that an explosion is prevented, the ventilation of the pit will be seriously and sometimes fatally interfered with. At the Tyne Main Colliery a blower suddenly broke out in the floor of the mine, which is stated to have given out from 6,000 to 7,000 cubic feet of marsh gas per minute, and which continued for 12 months before it ceased. At the Oaks Colliery, near Barnsley, after an explosion, the amount of gas passing out of the mine averaged 600 cubic feet per minute. At one time, at Wallsend, near the church, about four acres of fiery coal were worked at a depth of 150 fathoms, and they were drained by a 4-inch gas pipe, which was carried to the surface and there ignited, a flame of from 8 to 9 feet being produced, which roared like a furnace; not less than eleven thousand hogsheads of gas per minute formed the average supply collected in this imperfect way from the four acres of coal. In the mines of South Wales Mr. William Galloway, one of her Majesty's inspectors, has kindly calculated for me the amount of gas escaping from one of the pits in a given time, and states that it is of a heating value of about one-tenth that of the coal won from the same spot. The gas ordinarily issuing from the partly exposed face of the coal produces a slight hissing sound, particularly if the surface be wet; this is called by the miners "singing coal."

THE TURNERS' COMPANY'S PRIZES.

THE Master, Wardens, and Court of Assistants of the Worshipful Company of Turners, according to their custom, propose to give this year their silver medal, the freedom of the company to, and (subject to the consent of the Court of Aldermen) will also obtain the freedom of the City of London for, any workman, whether master, journeyman, or apprentice in the trade in England, who may send in the best specimen of hand turning in wood, and diamond-cutting and polishing. The subjects of competition will be turning in wood, throwing and turning in pottery, and diamond-cutting and polishing. The competition in wood includes turning in both hard and soft wood. The qualities which will be considered in awarding the prize will be the following—viz, 1. Beauty of Design, Symmetry of Shape, Utility, and General Excellence of Workmanship. 2. Exact Copying, so that two objects produced (such as two cups, vases, boxes, or other articles) may be fac-similes in every part, or exact measures of capacity. 3. Fitness of the Work and Design for the Purpose Proposed (for instance, turned work for portions of domestic or church furniture). 4. Ability to Turn, whether Circular or Oval, in both Classes of Wood. 5. Novelty in Application of Turning or in Design. 6. Carving and Polishing is admissible, and if skilfully done, any additional effect produced by it will be considered, but it must be subsidiary to the turning. The candidate may make his own selection from the above conditions; but the one who best fulfils the largest number, including the most important qualities, will be preferred. The work must be all hand-turning, produced in the lathe without special rest or tool apparatus, and the carving must be the work of the exhibitor. Specimens must not exceed 24 inches in height and a foot in diameter.

A bronze medal will be given as a second prize, and certificates of merit, as well as money prizes, will be awarded in this class, according to the discretion of the judges.

The competition in *Pottery* includes terra cotta, stoneware, earthenware, and porcelain. Specimens of work under this heading will be divided into three classes:—In Class A.—The freedom of the company and a sum of money will be given, and the freedom of the City of London will (subject to the consent of the Court of Aldermen) be obtained for the best piece of pottery thrown on the wheel in one piece, without joints, and not afterwards shaved or turned in any way, or glazed. Form and execution will both be looked for by the judges.

In Class B.—A silver medal will be given for the best piece of pottery thrown and turned, the throwing and turning both to be the entire work of the same person.

In Class C.—A silver medal will be given for the best piece of turned or shaved pottery, ornamented by the runner or other hand tool; in this class incised work will be permitted, and the specimens may be glazed and coloured. Execution and beauty of form must be equally attended to.

A bronze medal will be given to the competitor second in merit in each class, and certificates of merit and money prizes will be awarded, according to the discretion of the judges. No competitor to send in more than two specimens, neither of which must exceed 30 inches in height.

In the *Diamond Cutting and Polishing* competition the Baroness Burdett-Coutts, who is a member of the company, has placed at the disposal of the court the sum of £20, to be distributed in this class among the competitors. The following are to be the conditions of the competition. Specimens of work under this heading will be divided into classes, as follows:—Class A.—Brilliants weighing more than one carat. Class B.—Brilliants under one carat. Class C.—Single cut. Class D.—Roses.

In each class a prize will be given if the specimens entered are considered worthy, but the first prize of the freedom of the company and a sum of £10, together with the freedom of the City of London, will (subject to the consent of the Court of Aldermen) be adjudged to the candidate who shows the highest excellence of workmanship in the greater number of the above-named classes. In making their award the judges will chiefly consider the following qualities:—1. Symmetry of form and proportion. (N.B.—The stones should be no thicker than is necessary to produce the maximum brilliancy.) 2. Accuracy in the finish of facets and excellence of polish. 3. Form and relative proportion of facets. 4. Perfectness of edge. (N.B.—The girdle should be even throughout, and polished up to a sharp edge.)

In addition to the above-named prize there will be the silver and bronze medals of the company and certificates of merit, and £20 will be distributed according to the discretion of the judges. Candidates for the first prize must send in specimens of work in not less than two out of the four classes.

Any specimen of work will be received, but in order to enable the judges the better to estimate the excellence of the work, candidates are requested, as far as possible, to send some of the following samples of work:—In Class A.—Two or three stones ranging from one to three carats each. In Class B.—Three or four stones of any of the following sizes, weighing 8, 12, or 16 to the carat, and 1, 2, or 3 grains. (In both Class A and in Class B some of the brilliants should be round, if practicable.) In Class C.—A series of stones ranging from 20 up to 8 to the carat. (N.B.—The single cut should have the tops cut with the star facets.) In Class D.—A few roses, 20, 50, 80, 100, or 200 to the carat. (N.B.—The roses should be round, having thin edges and well-polished backs, and the usual amount of facets.)

It would be preferred if any rough diamonds of important size could be submitted to the judges before being cut, in order that they may see the form, size, and quality of the stones, and that they may be enabled the more easily hereafter to judge of the remaining weight and brilliancy; or, if possible, a plaster cast of the original crystal should accompany the finished specimen.

Competitors in this branch are requested to send their specimens to Messrs. Hunt and Roskell, 156, New Bond-street, marked "Turners' Company," during the week ending October 5th.

Amateur Turning.—Past Master C. Christopherson has placed at the disposal of the company a sum of £10 to be awarded as a prize for the best specimen of amateur work, in ornamental turning in either ivory or hard wood, executed during the period of competition. Any lathe apparatus may be used.

The court has placed at the disposal of the competition committee a sum of £50; and the Baroness Burdett-Coutts has, in addition to her gift of £20 for the diamond competition, given £15 towards the wood and £15 towards the pottery money prizes.

The different objects in wood, pottery, and amateur turning must delivered free at the Mansion House, London, during the week ending October 5th, and will be on view on Tuesday, October 8th, Wednesday, October 9th, and Thursday, October 10th. They must be each marked with a private mark or motto, and numberedand accompanied by a list, showing for each number the grounds on which the prize is sought. They must be accompanied by a sealed envelope, marked with the same mark or motto, and containing the name and address of the competitor, and his age if an apprentice, and in all cases a certificate of good conduct, and a certificate or declaration that he is in the trade, and that the work is by his hands only, and has been executed during the period of competition; the competitor may be required to do, in the presence of the judges a portion of the work similar to the successful xhibit.

(N.B.—This paragraph will not apply to the amateur competition).

No one who has already obtained the company's silver medal, or a first prize in any of the previous competitions, will be eligible for a first prize this year.

CUSHMAN'S COMBINATION LATHE CHUCK.*

In all shops where the work done varies constantly and greatly in size and shape it is desirable to have a "combination" chuck that can, quickly and at will, be made either concentric or eccentric (that is, with universal or independent jaws) without removal from the lathe-spindle. A good chuck should be light and strong, easy to handle, having a positive jaw-motion and a firm grip, and with no uncovered slots or spaces to let in dirt or chips. It may in some cases be an advantage if, when the jaws are *set* eccentrically, they can be *moved* together.

FIG. 1

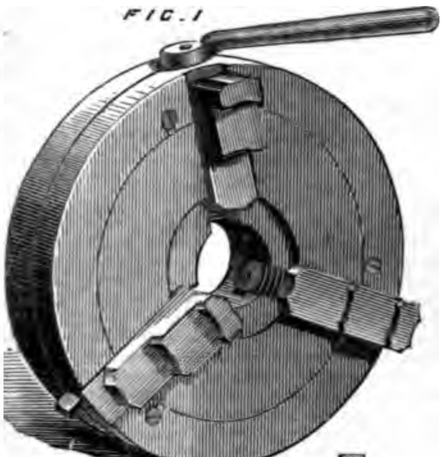


FIG. 2

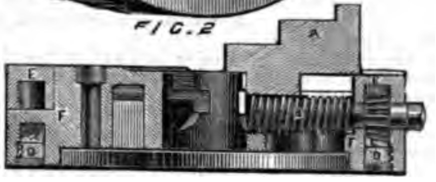
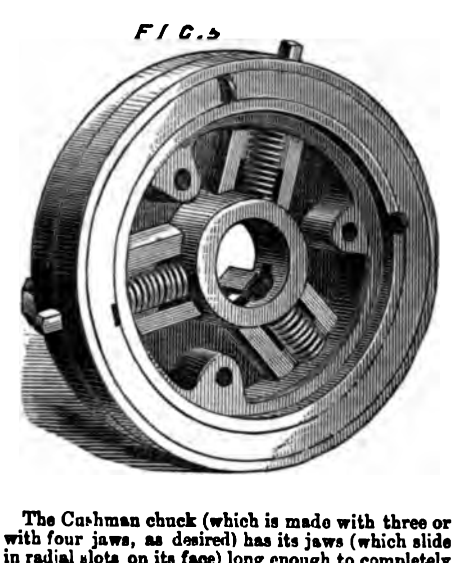


FIG. 3



The Cushman chuck (which is made with three or with four jaws, as desired) has its jaws (which slide in radial slots on its face) long enough to completely close the slots against access of chips or dirt. Each jaw (which is three-stepped, as shown in the cuts) is reversible, so that the highest steps may be placed inwards to hold drill or reamer shanks, &c.

The foot or inward projection of each jaw is cut into a half-nut, A (see Fig. 2), and engages with a square-headed screw, B, projecting through the rim. The screw, B, bears below its square head and inside the rim a bevol-pinion engaging in a circular rack, C C. Turning any one screw will swerve the rack circle, C C, and move every jaw concentrically. But the toothed ring, C C, rests upon a plain ring, D D, the periphery of which is threaded to correspond with the interior of the shell; hence, if this ring be swerved in one direction it will be advanced towards the chuck-face, and *vice versa*. By this means the circular rack and its bevel-pinions may be meshed or unmeshed, in either case the ring being held by a spring-catch. By pressing the thumb upon this catch the supporting ring may be turned by a knob at the back of the chuck (see Fig. 3), thus enabling the circular rack to be unmeshed, and any jaw separately moved nearer to or farther from the centre than the others, thus making an eccentric chuck. By again meshing the pinions and rack these eccentrically placed jaws may be moved simultaneously. As built, the centre holes are proportionally very large; the parts are few, and of steel.

PHOTOGRAPHY AT THE LEAST REFRANGIBLE END OF THE SOLAR SPECTRUM.*

By Capt. Abney, R.E., F.R.S.

NEARLY two years ago I had the honour of reading a preliminary note on photographing the least refrangible end of the spectrum, and it seems that the time has come when I ought to redeem the promise implied by a "preliminary note" and enter further into the subject. Last year, owing to a change in residence, I was unable to pursue the subject with any degree of activity, but during this last winter and the present spring I have made fair progress in my researches, the results of which I lay before the meeting. These results are principally photographs themselves, and the first to which I shall call attention is one taken through three prisms of dense flint glass, each of which had a vertical angle of 62°. They were placed at the angle of minimum deviation of B, and kept so. The focal lengths of the collimator and camera were 18 inches and 2 feet respectively, and a condensing lens of 6 feet focus was employed to collect the light, the middle of the collimating lens alone being filled with solar rays. In front of the slit was placed a plate of orange glass, in order to cut off the suffused blue rays, which experience had previously taught me were inimical to the production of good negatives, owing to the light dispersed in the prisms themselves. It will be noticed to what an enormous distance below A the impressions of the bands in the ultra red are to be found. If the wave-lengths be used as abscissæ, and the measured distances of the known lines be used as ordinates, it will be found if the waves be completed by hand, that a wave-length of not less than 10,400 tenth metres is impressed. Roughly speaking, A is 7,600 tenth metres and D 5,900 tenth metres, by which it will be seen that I was within the mark when I announced that I had obtained photographs as much below A as D was above it. Now this negative, though interesting as a feat in photography, has no practical scientific value, as the ultra red is so tremendously compressed that the absolute wave-lengths could not be obtained from it.

About the time I read my last paper, Captain Tupman kindly lent me a speculum metal grating, by Rutherford, having about 8,600 lines to the inch; but it was only lately, after removing its glass covering, that I was fully able to appreciate its value. In all gratings the red, or rather the ultra red, of the first order is overlapped by the ultra violet and violet of the second order, and the higher the order the more overlap there is. To remedy this, which was a defect for the purpose for which I required it, I placed before the slit of the collimator red glass, which completely cut off the yellow and only allowed a little of the green to pass. The prisms were replaced by the grating, and a photograph of the second order of the spectrum was taken by it. Theoretically speaking, the time necessary for taking a photograph of the first order is ¼ that for taking one of the second, and 1-27 for that of the third. Practically, this is not quite true, for reasons which it is unnecessary to enter into here. This induced me to think that, if I could get a grating with double the number of lines to the inch, its first order should give me the same dispersion as the second order of the grating I was using, and at the same time the exposure ought to be more than halved. Mr. Lockyer kindly lent me such a grating, and the third photograph was taken by it. You will see that it gives the lines from C to A almost perfectly. A positive copy of this photograph I sent to Professor Piazzi Smyth, as he drew the map of this region of the spectrum which he published in the last volume of the *Edinburgh Astronomical Observations*; and I cannot do better than quote his words regarding the accuracy of the photograph:—"As the size of the glasses approximated closely to my standard camera size, 1·25 inches + 4·25 inches, I was able at once to view them with any magnifying power in a compound microscope long since arranged for such things, and the effect was astounding. I almost thought I was back again in Lisbon, viewing the sun's spectrum itself as I used to see it."

This acknowledgment of the value of the photograph was particularly gratifying, as it came from an astronomer who had paid particular attention to this particular part of the spectrum.

The next plate shows the region of the ultra red as taken with the same grating. The most conspicuous group has a wave-length of about 8,400 tenth metres and the extreme line visible has a wave-length of about 9,200 tenth metres. At this point the closer-ruled grating seemed to fail me, and I could not get beyond this point. It then struck me that the glass on which the lines were ruled might absorb the rays beyond (for I must explain that this grating was ruled on glass and silvered at the back), or that the red glass might absorb them. I then reverted to the first grating and adopted a different method of proceeding.

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* [illegible] Review.

* From the *Monthly Notices* of the R.A.S.

This was Fraunhofer's method, to which I was practically new—though I believe I have been credited (though inaccurately) with using it for other experiments—and after various attempts the following is an outline of the arrangement adopted:—The slit was placed horizontally, a prism of 60° occupied a position at the end of the collimator next the lens, the reflection grating then received the rays and reflected them into the camera lens, the camera being tilted at an angle to make them fall on the sensitive plate. To show what sort of effect can be got I exhibit a photograph in which from the first to the fourth order of spectra were impressed on the same plate in a small camera. When this method was applied to the larger apparatus I got further into the ultra red than I had done before, and such a plate you see before you; the wave-length of the last line of my group of lines visible on the plate is about 10,300 tenth metres. From indications on other plates I am inclined to think that we may get as far as 12,000 tenth metres, which it will be admitted is a tolerable distance to travel along the invisible spectrum. In these ultra regions the lines are faint, but perfectly measurable under a moderate magnifying power, and I have there proposed to myself to make a map of the ultra red. For the purpose I propose to use the overlapping of the higher order of the spectrum over that used. By cutting off the red in one case and using half the length of the slit for one exposure, and then by cutting off the blue and using the remaining half of the slit for the other, we shall have one spectrum over the other. The wave-lengths of the most refrangible rays are known, and since the dispersion of the higher order is double the one below it, the wave-lengths of the latter can be accurately ascertained. When once a scale is obtained the greatest difficulty will have vanished.

Now as to the process. My object has been to weight the molecules of silver bromide that they may absorb the red rays. With ordinary silver bromide the film allows these very rays to pass through whilst a blue absorption takes place. In other words, my endeavour has been to find a heavier molecule of a sensitive salt, which shall answer to the swing of the waves of the red and ultra red rays. This I first accomplished, as I stated at the time, by adding resins to the silver salt, and forming what I may call a bromo-resinate of silver. But I am happy to say that I have secured the same end by, I believe, doubling the molecule of the silver bromide. Now this doubling the molecule is a matter of manipulation more than of chemical knowledge, and I might describe the process in detail, as I have already done in papers I have published, and yet the double molecule would not be obtained unless careful manipulation was attended to—manipulation easy to follow when seen, but difficult to follow from any description. I should therefore prefer t oteach practically any one who is acquainted with silver bromide emulsion-making, rather than allow him to be misled by what must be imperfect directions.

I exhibit two films, both prepared with sensitive emulsion, which is composed of exactly similar ingredients—viz., pure silver bromide. You will at once note the difference in colour of the light transmitted. The one which is sensitive to the red and ultra red is of a blue tint; the other is orange. You will see that the blue tint would appear to be due to a physical arrangement of the molecules, for if a part of the film be rubbed you will see that it changes to a ruddy tint, passing through an emerald green stage. We have it so on the screen. Whether it be right or wrong in regard to other matter, I am convinced that in silver bromide we have the possible existence of two sizes of molecules. In the blue film we have the presence of both; when only the larger size is present we shall have a compound which is very much more sensitive to the lower end of the spectrum than it is to the upper. Allow me to say that these views are not original except in so far as they are applied to this subject. Whether they are correct or not, they have formed a good working hypothesis which has led me to the results obtained.

Before closing I must refer to the comparative lengths of exposure required for these photographs. My impression is that at A the exposure required is about 25 times that required for G, in a fairly bright sun at midday; for the ultra red, as far as I have gone, I should say about 35 times. These are only approximations, but still will enable you to form some idea of the sensitiveness. I show you a photograph taken about 4 p.m. on March 18. The exposure was about 50 seconds. You will see that the red end is as strong as the blue, with the *yellow* much lacking in density. In other words, the yellow rays are nearly inactive.

The photograph which I showed you of the four orders of the spectrum was taken on April 3, at 2.30. It had an exposure of one minute and a half. The photograph in which the furthest band of lines was seen had an exposure of 12 minutes on the 8th, at 2.30. The slit was in this case closed as nearly as possible.

In conclusion, I have to remark that in a short time I hope to reduce the exposures considerably. In the course of some investigations, the results of which have just been communicated to the Royal Society, I found that the red rays could oxidise a photographic image as well as form it, and that in an oxidised state it was unable to be developed. If the tendency of the sensitive compound to become oxidised exceeded its tendency to become reduced, no image could be developed. By exposing *in vacuo* or in a nitrogen atmosphere I hope to eliminate altogether this oxidising effect, and so get firmer images.

HOW TO MAKE A PHOTOGRAPHIC PRINT UPON PAPER IN FIVE MINUTES.*

It is sometimes desirable to produce a positive upon paper in much less time than is possible by the ordinary process, in which manner it takes not less than twelve hours to complete a good photograph. We believe, therefore, that the following process will be taken up with some interest.

The following solution is prepared in a stoppered bottle, and protected against light:—

Distilled water	500 grammes
Citric acid	30 „
Citrate iron and ammonia ...	15 „
Conc. liq. ammonia	30 c.c.

After shaking the bottle until everything is dissolved the solution is filtered. Now fasten a piece of positive paper with clamps upon an even board, and cover the same with the above solution, applying a flat camel's hair brush up and down the paper, until it is evenly coated, after which manipulation it should be dried in the dark.

The paper prepared in this manner will have a deep yellow tone. The printing is done, as usual, in a printing-frame; but care must be taken that the action of the light commences simultaneously with the copying. The exposure should be very short, and continue only until the principal lines of the picture are visible. After this the picture is placed in a flat dish, the exposed side up, and then moistened with distilled water, when the following developer is to be poured upon it:—

Distilled water	500 grammes
Cryst. nit. silver	16 „
Conc. liq. ammonia	8 c.c.

This solution must be filtered, and will, after application, bring out all the details of the picture, but with a disagreeable red tone. (This developing solution, by shutting off the light, can be kept for a long time, and, by filtering again when wanted, can be used repeatedly.) Afterwards the picture is carefully washed in running water, and fixed in the following bath:—

Distilled water	500 grammes
Hyposulph. soda	30 „
Aqua regia	10 „

In this bath the picture remains several minutes, until it has changed to a deep purple tone, after which it is put into a dish with warm water, and washed, and then rinsed three or four times in a change of water. Now it is placed between a few sheets of blotting-paper, and then dried over a spirit lamp. According to the quantity of aqua regia and hyposulph. soda in the fixing bath, the tone can be changed. The tone can likewise be modified by adding a little pyrogallic acid. This copying process can be also used for enlargements.

The Destruction of Tin.—The phenomenon of the disaggregation of tin has been often observed. Organ-pipes, after long use, become brittle [?], and Oudemans stated in the *Chem. Jahresber.*, 1872, p. 256, that plates of pure tin, containing at most 0·3 per cent. of lead and iron, break into small fragments, like molybdenum-sulphide, in the railway transport from Rotterdam to Moscow, in severe cold weather. A similar phenomenon has been lately observed at the Royal Pyrotechnic Laboratory in Spandau. A large quantity of tin plates (295 kilogs.) became exfoliated, and crumbled into small particles. Still later, larger quantities of Billeton block tin (1,950 kilogs.) were similarly affected. The warehouses were thoroughly dry; the tin contained only traces of foreign metals, no sulphur or phosphorus, and no tin-oxide. According to Dr. Petri's account, the tin could be pulverised more easily than ordinary tin filings, and gave out hydrogen more quickly with acid. While it was in the warehouse there was no severe cold, yet the disaggregation went on.

SCIENTIFIC SOCIETIES.

ROYAL ASTRONOMICAL SOCIETY.

The third meeting of the session was held at the Society's rooms, Burlington House, on Friday, the 10th instant; Lord Lindsay, M.P., President, in the chair.

Maxwell Hall, Esq., M.A., Jamaica, and James L. McCance, Esq., Rathfern, Rayners-road, Putney-hill, S.W., were balloted for and duly elected fellows of the society.

Mr. Ranyard read a paper by Mr. Waterston "On the Heat of the Stars." The paper referred to the observations of Mr. Stone, by which he determined the radiant heat of Arcturus to be equal to that of a cubical 3in. vessel of hot water at a distance of 400 yards. Taking the parallax of Arcturus at ¼th of a second, this would give an absolute radiant force for the star more than 12,000 times as great as the absolute radiant force of the sun.

The Astronomer Royal said that it seemed to him that the accounts of the spots which had been seen upon the disc of the planet Mercury when in transit should be received by the society with great caution. It was very improbable that if such a spot had an actual existence upon the planet, that the period of rotation should be such as to bring it into the centre of the disc at the date of each of the transits during which it had been observed. He thought that it was much more probable that it would be found to be merely an optical phenomenon which had its origin in some reflection from the surfaces of the lenses or the sides of the tubes. He had in his experience seen and heard of several such optical phenomena, which had at first been very perplexing. Once when standing in a room with Mr. Francis Baily and Admiral Smyth, Mr. Baily suddenly called their attention to what appeared to be a double star shining in the heavens at some distance from the sun. There it was distinctly, and it was not till after some little cross-questioning and experimenting that they discovered that it owed its existence to two reflections of an image of the sun in the plate glass through which they were looking. On another occasion an astronomer had assured him that he saw a luminous atmosphere round one of the planets which it was perfectly certain was not seen by other observers. Bearing in mind these and similar appearances, he thought that the accounts of the bright spot and ring round Mercury during transit could not be received with too great caution.

Mr. Christie said that, after the remarks of the Astronomer Royal, he should bring forward his observations with great caution, and should not endeavour to assign the causes of the phenomena which he had observed. His observations were made in a very limited time in intervals between a cloud. He saw a minute bright spot in the middle of the disc of Mercury, and, as far as he could make out, the visibility of the spot and its position upon the disc did not alter as he moved his eye; he also saw a ring of light round the planet. It seemed of an irregular shape, not altogether circular, in the interior of a larger ring, perhaps half a radius of the planet in breadth. The outer ring seemed perfectly circular, and ought possibly to be spoken of as a halo. He observed the transit with 5 different eyepieces—that is, with ordinary negative eyepieces, with a solar diagonal, and with two prisms and polarising solar eyepiece; but he could not pretend to have thoroughly investigated the phenomena, as he only had ten minutes at his disposal. Captain Tupman, who had also observed at Greenwich, but with another instrument, could not detect any permanent white spot within the disc, but there was occasionally a diffused light over the planet. He had not been able to detect a ring, either luminous or shadowy, around the planet.

On the invitation of the President, Mr. Rutherfurd, of New York, said that he concurred with the Astronomer Royal in thinking that these phenomena had their origin in the telescope or in the eye of the observer. If one gentleman saw a dark ring, and another a bright one, and another none at all, it seemed to point to the conclusion that the phenomena had no actual existence. It must be remembered that, with an object so bright as the sun, all reflections and images from lenses would be seen under the most exaggerated conditions.

Mr. Dunkin, who had also observed the transit at Greenwich, said that during part of the time, when there was a break in the clouds, he had had a superb definition. He had then seen a point of light near the centre of the disc a little towards the following limb, and there was also a ring or corona of light around the planet. The halo seemed to him of a half tint, and his impression was that it was produced by contrast with the intensely black disc of the planet. He had made his observation with a 6in. telescope by Simms, which had been used for observing the transit of Venus.

Mr. Proctor said that he had observed the transit with his daughter. He [illegible] spot at the centre of the [illegible] not to prejudice his [illegible] tion to it. She is [illegible] and her first imp[illegible] been playing her a trick, and had put a piece of card, as she explained, on the eyepiece, and that the point at the centre was the place were one of the legs of the compasses had been placed to strike the little circle. Mr. Proctor noticed that, as the clouds came over, the point of light changed in brightness, and grew dark as the sun was covered. If it were a real phenomenon, he thought that it should have grown relatively brighter as the eye was sheltered from the sun's light. When he changed the power he could not see the bright point, but he detected a misty sort of light at the centre. One other matter, but he was doubtful about it, was, that as the light of the point waxed and waned, it seemed as though it assumed a triangular form; but the phenomenon was so momentary that he did not like to speak about it with certainty. With regard to the bright ring, when he directed his attention to the side of the planet furthest from the sun's limb, he saw it, and sometimes when he directed his attention to the other side he could not see it. It seemed like a very thin thread of light; the limb was beautifully defined —in fact, the definition was perfect.

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* From An'hony's Bulletin.

Mr. Chambers said that he was only able to see the sun through clouds for about 10 minutes. He could detect no spot upon the disc, but a ring was visible round the planet. The breadth of the ring was slightly more than a diameter of the planet. To him it appeared as a bright ring; but his wife, who also saw it, described it as a dark ring.

Mr. Brett said that he observed the planet in company with Mr. Walter Pye. There was no break in the clouds until the planet was upon the sun's disc at a distance from the limb equal to about its own diameter. The planet was intensely black, and seemed surrounded by a ring of light. His first impression was, that the width of the ring was equal to about a third of the diameter of the planet. The bright ring was much brighter, perhaps twice as bright as the sun's disc. His observations entirely confirmed his views as to the specular reflection at the surface of the planet.

Captain Noble read a paper from Baron von Ertbon, who had observed the transit in company with M. de Böe. Neither they nor any of the observers with them saw a black drop or ligament. When the planet was upon the sun's disc, an aureola of brighter light, whose breadth was equal to the radius of Mercury, was seen about the planet. There was also a small point of light upon the disc which was decidedly eccentric, being nearer to the limb than the centre of the planet.

Mr. Penrose had observed the transit from Wimbledon. At the time of internal contact the sky was clear, and he had observed no ligament. There were waves of light running along the limb which made it difficult to say when the contact was complete. Observing with a diagonal eyepiece he saw a white light upon the planet, slightly flickering. It was decidedly not central. A lady who was with him saw the white light, but did not agree with him as to its exact position.

Mr. Glaisher read a paper by Prof. Pritchard, who had observed the transit at Oxford. During two glimpses he thought that the centre of the planet was brighter than the rest of the disc, but during a third glimpse he could not detect this phenomenon.

Mr. Ranyard said that he observed the transit with Lord Lindsay's 15in. refractor, stopped down to 10in., before the time of external contact. He had his eye at a spectroscope upon one of the finders of the larger instrument. The slit which was 5′ 45″ long was placed so as to be across the path of the planet as it came up to the sun's limb, and was swept slowly backwards and forwards in right ascension. The viewing telescope of the spectroscope was placed so that the red end of the spectrum below C was in the field of view, but no trace of the planet was seen until it had entered upon the sun's disc. At the time of first external contact thin clouds were over the sun, which, however, did not prevent the other observers at Dunecht from observing the external contact. When the planet was about one-third of its diameter upon the sun's disc Mr. Ranyard passed to the 15in. instrument upon which was a merely polarising eyepiece with a power of about 400, but no trace of the planet outside the sun's limb was detected, although the brightness of the image was varied by turning the polarising eyepiece. Mr. Ranyard then passed again to the spectroscope, but could see no change of intensity of the spectrum corresponding to the outer limb of the planet when the planet was rather more than $\frac{2}{3}$ of its diameter upon the sun's disc. He passed back again to the larger instrument, but could see no trace of the part of the limb of the planet outside the sun's disc, and there was certainly no line of light around the limb as described by some of the observers who witnessed the phenomena of ingress at the transit of Venus. At this time the sky was exceptionally clear, and he continued to observe in the larger instrument until the planet was well upon the sun's limb. No black drop was observed. For about a second, or at most two seconds, he was uncertain whether the moment of geometrical contact had arrived, and then the line of light was seen between the planet and the sun's limb. The slit of the spectroscope was afterwards placed across the disc of the planet, but no change in the solar spectrum at the limb of the planet could be observed either by Mr. Ranyard or Dr. Copeland, who came to his assistance, but the latter observation was somewhat doubtful owing to the unsteadiness of the atmosphere which caused the image of the planet upon the slit to be in continual undulation. The edges of the dark band running across the spectrum corresponding to the disc of the planet were consequently not sharply defined.

Lord Lindsay described his observations of the transit. He said that he was making use of a 6in. telescope with a large prism outside the object-glass, and a direct vision spectroscope of corresponding dispersion placed on the other side of the slit, so that a coloured image of the sun's limb was seen. The part of the limb where the first contact would take place was brought to the part of the spectrum corresponding to the C line, and 13 seconds before external contact of the planet's limb with the photosphere the limb of the planet was seen eclipsing the red image of the chromosphere. No bright spot upon the disc or rings round the planet were seen by the observers at Dunecht, except in an instrument which was stopped down with a card diaphragm to an aperture of less than 1in. With this, Dr. Copeland, Lord Lindsay, and Mr. Carpenter thought that they saw rings round the planet, and Mr. Ranyard did not feel certain as to the phenomenon.

Mr. Rutherfurd exhibited to the meeting two photographs of the sun taken in 1871, which showed structure similar to the structure visible on the photographs more recently taken by M. Janssen. He also amid much applause exhibited to the meeting a gigantic photograph of the solar spectrum some 10ft. in length with innumerable sharply-defined lines. The photograph had been taken by means of a diffraction grating ruled upon speculum metal with upwards of 17,000 lines to the inch. Mr. Rutherfurd explained that the photographs had been taken in some 8 or 10 sections, and that very different exposures were necessary for different parts of the spectrum. The meeting adjourned at ten o'clock.

USEFUL AND SCIENTIFIC NOTES.

Delicate Manometers.—The want of manometers of great precision, capable of measuring the smallest difference of gaseous pressure, has long been felt. Peclet was the first experimenter who succeeded in approximately satisfying the want. Palomede Guzzi describes an improved instrument in *Il Politecnico* (v. 25, pp. 689-703), by which he is able to measure differences of pressure equivalent to 1·500th of a millimetre of water.

Resistance of Iron to Repeated Blows.—Giambattista Biadego publishes a note upon the determination of the strains which iron can sustain, with special reference to Wöhler's experiments upon the effects of repeated blows. He recounts the experiments of Fairbairn (1849-61), Wöhler (1859-70), and Spangenberg; the analytical discussions of Gerber (1872), Launhardt (1873), Weyrauch (1877), and Winkler (1877), and some deductions of his own, giving a preference to the formulæ of Launhardt, as improved by Weyrauch.

Microscopic Mineralogy.—A. Michel Lévy has contributed to the *Annales des Mines* a valuable paper upon the use of the polarising microscope, for the determination of mineral species by small sections. The investigations of Rosenbusch, Fouqué, and Descloiseux, although all embraced within the last decade, have already become classical. Lévy tabulates their conclusions, and gives a complete mathematical analysis of the angles of extinction presented by the sections of a zone, together with a practical application to the study of the principal monoclinic minerals, and of some tricline feldspars.

High Furnaces.—M. L. Greever divides smelting furnaces into two classes, which he calls *trapu* (squat), and *elancé* (long). In the trapu the height does not exceed three times the length; in the elancé the ratio is four or more; and he admits an intermediate class, the *ordinaire*, in which the ratio is between three and four, and generally about 3·5. He compares the productions of various furnaces in England, Styria, Carinthia, America, Sweden, Germany, and France, drawing conclusions unfavourable to the elancés, which have increased so largely within the last quarter of a century.

Cementation of Nickel.—Boussingault has experimented to find whether the carburation of nickel would affect it like iron, and, if so, whether its combination with steel would render it less oxidisable. Although he was able to carbonise the nickel as highly as steel, he did not find any increase of elasticity, hardness, or resistance to tension; he was unable to temper it; and the alloy with iron easily rusted, unless the nickel was in very large proportion. Damour found, in the meteoric iron of Santa Caterina, 34 per cent. of nickel. Boussingault exposed a piece of it under water for more than a month, without finding the least rust. He then made a very homogeneous alloy, by melting 63 parts of steel with 37 parts of nickel, which was malleable and resisted the action of water as well as the Santa Caterina iron.

SCIENTIFIC NEWS.

WITHIN the past fortnight science has lost several of its sons—amongst the best known being the Rev. Robert Main, Prof. Henry, and Prof. Wolfers.

The Rev. R. Main, M.A., F.R.S., who died on the 9th instant, was Director of the Radcliffe Observatory, the duties of which post he undertook after the death in 1860 of Mr. M. Johnson. Mr. Main was born in 1808, and graduated as sixth wrangler at Cambridge in 1834; he was made a fellow of his college (Queen's), and when the present Astronomer Royal was appointed (1835) went to Greenwich as First Assistant—a position he held for a quarter of a century, with credit to the Observatory and honour to himself. Besides his routine work Mr. Main carried on independent investigations, and the value of those in connection with the proper motions of the fixed stars subsequently obtained for him the gold medal of the Royal Astronomical Society. The volumes of "Radcliffe Observations" published during his directorate are evidence of his painstaking industry, and the unpublished (but nearly finished) catalogue of stars upon which he had been engaged for some years will be his best monument.

By the death of Joseph Henry the United States loses one of its most famous men. Born at Albany (N.Y.) in 1797, he received the usual school education, and commenced life as a watchmaker in his native city. At the age of twenty-nine he became Professor of Mathematics at Albany Academy, and in 1827 commenced a series of experiments in electricity and was one of the first, if not the first, to demonstrate the principles upon which modern telegraphy is based. In 1832 he became Professor of Natural Philosophy at Princeton, and a few years afterwards visited England, where he made the acquaintance of Prof. Wheatstone, and doubtless, by recounting his own experiments and discoveries, helped the latter in the prosecution of the researches which then engaged his attention. In 1846 Prof. Henry was elected the first Secretary (*i.e.*, Director) of the Smithsonian Institution—a post he occupied till his death, which took place on the 13th instant. Prof. Henry published a volume of "Contributions to Electricity and Magnetism," and was a frequent contributor to scientific periodicals; but he will be best remembered for his life-long unceasing labours in furtherance of the spread of a knowledge of nature.

Prof. Wolfers, for many years astronomer at Berlin and editor of the "Year-book" of that Observatory, died recently in his 76th year. His work was of that steady kind which, though unaccompanied by any brilliant discovery, is of the greatest value to astronomy, and latterly he devoted much time to meteorology, compiling from a mass of observations several comparative tables of much interest.

The fund collected for the Morris testimonial and the first Lyell medal were awarded to Prof. Morris, at Cambridge, a few days ago.

The Commissioners of Patents have determined to so far meet the wishes of inventors and patent agents as to revise and consolidate the whole series of subject-matter indices. They have, accordingly, issued a notice through the Civil Service Commissioners that the latter will hold preliminary examinations on the 4th of June. The competition will be held on the 18th of June. Six clerks will be selected—four must have a knowledge of mechanics, and two be well acquainted with chemistry; but applications must be sent on the prescribed form on the 28th instant. Candidates must be not less than 21, and not more than 25, and the salary will be £250 a year, increasing triennially up to £400. We are at a loss to know why this competition has been kept so close. Instead of giving at least three months' notice, the intimation precedes the date of application by so short a time that many competent persons will probably remain in ignorance of the examination until it is over.

Mr. E. Cox Walker, of the firm of T. Cooke and Sons, York, has invented and patented an improvement upon Bell's telephone, by means of which the sound transmitted is considerably intensified. The improvement consists in an arrangement of duplex and quadruplex diaphragms—each diaphragm having a sub-mouthpiece leading into the principal mouthpiece. The description forwarded to us is vague and incomprehensible, but as an octoplex instrument has been made, giving eight times the volume of a single telephone, it will, probably, soon find its way into use. At present we cannot say whether or not the improvement is a modification of Trouvé's quadruplex telephone, or is based on a different principle.

A Société de Minéralogie has been formed at Paris under the presidentship of M. Descloizeaux, and will hold monthly meetings at the Sorbonne.

At Gratz an Anthropological Society has been founded by a number of Austrian antiquaries, mainly for the purpose of working up the prehistorical condition of Styria.

Six expeditions leave for the Yenesei this month—a German, a Dutch, a Swedish, a Danish, and two Russian; and but for the threatening state of affairs more than one would have left England with a view of testing the feasibility of navigating the northern seas as a regular branch of summer trade—many London merchants regarding the scheme favourably. A telegram has been received from the Willem Barentz, which had touched at a Norwegian port. The little schooner is reported to "behave splendidly."

A Connecticut paper gives a warning to telephonists. A Dr. Stevens, of Hartford, was conversing with his clerk, the latter being at the drug store in town, when a flash of lightning, followed by a peal of thunder, startled both. The doctor observed the flash play about his telephone, and found that the wire coil had been completely destroyed, but the unfortunate clerk, who had his ear to the telephone at the other end, received a severe shock, the report sounding like the discharge of a gun, and affecting his powers of hearing for several hours.

Dr. Delaunay, who a short time ago, made some inquiry, among the Parisian hatters, into the forms of heads, has now gone to the shoemakers and studied the foot. He is led to be of opinion that the foot is longer, flatter, and less arched in inferior races. The Nubians, Arabs, and Japanese have the foot flat and long. In the English, among Europeans, the foot (he says) is long, thin, and flat; in the Germans, it is long, thick, flat, and flabby. On the other hand the foot of the French is short, small, elegant, and arched. This is no doubt flattering to the French; the objection, however, occurs that Spaniards and Portuguese, who are not generally thought more advanced than other European people, have a well-arched foot. He meets this difficulty by saying that the evolution of the foot may be accomplished when that of the head is still incomplete or arrested (which seems rather a fatal concession). In Paris, M. Delaunay finds differences in the feet in different quarters, and he states, not without satisfaction, that ecclesiastics are at the bottom of the scale, while students are at the top. Thus there is opposition between the volume of the head and that of the foot. The small heads of the Quartier Saint Sulpice have the foot large, and the large heads of the Quartier Saint Michel have the foot fine. M. Delaunay explains the fashion of high heels by the desire to conceal the flatness of the feet, which, he says, is common in the old ruling classes, that are in course of degeneration. With the reporter of these researches (in the *Bibl. Univ.*) we think some of the points are open to question. The students who, according to M. Delaunay, have the foot so arched, come from nearly the same social strata as the idlers of the boulevards, or the youths trained in ecclesiastical seminaries. Are we to suppose, then, that the intellectual work to which they are put has the direct and immediate result of shortening and arching the foot? This would be rather a surprising effect of studying anatomy or civil law.

A differential counter, furnishing precise indications for regulating the mean velocity and working of an engine, is now used on board many of the vessels of the French Navy. Its principal part is a seconds watch, the case of which turns by the action of the engine in the opposite direction to that of the needle. Supposing there is a gearing ratio of $\frac{N}{1}$ between the rotation of the screw and that of the case, and that the engine produces N turns of the screw in a minute, the differential second, needle appears at rest, and is directed towards a fixed mark; but it moves to the left of the mark when the velocity of the engine is increased, and to the right in the opposite case. Hence the engine-man has a very delicate means of maintaining a rate of N turns per minute. The indications of the needle are given on a graduated limit.

In using the telephone with telegraph lines, M. Grenier has observed, besides the noises produced by inductive action of currents passing in other wires, interrupted confused detonations, which are often very intense, and almost threatening to rupture the plate. His opinion is, that these noises (which are heard most at night) are due to special currents arising from difference in electric potential in the layer of air through which the wire passes; and he thinks the telephone might very advantageously be used to study the variations of potential. M. du Moncel, commenting on this in the French Academy, considered that the telluric currents in question were chiefly caused by solar heating of the telegraph wires; and that they were, in fact, thermo-electric currents directed from a hot part of the circuit to a cold part. When night comes a dew forms, the moisture covering the wires causes a change of polarity, and the currents are reversed. M. du Moncel has long since studied these phenomena with a special galvanometer, which had not less than 36,000 turns.

According to M. Olivier, the plane circular form of the diaphragm in Bell's telephone and its uniform thickness are opposed to the reproduction of *timbre*. In these respects it is unlike the tympanic membrane, which, having a series of different tensions, can enter into vibration for all the parts of the tonic scale. M. Olivier makes a telephone with a concave plate of unequal thickness, elliptical in front view, its general plane inclined to the axis of the apparatus. It is attached, not only round the border, but by a silk thread at the point of maximum thickness. To transmit with less loss of intensity, he recommends the use of five telephones on five faces of a cube (an arrangement devised by M. du Moncel), but all the five having different thicknesses and different forms.

In the course of toxicological reseaches, Prof. Selmi, of Bologna, recently found in extracts from the bodies of persons that had died naturally several substances having the general characters of alkaloids. He supposed that these substances, which he calls *ptomaines* (*πτωμα* a corpse), arise from spontaneous decomposition of cadaveric matter, and this was fully confirmed. He was led to study the properties and mode of formation of these alkaloids, and the reactions which distinguish them from vegetable alkaloids. The grave consequences which may flow from a mistake in a medico-legal investigation lend a special interest to Prof. Selmi's researches. A full account of them will be found in the *Moniteur Scientifique* for May.

An interesting collection of facts about balloon voyaging is given by M. Obermayer, in "Carl's Repertorium für Experimental Physik" (14th Band, 6th Heft). He appends a list of works that have appeared on the subject from 1627 (when Flayders published his "De Arte Volandi"), to 1876, the date of M. de Fonvielle's "Aventures Aëriennes."

A large number of specimens of dried or living plants (nearly 600 species) have lately been examined by M. Contejean, with reference to the soda they contained. He finds that more than three-fourths of terrestrial plants, proper (non-maritime) growing in media, not apparently saline, contain soda, and often a good deal of it. It is nearly always accumulated in the subterranean part of the plant, and diminishes in amount as you proceed upwards, so that the flowers, fruits, branches, and top of the stem show no trace of it. Aquatic plants are an exception; they contain much soda in all the submerged parts; the parts rising out of the water contain much less, and often none at all. The aptitude for soda varies according to families, genera, species, and even individuals. Azotised plants (as *Lycium*, &c.) contain least; there seems to be an antipathy between soda and nitrogen, or at least between soda and nitrous and ammoniacal compounds. Non-saline soils, which do not contain lime, seem more favourable to soda-containing plants than calcareous soils. All the facts seem to indicate that soda is hurtful, or useless, to the majority of plants. The roots seem to absorb without discrimination and by diffusion, all the soluble principles they are in contact with, and afterwards a sort of sifting takes place, which hinders the deleterious substances from penetrating into the organs where their presence might be mischievous.

Investigating recently the presence of the ferment of urea in the air, M. Miquel sealed 80 balloons containing sterilised urine, after they had received, at different times and in different places, a small portion of air. The liquid in 15 of them fermented, and always showed the presence of ammoniacal torula. Of the 15, 6 contained besides a greenish algal, which seems to flourish in putrefied urine. M. Miquel concludes that the ammoniacal ferment is largely expanded in the atmosphere, that it can be followed, brought under the microscope, and so used to corroborate by rigorous experiments the data of direct observation. (M. Miquel's researches have been described to the Paris Chemical Society).

Some excellent curative results are said to have been lately obtained by Dr. Trieze, an Alsatian physician, by use of ferric albuminate in solution. The mode of preparation (slightly modified by M. Koblige, of Berlin) is as follows:—With the white of an egg is mixed 10 grammes of liquid perchloride of iron. The brownish red precipitate is collected in a filter, and washed with distilled water till the liquor passes transparent. The precipitate is then dissolved in 500 grammes of distilled water, acidulated with 12 drops of hydrochloric acid. The substance is administered by spoonfuls three times a day.

German commerce with China and other foreign countries seems to be rapidly on the increase. Thus, at Shanghai last year, twenty-three German commercial houses were established. Among the twenty-six societies of marine insurance there may be reckoned ten German, and five out of eighteen companies for insurance against fire are German. The exports from Germany to China are chiefly arms and manufactured products. By a treaty concluded last year four new ports in China have been opened to German trade, and two of them promise to become great centres. On the northern coasts of the Yellow Sea, in the port of Yonze, German commerce is more considerable than that of any other nation. In 1874 there arrived at that port 101 German sailing ships, laden with 35,000 tons, whereas all the other nations together would not count two-thirds of this tonnage. At Hong-Kong and Canton, the coasting trade, spite of strong competition, remains in the hands of Germans.

Wood Injection.—The value of creosote as a wood preserver is generally recognised, but the direct injection requires great quantities of heavy oil, and a desiccation of the injected pores. The high boiling-point of creosote (300°) does not permit its employment in vapour. John Blythe formed the idea of saturating a jet of steam with creosote in minute division, forming, so to speak, a gaseous emulsion. The apparatus comprises a high-pressure steam-boiler; another boiler containing creosote, in which the steam is saturated; a vat, filled with creosote, to be pumped into the boiler; sheet-iron cylinders, for the pieces which are to be injected; and a system of tubing connecting the several parts. In this way Mr. Blythe completely fills the heart of oak, pine, or red beech; he uses 2 to 3 kilos. of creosote for a cross-tie, and 2 kilos. of brown phenic acid per cubic metre of saturated wood or cross-ties. The cost of preparing a cross-tie, measuring 0·085m., is from 0·60f. to 0·70f. The apparatus can prepare 500 ties per day; the wood comes out softened, so that it can readily be bent or shaped, but it rapidly hardens; at first it shrinks, but after a few weeks it becomes seasoned, and resists the influence of moisture; finally, the fib [illegible] strengthened.

LETTERS TO THE EDITOR.

[We do not hold ourselves responsible for the opinions of our correspondents. The Editor respectfully requests that all communications should be drawn up as briefly as possible.]

All communications should be addressed to the Editor of the English Mechanic, 31, *Tavistock-street, Covent-garden, W.C.*

All Cheques and Post-office Orders to be made Payable to J. Passmore Edwards.

⁂ *In order to facilitate reference, Correspondents, when speaking of any Letter previously inserted, will oblige by mentioning the number of the Letter, as well as the page on which it appears.*

"I would have everyone write what he knows, and as much as he knows, but no more; and that not in this only, but in all other subjects: For such a person may have some particular knowledge and experience of the nature of such a person or such a fountain, that as to other things, knows no more than what everybody does, and yet, to keep a clutter with this little pittance of his, will undertake to write the whole body of physicks: a vice from whence great inconveniences derive their original."—*Montaigne's Essays.*

STAR IN HYDRA—MORE WASTE OF NATIONAL MONEY—CALCULATING SUNRISE AND SUNSET, &c.—THE NOCTURNAL—ATTRACTION—THE USE OF THE SIGNS ′ AND ″—STELLAR PHOTOMETRY—THE SATELLITES OF MARS—A 3in. TELESCOPE—POWERS FOR A 2¾in. OBJECT-GLASS.

[14349.]—Since writing letter 14296 I have had an opportunity of consulting the B. A. C., and searching for the star, with reference to which Mr. Gore put query 32837, p. 202. Proctor's "Atlas," as stated by your correspondent, shows two 5m. Stars S.P. π Hydræ; but the B. A. C. contains *one* object only in this region, numbered 4,671. Its R.A. on January 1, 1850, is given as 13h. 53m. 51·81s., its N.P.D. as 116° 42′ 12″·0, and its magnitude as 5½. Nothing else appears in the Catalogue within a considerable distance of π. Perhaps Mr. Proctor can clear this up, and indicate the source whence he obtained the place of his second small star.

The shameful waste of National funds to which "Aliquando" refers in letter 14320, p. 221, is pretty obviously intended by the South Kensington Ring as a slap in the face to the Committee of Public Accounts, for their presumption in calling attention to the "grave irregularities" committed by those for whose pecuniary benefit the Loan Collection of Scientific Instruments was worked. These gentry seem determined to show that they have both the will and power to defy anybody and everybody, and to spend public money as seemeth best unto their wisdom. I wonder whether the commonly-reported fact, that one of their ringleaders is under the protection of a prominent Cabinet Minister has anything to do with such an outrage on public opinion, and with the impunity which its perpetrators appear to enjoy?

If "Little Harry" (query 32868, p. 226) really wishes to calculate *accurately* the times of rising and setting of the Sun and Moon for every day in the year 1879, I can only say that he has a delightful task of the most dreary computation before him. Let us take the most simple case, that of the Sun, first. Premising that (as your correspondent probably knows) every change in Latitude introduces a change in the times of the rising and setting of all heavenly bodies—as, in fact, does a difference of Longitude, too, when it is sufficiently great for the Declination of the Sun or Moon to have altered perceptibly in the interval—we will suppose that he wishes to find the time of Sunrise and Sunset at Liverpool on June 20th, 1879. The Latitude of Liverpool we will take at 53° 24′, and the Sun's Declination North on the day named (*Nautical Almanac*, p. 93) at 23° 27′, then the quantities we require for our subsequent calculation are the colatitude = 36° 36′, the Sun's Zenith distance at rising = 90° 50′ (this is supposing his semi-diameter to be 16′, and refraction at the horizon to be 34′); and his North Polar Distance = 66° 33′. Our first step is to add these three quantities together, thus,

Colat.	36° 36′
Sun's N.P.D.	66° 33′
Sun's Z.D	90° 50′
	193° 59′

which we divide by 2, and call the quotient (96° 59′) S.

Then S. – Co. lat. 96° 59′ – 36° 36′ = 60° 23′
and S. – N.P.D. 96° 59′ – 66° 33′ = 30° 26′

Sin.	60° 23′	...	9·939105
Sin.	30° 26′	...	9·704610
Cosec.	36° 36′	...	0·224590
Cosec.	66° 33′	...	0·037438
		Dividing by	2)19·905833
Sin. of half hour angle	63° 48′		9·952917

and 63° 48′ × 2 = 127° 33′; or in time 8h. 30m. 24s. Now the Sun souths at Liverpool on June 20, 1879, at 0h. 1m. 12s. p.m. So that he must rise there at 3h. 30m. 48s. a.m., and set at 8h. 31m. 36s. p.m. I have taken the most simple possible case—that is, when the Sun's declination remains sensibly unaltered for 24 hours; but had I selected a day in March or September, a semidiurnal arc must have been computed from his declination at the time of his rising; and another from that at the time of his setting. The same method will give very roughly the time of the Moon rising and setting; but here several corrections for the errors introduced by her relatively rapid change in declination (involving interpolation to the second order of differences) will enter into the calculations. Why does not "Little Harry" compute a table of semidiurnal arcs for his station from this simple formula: tan Lat. + tan Dec. = sin. of an angle which added to, or substracted from, 6 hours (according to the declination of a heavenly body is N. or S.) gives the semidiurnal arc as it would appear in the absence of refraction. Refraction will (rudely) cause an object on the equator to rise 4 minutes sooner and set 4 minutes later than it would were our atmosphere removed.

As far as I can understand from the description given by "Plumb-bob" of his Nocturnal (in query 32890, p. 226) it is one of those which were used both with Polaris and β Ursæ Minoris, and also with Polaris and α and β Ursæ Majoris. Should this be so the handle is moveable, and its middle must be made to coincide with that day of the year when the star with which the instrument is used has the same R.A. as the Sun. The G. stands for Great, and the L. for Little (Bear). Suppose that it is proposed to find the time of night by Polaris and the Pointers of the Great Bear. Now α Ursæ Majoris and the Sun have the same R.A. on Sept. 5. So that the mark in the middle of the handle must be set to Sept. 5 on the lower one, then, setting the long tooth marked G to the month and day on which the instrument is being used, it must be employed as described in letter 14027, Vol. XXVI., p. 600. The description given by my querist of various marks upon the plates of his Nocturnal conveys no very definite idea to me. The "abo" and "und" probably has reference to the second star being supra Polum or sub Polo.

Assuming that I rightly comprehend query 32900 (p. 227), it was shown long ago by Sir Isaac Newton that the attraction of the Earth (supposed to be spherical) on a body on its surface, is the same as though its entire mass were concentrated in a point at its centre, and this rule would practically hold good for your correspondent's purpose for a body whose form was so slightly spheroidal as that of our Globe. The calculations then need present no difficulty to "Volvox."*

I am very glad to find "Kelby" (letter 14333, p. 242), protesting against the fashion of using the marks ′ and ″ for feet and inches. Their only legitimate meaning is minutes and seconds *of arc*; and no one has even a right to use them (as is occasionally done) for minutes and seconds of time. Nothing hinders the acquisition of knowledge more than an inexact mode of thought, and nothing contributes more towards such inexactitude than vague language. What would a chemist say if he found fruiterers using H_2O for 2 hundredweight of oranges; or a geologist should he hear a hotel-keeper speaking of tertiary beds when he was merely referring to the sleeping accommodation on his third floor? Every technical word or sign has—or should have—a perfectly definite connotation, and a fixed and unalterable meaning; and all who are interested in the diffusion of knowledge must reprobate its employment in any other sense.

In order that the method of Stellar Photometry, described by Mr. Dennett, let. 14334 (p. 242), should have the slightest scientific value, it would be necessary that the angle of incidence of the light from the reflected star should be determined. For example, at an angle of incidence of 85°, 543 out of every 1,000 rays of light falling upon a plane surface of glass are reflected, while when such angle diminishes to 30°, only 25 out of the 1,000 reach the observer's eye. Thus, were it conceivably possible that Capella could be viewed by anything approaching to perpendicular reflection at the same time that δ Orionis was visible too, the former star must emit, according to your correspondent, 40 times the light of the latter.

"Lator" (letter 14335, p. 242) appears to have as exaggerated an idea of the size and mass of the satellites of Mars as I had, when, on first hearing of their discovery, I imagined that they must create perceptible tides in his land-locked seas. Why, the diameter of the outer satellite (6 miles or so) would last autumn subtend an angle of about 0·03″ to an observer on the Earth. In what way such a body as this could influence the motion of our own moon, or be seen in transit across the disc of its primary, I leave "Lator" to determine.

The description of the performance of his telescope, given originally by "Totham," would have been bad enough had the instrument been a £5 one, but now I learn from query 32924 (p. 251) that it has actually cost him £12 18s. 6d., I can only say that he seems to me to have been swindled. Were I "Totham" I would submit the glass to some friend who is a skilled observer, who would properly clean the lenses of the astronomical eyepieces, and test them upon appropriate objects in the heavens. Should he confirm your correspondent's estimate of the goodness (or rather exceeding badness) of his instrument, I would then request the maker or vendor of it to return me the money; and, should he refuse, sue him in the County Court. It is only fair to say though that sometimes the lenses of eyepieces get covered with a kind of deposit (which opticians call "sweat") which would envelope a bright star viewed through them in a mist.

Should "A Poor Student" (query 32956, p. 251) be the possessor of a first-rate 2¾ inch achromatic he might, on a really fine night, very well employ a power of 200 on it for viewing the Moon. This would be as high an eyepiece as he could use for Lunar observation with the slightest chance of success, but a first-class objective will, under the most favourable circumstances, bear a power of 100 to each inch of aperture on *a Star*, so that he might obtain one magnifying 250 or 260 times for the examination of close doubles, &c. These eyepieces should cost 15 shillings each. I can say nothing about the insertion of maps of the Constellations, which is entirely a matter for the Editor of the paper, and certainly not for any subscriber to it, and I am, moreover, wholly ignorant of the price of engraving; but I should think that such maps as my querist seems to require would be far too costly to justify any one in asking you, sir, to insert them. Cannot "A Poor Student" obtain a copy of Proctor's *Small Star Atlas*? Its price is five shillings, and it contains a surprising amount of detail.

A Fellow of the Royal Astronomical Society.

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* Should "Volvox" wish to determine rigidly the attraction of a homogeneous oblate spheroid of small eccentricity on a particle at either its equator or its pole, he may do so easily by the following equations (neglecting, of course, the effect of the earth's rotation). Calling c the length of the minor axis, and ϵ the eccentricity of the ellipse:—

(1). The attraction for a particle at the equator
$$= \tfrac{4}{3}\pi \, . \, \rho \, (1 + \tfrac{2}{5}\epsilon) \, c; \text{ and}$$
(2). For a particle situated at the pole
$$= \tfrac{4}{3}\pi \, . \, \rho \, (1 + \tfrac{4}{5}\epsilon) \, c.$$

PLANETARY RAIN.

[14350.]—To the many popular and scientific opinions as to the cause of rain I would beg to add one that I have not yet seen described in any book—viz., the influence of the moon when passing Venus, Jupiter, and other planets. It may only be a peculiarity of this "station," but I have noticed over and over again that rain falls when the moon at night is two or three degrees to the west of Venus or Jupiter, when these planets are in the west, or when the moon in the morning is two or three degrees to the east of a planet situated in the east.

In countries where the sky is always filled with rain clouds, or where rain clouds are carried from one place to another by some constant wind, the least fall of temperature or of the barometer, or the resistance of a hill's side, causes rain; but when rain falls in Nagpur in the hot season, clouds form in a clear sky, and the rain falls on a dry hot plain. Any occult influence of the planets, or any residuary cause of rain, becomes thus more clearly perceptible.

As Venus is often an evening star, and close to the sun at new moon, the belief in a change of weather at the new moon is not so unwarrantable as some suppose. Why the planets should thus effect our atmosphere is another matter. It may be that the ether pervading the space between the sun, earth, and planet is at its greatest density for the temperature of that space, and that the introduction of the moon's weight between the three bodies disturbs the equilibrium, so that a precipitation of ethereal matter takes place—always supposing that the ether has the qualities of natural vapour, and is able to condense on increased pressure.

Nagpur, India. **G. P. Carruthers.**

THE LAST TRANSIT OF MERCURY.

[14351.]—While the transit of Mercury is likely to occupy the attention of your readers, I should like to lay before them an observation of the same phenomenon in November, 1868. I believe that I saw during that transit a portion of the enlightened surface of the planet in the shape of a crescent on the northern limb. Its appearance was that of a chocolate-coloured shade, and gave the planet some resemblance to a full-stop in shaded letters with the shade in the wrong direction. The telescope I used was in perfect adjustment, and gave a good disc to a large star the same evening. Several friends also noticed the appearance on its being pointed out to them. I do not know whether the conclusion I came to may be correct, but there can be no doubt about the observation. I made several attempts to get something like a distinct view of the present transit, but could only see the planet now and then as a very hazy spot. The sky here was covered with clouds from its commencement to sunset.

Henry T. Vivian.

IALL STAR NEAR CASTOR.

]—The interesting notices of this delicate
ar, which have appeared in your journal
ıe past few weeks, induce me to describe
ience with it. On Tuesday evening (the
ere favoured with a night of such excep-
ood air (perhaps as a "solatium" for the
ı cœlum" of the day before), that I deter-
look up this little star, and some other
oublet, and as my optical means have been
bly enlarged of late, the results may per-
e interesting to some of your readers.

ave no micrometer eyepiece, I was anxious
d compare this star with others (ζ Cancri,
tis) of about the same distance, to discover,
e, whether it was closing up since I last ob.
(April, 1878). I may say at once that (ζ
as of no use to me, as its components are
considerably over half a second apart—
rer to one second I would say (may I hope
l friend will accede to Mr. Webb's request
he last measurement)—so I confined myself
parison of the star in question with (μ^2

st I turned my 8½in. (With) mirror on the
ing the highest power Huyghenian eye-
essess (about 290), and was pleased to see
e discs clearly divided by a black thread.
ı a higher power I removed the field-lens
yepiece, and getting the star well in the
he field the separation was excellent. Leav-
epiece in focus I turned the telescope to the
Castor, and was very well satisfied with
, the two discs, considerably brighter than
μ^2 Boötis), were well divorced, round and
t when I returned the field-lens to the
he discs were in contact. This would not
prove their distance less, as the
ts are certainly from 1½ to 2 magnitudes

Turning from this admirable mirror to
(Calver), 10ft. 5in. focus, I brought it into
examine the same pairs, and, in the first
sed an eccentric stop of 8in. aperture, so
the telescope that the rays fell upon the
thout any obstruction from the central flat
arms which support it.

ision was splendid in each case—the discs
ıner, and perceptibly more free from
ce rings, which was to be anticipated. The
d, however, was somewhat higher (about
the additional focal length was of course,
of the portion of the large mirror which

ssuredly a very considerable advantage,
possessors of large telescopes have over
h more limited apertures, that a large
an be adapted to almost every state of the
re by the use of stops, and when thus
ill certainly do more than the same aper-
aller telescopes (the careful observer will
ı using eccentric stops, select that portion
rface of the mirror which gives the best
r the best mirrors have some portion of
ace better than the rest), and when the
rture can be used, the views of celestial
ll astonish and delight the observer.

very interesting to watch the gradual
f the dark space between the components
loubles as the different and larger stops
loyed (8in., 12in., 15in., and the full
Indeed, as an experiment on the
perture in reducing the size of star discs,
ould be more convincing. With the 8in.
also, on both the With and Calver, it was
possible to say whether there was any dif-
magnitude in the components of these
nd the mind would lean sometimes to one,
ı to another, but with the larger there
o doubt, and in both couples there is a per-
ifference. As to divergence in colour in
of very good air with the full aperture, I
detected a more bluish tint in one of the
ts of μ^2 Boötis, but would not like to speak
until I examine it again.

is careful examination, speaking from eye
ı alone, I am inclined to think that the
f these pairs is about equal, and that the
r Castor has closed a little since I last
it.

bservations were made between the hours
.0 on the night of the 7th. The sky was
azy, and ultimately became completely
ith clouds, so that the opportunity was as
was good. **Hyperion.**

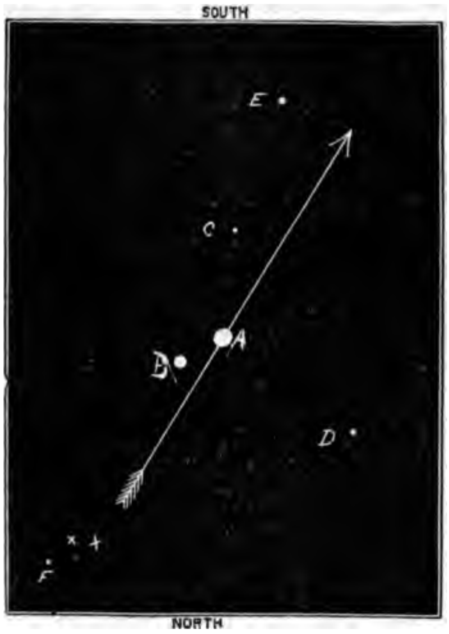
ince writing the above I have seen Mr.
etter, giving Dembowski's measurement
i, for which I thank him. From the
e of this double in the telescope, I should
ed to say the measurement which brought
istance as over ·8 of a second more near
than those under it.

ON THE DOUBLE STAR Sh. 190 (PIAZZI XIV., 212).

]—This pair was discovered by Sir Wm.
ı 1785 (=H No. 28), and is interesting from
ish orange colour of the components, and from the decided change that has taken place in the relations of the stars to each other. But few careful micrometrical measures have been made of this in the last 30 years, partly owing, perhaps, to the low altitude of the star in northern latitudes. The change will be best seen from the following, which include nearly all the measures recorded. Unfortunately Herschel only estimated the angle, so that the period covered by the observations is but little more than half a century.

		°	″	
South & Herschel II.		P=270·1	D=10·82	1823·32
Smythe	... ...	272·6	10·30	1833-44
Herschel II.	...	279·7	...	1835-40
Herschel II.	...	277·4	12·08	1836-66
Jacob	... ...	284·0	13·34	1856·37
Main...	... ...	283·9	13·51	1862·41
Dawes	... ...	285·1	...	1862·63
Burnham	... ...	288·6	...	1874·60
O. Stone	... ...	290·2	14 98	1877·37
Burnham	... ...	290 8	15·30	1878·30

The magnitudes are variously rated by different observers. A from 5¾ to 7 magnitude, and B generally about one magnitude smaller. The principal star is B.A.C. 4923, and there called 6 magnitude. It is remarkable for large proper motion, the value of which by the B.A.C. is—R.A. + 0 068s. and Decl. — 1·68″. Evidently this movement is shared by B, as otherwise it would have been left far behind. The relative change in A and B appears to be the result of orbital motion. Flammarion thinks that this is a system analogous to 61 Cygni, the two stars moving through space with a rapid and nearly equal proper motion, the change with reference to each other being in a right line. It is certainly a most interesting object, and deserves more attention than it has received at the hands of double-star observers.



I was led to examine this with some care in looking for a 15 magnitude star detected by Sir John Herschel, and noted in his Fifth Catalogue. For B C, he gives P = 321·5°, and D = 20″ (estimated). I do not know of any other observation of it, except that in Smythe's "Cycle of Celestial Objects." Of course the Admiral saw it; but, unfortunately in this instance, as in a great many others where faint stars were looked for, he saw it where it could not possibly have been at that or any other time. He gives for A C, P = 320·0°, and D = 20″ (1833-44). He says the measures are a "mere estimation, for the *comes* is the very *minimum visible* of my refractor, and not to be caught at all times." Notwithstanding all this, he calls the small star pale red! Invisible red would have been better. It may be said that this is a misprint in the "Cycle" for B C, and possibly this may be the case; but there are so many instances of faint stars being seen and measured in places entirely away from the true positions—the measures agreeing admirably with the wholly erroneous estimated places of the only prior observations—that it does not by any means necessarily follow. I looked for this a number of times with the 6in. refractor, but always without success. Lately I have examined this pair with the 18½in. refractor of the Dearborn, and after careful measures of A and B, took the approximate angles and distances of four small stars in the field, the nearest visible with that aperture under favourable conditions. They are as follows:—

	°	″
A and C	P = 171·0	D = 52·3
A and D	52·5	69·4
A and E	166·5	105·8
A and F	322·2	120·6

These are single distances, and, therefore, not rigidly exact. D and E are very faint stars, and beyond my small aperture; but E and F are comparatively bright. The accompanying diagram, drawn to scale, gives the relative positions of the six stars at the present time. The arrow indicates the direction of the proper motion of A. Fifty years ago the large stars, A and B, were in the places marked by two small crosses near the lower left-hand corner of the diagram. It will be seen at once that the star, F, was exactly as described by Herschel with reference to C. Evidently there was a time when B and F formed a moderately close pair.

The time will come when B and C will be very near each other, forming a couple which only large apertures will be able to deal with, C being the smallest star of the group and very faint.

The place of this pair (1880) is:—

R.A., 14h. 50m.
Decl. — 20° 52′

According to Heis and Argelander it is not a naked-eye star.

Chicago, May 2. **S. W. Burnham.**

PAIR NEAR 1 GEMINORUM — STAR NEAR RIGEL—Σ 1899, TO MR. WEBB—STARS NEAR π HYDRÆ.

[14354.]—"Mac's" little pair P. 42 seconds (of time) 1 Geminorum, R.A. 5h. 55m., N.P.D. 66° 44′, I have looked up, and cannot make out how I missed it before. The magnitudes are about 9, 10, and the third star, which forms a pretty triangle with the other two, is about 10½. I once or twice thought 10½ was closely double. Perhaps some one with more powerful means than mine at his disposal will look for it. I did not notice any other companions to the star in field P. Rigel.

While looking for red stars some little time ago, I came across Σ 1899, R.A. 14h. 55min., Dec. 2° 39′ S.; P. 67°; D. 28″; mag. 8, 11. Mr. Webb has mentioned several doubles lately, and as this is not in his "Celestial Objects," and, at the same time, from its close proximity to the 6 mag. star B.A.C., 4941, it can be easily found, he will pardon my mentioning and calling his attention to it. The B.A.C. only gives one star near π Hydræ. It is B.A.C., 4671, 5½, and lies 4 minutes (of time) P. 45′ S. π Hydræ; the next nearest star is B.A.C., 4650, 6 mag., which lies 5m. 26s. (of time) P. B.A.C. 4671, and 13′ S. of it. **T. E. Espin.**

OCCULTATION OF A SCORPII.

[14355.]—I recently had the pleasure of witnessing an occultation of A. Scorpii, and, thinking it might interest some of the readers of the English Mechanic, I venture to send a short account of it. The telescope I employed is a 6½in. equatorial reflector by G. Calver, of Widford, which I received in fine order after coming half round the world. Up to the time of disappearance I had a fine view of the small 7th magnitude companion to Antares, employing a power of 300 upon the 6½in. mirror. I watched the small star to the moment of disappearance, which occurred about six seconds before the primary—disappearance, March 23, 2h. 53½m., Greenwich time; reappearance, 3h. 52½m. While on this subject I may state that in January, 1877, while watching for the reappearance of this star (without the aid of a telescope), I noticed rays shooting out from behind the dark limb of the moon for fully three seconds before the star reappeared.

In Mitchell's "Popular Astronomy" it states "that immersion from occultation is instantaneous;" I would therefore feel obliged if any of our astronomical correspondents could inform me whether these rays are generally seen before the star emerges. I am positive it was not an optical delusion, as I was not aware the star would reappear at that instant.

The white patch near Picard, to which reference has been made in the English Mechanic, seems to me to be smaller during the wane than it appears a few days after new moon. I have sometimes thought it appeared raised above the general surface of the Mare.

Auckland, New Zealand, **J. T. Stevenson.**
April 2.

ANCIENT GLACIERS OF FRANCE.

[14356.]—Some investigations have been lately made concerning the ancient glaciers of France. That of Oo, in the environs of Luchon, Haute Garonne, has left on its passage a considerable quantity of erratic blocks.

The remains of this glacier extend from the crests that dominate the left bank of the torrent of the Arboust on the south; on the north they are limited by the valley of Oueil; on the east they are arrested at Peyresourde; and at the west by the confluence of the torrents of the Arboust and Oueil at Cape St. Aventin. The blocks are spread over the region, and also heaped up at certain points. In some places they have been concealed by the finer débris; but, in the inundation of [illegible] that passed over the promontor finer matter which formed the soil of the meadows of Gorin, and brought to light an enormous accumulation of blocks. All the bottom of this valley had been filled by the débris of the glacier, and at St. Aventin the Department of Bridges and Roads made a vertical cutting of more than 20 metres height in the deposit.

With few exceptions the blocks are granite from the crests of Oo; some are calcareous from the Pic Quariat. The largest is on the talus of Oo, under the chapel of San Triton, and measures 96 cubic metres. By the side of it is one of 30 cubic metres, and another 24. The last is immediately under the village of Oo, resting upon some small edges, and looks as though a slight concussion would precipitate it to the bottom of the talus, to prevent which the inhabitants place wedges of wood, which are carefully renewed.

The most elevated blocks of this middle region are at Port de Sainreste, at about 1,900 metres altitude. Taking this point and the village of Oo to calculate the thickness of the glacier it would be found at about 1,000 metres.

The vestiges of glacier action in the middle basin of the Rhone are of great interest, as showing a totally different climatic régime existed in Europe to that under which we now live, and that it has exercised a very considerable influence on the profile of that part of the Continent, as well as the disposition of the alluvium that covers vast extents of it. Erratic blocks are the most frequent vestiges of the glacier action. They are sometimes spread out, and sometimes accumulated as moraines.

These blocks are not confined to the mountainous regions. They extend over part of the south-east of France, and present very interesting characters. It was not until 1858 that their presence was attributed to glaciers that had invaded the valley of the Rhone as far as Lyons, Bourg, and Vienna. Ten years afterwards the colossal proportions of these glaciers were recognised. At Culoz, Chambèry, and Grenoble their thickness approached 1,000 metres. This mass of ice was encountered by another branch of the Rhone glacier, which in one part, by a back turn under an angle of 45°, remounted to the north in place of descending towards the south, and in the other part invaded the great valley of Switzerland by debouching into that of the Rhine. Quitting the mountains of Bugey and La Chartreuse, in which the great glacier pushed out branches, encountering the small local glaciers, the higher level of the ice lowered itself constantly towards the west into the midst of the plains of Dauphiny, the Lyonnais, and Dombes. In Bas Dauphiné a kind of sill of molasse opposed itself to the progress of the ice southward, and forced it to direct itself towards Bresse.

From Bourg to Vienne, Thodure, and beyond, the terminal moraines of this immense glacier, spread out like a fan, can be followed. Its vast perimeter was comprised between the Alps of Savoy and Dauphiny on one side, and on the other between the mountains of Beaujolais and the Lyonnais. The passage of the ice is attested by striæ on the rocks, by masses of striated pebbles, and by the erratic blocks.

John J. Lake.

MICROSCOPICAL.

[14357.]—I REGRET that I am unable to give "Simian" any definite information regarding his question (letter 14280) about the behaviour of Zeiss's new oil-immersion lens on Nobert's lines, because I do not possess this valuable test object. I may say that Mr. Zeiss wrote me some months ago that the new oil-lens would easily resolve the 19th band by lamplight, modified by blue glass, and seeing that a number of good water-immersion lenses have resolved this test, and judging from the brilliancy and ease with which the oil-lens resolves the finest diatomaceous tests by lamplight, there seems little room for doubting that it will not only resolve the 19th band of Nobert's lines very well but also easily—at least it ought certainly to do so as the oil-immersion objective is essentially a resolving lens.

"Simian" may also obtain excellent unilateral reflected light by means of Dr. Edmunds' immersion paraboloid, by placing a stop under the same, which will admit only a marginal set of rays ¼in. long. With my F. H. Wenham's new binocular arrangement for high powers, which I described in No. 144 of *Science-Gossip*, December 1, 1876, I can see the finest lines on any diatom quite distinctly in both bodies, and probably with less loss of light than with any other binocular arrangement for high powers. Why do Messrs. Ross and Co. not make more of these excellent high-power prisms? Some of my friends have asked for them and have not been able to get them.

Glasgow, May 11. **Adolf Schulze.**

ON THE MEASUREMENT OF THE APERTURE OF MICROSCOPE OBJECTIVES.

[14358.]—I CANDIDLY admit that Drs. Nickols and Bull have carried on their argument with myself in the most courteous manner, and without the least tinge of any of the jealousy of partisanship. I feel that the correspondence has been conducted in a friendly spirit, and regret that I have not had the opportunity of expressing myself to this effect personally. I have now to say a few words in conclusion.

It is an absolute fact, of which every one must be certain, that if a lens is half obscured or cut across the optic centre, that transversely to this line from the semi-diameter, half the light, half the pencilled rays, and half the angle of aperture, are all equally destroyed. But this fact is not shown by the usual method of measurement, because the axial ray is beyond the obscured half nearly to the extent of the field of view. This is the direction of rays of greater obliquity, which, I for years have maintained, give false measurements of angle of aperture. It is a very easy matter to obscure half of a microscope object-glass in this way. Take a small piece of tinfoil with a clean-cut edge. Lay it on a glass slip and smear its upper surface with a bit of dry soap (nothing moist must be used, as it will bedew the glass). Lay this on the microscope stage, and bring the edge in focus under the object-glass, till it exactly bisects the field vertically, then lower the object-glass (which must have a flush front) on to the foil, which will adhere to the front lens. The microscope body may then be laid horizontally, and the apparent aperture of the open half of the lens measured by the sector, which invariably indicates considerably more than half of the full aperture by the same method.

Take an inch object-glass, unscrew the ferrule that protects the front (which is generally then flush with the setting). Obscure one half by an adherent piece of foil as above described, raise the glass, and observe any ordinary plain object on the stage with the open half only. There is no diminution or cutting off of the field, the whole of which is equally illuminated and the object so well defined that a casual observer would not by any means suspect that half the object-glass was stopped off. Continue this with others, and it is not till we come to the highest powers that there is a slight shading off on the margin at the obscured side, and even these objects are seen to the full extent of the field of view.

Now, I ask, where in the name of common sense do these oblique rays come from, unless from the open half of the lens? Such an obvious fact needs no reply. A true measure of half aperture would show total obscurity in one half of the field, and consequently appear as half of the whole aperture as taken by the sector. But it does not, simply for the reason that the rays up to the bisected axis of the half that is stopped off, extend away behind this obscured half, giving a most considerable addition in measured degrees to what we positively know must be only a half aperture up to the axis, and knowing this we feel assured that this is a quantity in excess of angle proper, and, being a surplus beyond the half of the full measured aperture, must be deducted, otherwise twice the measure, or the double of this half lens would give absurd and impossible apertures.

This gives us the key for eliminating the oblique rays, extending to the margin of the field of view, that are measured as angle of aperture, causing very great error in excess. The rule is this: Subtract the measurement by the sector of the degrees shown by half the lens from the degrees of the entire lens, taken by the same means, and twice the difference is the aperture, provided the axial ray extends to the margin of the field of view, which probably it does.

By this simple rule we eliminate the angle of field, which has hitherto been superadded to angle of aperture, and which I have not hitherto been able to separate satisfactorily by stops, stage appliances, or other optical means. The application of this rule will be thoroughly investigated. At present I will only give its test on what I have repeatedly stated to be fabulous apertures—viz., 180°. No object can possibly be seen at such obliquity, and yet one maker boldly engraves this as the angle on his object-glasses, an assertion that would startle us with its mendacity were not light to be seen through at the extreme of 180°.

I have one of these objectives, a tenth of the so-termed 180°, yet in ridiculous disproof of such an aperture (which would bring the focal plane on to the surface of the front lens) it is remarkable for its working distance, and will penetrate through the cover of any object in my cabinet, and with thick covers, whether used as immersion or not, for clearness and definition its performance is very fine. Taking by the sector the open aperture, or what I will term angle of field as 180°, I find the aperture of half the lens is 115°, twice the difference is 130°. This represents the degrees of the central pencil or the true aperture. I take another example of an immersion lens, in which the maker actually claims plus 180°, but on trying this by the sector, the light image vanished at a range of 178°, beyond which it was totally obscured. The aperture of half the lens was 114°, twice the difference is 128°.

With these remarks, I beg to close the controversy with Drs. Nickols and Bull, kindly thanking them for their politeness. They again assert, without further explanation or modification, that half an object-glass, as bisected across the axis, shows by measurement only half the angle of aperture. I state that by the usual mode it shows much more. Some experience in controversy has shown me that when it arrives at this pass it becomes wearisome and even painful to impartial readers to witness the efforts of one side hopelessly attempting to convince the other, and as an individual dispute it ceases to have any public interest.

F. H. Wenham.

[14359.]—THE question of the angular aperture of the object-glasses of microscopes is an intricate one. It involves so many nice questions when the various media have to be considered, through which the pencil of rays may pass after it has traversed the objective, that we resolved, in a kind of despair, to try what we could learn from the object-glass alone as to the pencil of rays which it is capable of admitting per se, unmodified by passage through glass slides, water, balsam, or even, which may seem somewhat to modify the angle, the eyepiece.

It occurred to us that, if a minute opening were placed in the focus of an objective having a convex lens behind it, to give a telescopic view of objects in front, the limits of the field of view would give the air-angle of the glass, plus any trifling error which might be due to the admission of extraneous rays through the pinhole.

To test this idea we constructed a simple apparatus, consisting of two thin pieces of wood, glued together at a right angle. One of these, which we will call the floor, is horizontal, and has a groove in which the objective is laid, and kept level by a support of proper form and thickness put under its forepart. The other piece of wood is upright, and is pierced by an opening in which the face of the objective appears, like a miniature cannon looking out of a porthole. It is furnished also with springs to hold slides with apertures of various diameters, or slits in a dark ground, in the focus of the objective. In front of the porthole is fixed a sector, in black and white, of about 2½in. radius.

If now an object-glass is laid on the floor of the apparatus, its front lens being at its focal distance from the external surface of the porthole, with a pocket lens of 1½in. or 2in. focus in its rear, giving a telescopic view of objects in front, what we have called the supposed angle of the glass will be easily read upon the sector; and it will be observed that this will be increased or lessened as the objective is moved behind or in advance of its focal distance from the front of the porthole, which corresponds with the base of the sector.

The method, so far, is substantially the same as one published in the *Microscopical Journal* more than 20 years since. But if now we place in the focus of the objective a round aperture of, say, 1-100th of an inch, there will be, of course, a considerable lessening of light, and frequently, especially with higher powers of angle, read as before upon the sector. But what does pass must be, if not absolutely yet almost absolutely, pure angle, for the aperture is too narrow to admit more than a trifling amount of extraneous rays.

It is found that, with some glasses, the divisions of the sector are read clear to the very extremes of the field of view. With others there is more or less obscurity about the outer rays, which is probably due to spherical aberration. The apparatus acts, therefore, to a certain extent, as a test of the correction of the objective.

Of course, the higher powers, with short foci, require smaller apertures; but a limit is soon reached beyond which no further reduction of the angle can be effected by lessening the aperture, even by substituting for it a slit of 1-2000th of an inch in diameter. This fact gives confidence in the results of the method. When lessening the aperture produces no further diminution of angle, we may safely conclude that all extraneous rays have been eliminated.

Immersion lenses can have their angles measured by substituting narrow slits in a black ground covered with thin glass for the apertures. We have sent a sample of the apparatus itself to Mr. C[illegible], of Holborn, who, no doubt, will kindly show it to any one who might wish to see it.

The method is rather a combination of the suggestions of others, than one for which originality can specially be claimed. It requires care in being carried out. The two points to be specially attended to are that the aperture must be in the optical centre of the objective; and that the outer edge of that aperture must be the part in focus.

Richard Nickols.
Jersey, May 16. **Martin M. Bull.**

HISTOLOGY.

[14360.]—I QUITE agree with the wish of one of your correspondents to have another side of micro matters discussed—viz., those relating to injecting animal tissues, and the kind of objectives most suitable for examining them. My experience up to the present time is, that if you want a really good preparation the better way is to buy it already done by a professional mounter. I do not quite agree with those who judge a microscopist by the number of bought specimens in his cabinet. To those who

would ask could they do better? I
jority would come off badly. It has
ked for an easy method of injecting
ı afraid there is only one way, and
:tual experience. A carpenter may
ovetail joint, and give you the same
and the same tools that he used, and
ud you cannot do what he performs
ıd so it is with preparations. The
ach I have personally made up to the
ollows. I wish to open the discussion
cts with the hope that others will give
ce.

out the ovary from a hare. Having
hand at the time I could not inject it
always be done first). I placed it in
o or three weeks to harden. Dilute
night have been used with advantage,
stance it was not. Having found it
sufficiently hard, I flooded the specimen
with a Valentin's knife made several
ansferring and spreading the sections
slide, now, dropping on a solution of
ammonia, allowing same to evaporate
rmth, then with Canada balsam com-
.de. With respect to working with
m I was puzzled a long time until I
dissolvent, and this is benzole. Of
form would do; but, besides the trouble
owing to the new Act, it is so expensive,
ained you want it for other purposes.
which is cheap, you can make balsam
: wish, and so avoid heating and air
also does for damar and asphalt, but
ging a flame near. Now, although my
bad, they sufficiently show that I am
o succeed. They are broken up into
e clear as possible and no bubbles, the
being that they do not show anything
of an ovary. I can find no trace of a
. This may arise from it not having
The next trial I mean to vary it, and
ardening (we seem to lose colour by
and others I shall inject with carmine
Baker supplies a convenient syringe
se, with three small movable nozzles.
with me in this process arise from the
he vessels when pressure is applied;
a tedious one. In cutting the har-
I shall try it under water, and float
as described by Rutherford.

se trials can it be wondered at that we
ack to our prepared slides and appre-
have one by Needham, a section of a
an fœtus (6 months) quite beyond the
t is destined to be the bones is well
certain points there are clots sur-
lls, from which the changes are going
artilage. Further on the cartilage is
d. The principal muscles are well
another section, evidently the same sub-
ar the sole of the foot, shows these
ıtifully. Another slide shows cartilage
ification. Being outside the profession
uld I have to wait for subjects like
uld not forget to mention a section of
a horse. The white substance appears
ic cable, with all its wires and insula-
s subject the nerves are much more
ed than in human spinal cord.

the *Lancet*, April 27, 1878, "A new
tion-cutting by means of ether spray,
h, which appears worthy of notice. A
er has a solid cylinder of copper, sur-
t, fitted into it. Take a small piece of
flat surface, drop a very little strong
ıd of the copper, place the tissue upon
pply the ether spray. The tissue will
seconds and become firmly attached
block. The spray should be passed
, and then the wooden cylinder being
t hand, sections may be cut by the
usual way. Frozen tissues are so
razor may be made to cut section after
y, and extremely thin sections may be
out difficulty. No microtome is neces-
great dexterity in section cutting is

ned much information from Dr. Lionel
"How to Work with the Microscope."
third edition second hand it is not so
he later one. All his works are good
ding.

occasion I hope to have something to
jectives suitable for the above work.
be diatom-dotters. Theo Izod.

FERMENTED BREAD.

ı letter 14316, "Physician" asks
ic acid is used in the manufacture of
d, and if common air would not
well?" Carbonic acid gas is used
r absorbs it to a greater extent and
y than common air, hence its use in
s, wines, &c. As the carbonic gas
om the aërated water of the dough
g, the bread becomes vesicular and light. It also promotes the soaking or cooking of the bread. In aërated bread only pure wheaten flour is used, as any admixture of potatoes, beans, or alum would interfere with and prevent the successful working of Dr. Dauglish's process, which is dependent for success upon the elastic gluten of wheat, which preserves in aërated bread all the nourishing and digestive qualities of the wheaten flour in their natural state. In fermented bread on the contrary, alum, potatoes, and beans play a very important part, both in respect of colour and cheapness. The potatoes and beans assist fermentation, and alum improves the colour, and hardens the weak glutens of inferior flours.

The Secretary of the Aerated Bread Company (Limited).

2, Whitecross-street, London, E.C., May 15.

[14362.]—I HOPE some one practically acquainted with its manufacture will come to the rescue of aërated bread, and defend it from the charge "A Physician" quotes against it—a chemist having found in it "the mould of potatoes and beans, and alum." A description of the processes of making might remove some of the popular delusions respecting it, and throw light on the interesting question of "A Physician," as to why CO_2 should be used in preference to common air. There might be no more reason for it than the general tendency of mankind to work in a groove, thus: (1) By the yeast process, carbonic acid gas is generated by the fermentation and lightens the bread in escaping during baking; (2), the reformer (Dr. Whiting, or whoever it was) who doubted the expediency of starting incipient rottenness in bread, just to make it light, would naturally cast about for *some other source of* CO_2 instead of *another gas*, and, lighting on the HCl and $NaHCO_3$ process, found it answer very well; and (3) when on the large scale, and to save expense, it was found advisable to generate the gas separately and force it into the dough, still conservative instincts would prompt inquiry after *cheaper carbonates* and acids instead of a "new departure." But perhaps the solubility of CO_2 in water, and its easy expulsion by heat, with its peculiarity of escaping gradually in great numbers of small bubbles (effervescing) is the cause of its use. What does "A Physician" understand the chemist to mean by the "mould" of potatoes? I imagine the mere use of potato or bean meal would not be injurious. The "alum" is, of course, a serious charge, and I hope it may be disproved. As a specimen of the delusions current about aërated bread, I have heard it stated that vitriol and chalk, or whiting, are put in it! Perhaps these are the materials used in generating the gas; but I wonder what sort of bread would result from putting them *into* it!

How many "Aërated Bread Companies" are there at work? You see "dépôts" in most parts of London, and can get the bread in many provincial towns. Yet I suppose the requisite machinery and plant are pretty expensive. Thanks to "A Physician" for his correction of the erratum "13lb.;" he will see mine on the next page to his letter. **Daghbert.**

TELEPHONIC.

[14363.]—WE have heard so much of the telephone lately that I must apologise for writing about it, yet I have done so because I think I can say something new about the reason why it speaks. My idea is, that it speaks through sympathetic action of the diaphragms at each end of the line, which sympathetic action is caused, not by undulatory waves of electricity, but short intermittent strokes corresponding to the disturbing element—*i e.*, the voice or sound. Let me explain: 1. In St. Thomas's Church, Douglas, there is some panelling. Now, when the organ is played on certain notes there are two or three panels give out sounds. These panels are only affected by notes in sympathy with the note given out by them. Thus, one panel sounds to, say, the note C, another one to F♯, and another to E. These sounds can (or could a short time since) be heard on the north gallery of the church.

2. If we sing in a room where there is a piano, the piano will emit sounds corresponding to the pitch of the voice.

3. If there are glass ornaments or vases in the room they will answer to certain notes sung or spoken in the room.

Now, you will ask, what has all this to do with the diaphragms of the telephone? Simply this: In the circular plate we have every note of the scale within certain limits. Take a pin and tap the plate in the centre, and you have the lowest note of the telephonic scale. Now tap nearer the edge, and you have a higher note. Nearer still, and the note is higher still; and so on to the extreme edge of the plate. Now, by the attraction of the magnets, the plates are rendered extremely sensitive to sympathetic action, and when a certain note is sounded on one plate, the note on the other plate corresponding to it is emitted through sympathetic action produced by the disturbance of the electrical condition of the plates. Thus, as we have the notes of the scale on the plates, any sounds within the range of those notes can be produced by sounding them on either of the plates, and thus the telephone speaks, &c.

Crosby, Isle of Man. **W. C. Lockerby.**

P S.—If this theory is correct, the powers of the telephone are almost unlimited as regards loudness of tone, &c. I shall be glad to have the opinion of my fellow-experimenters in electricity.

THE MICROPHONE.

[14364.]—I HAVE just made some of the experiments described in the paper by Prof. Hughes, which is published in the current number of the ENGLISH MECHANIC, and the results are simply astounding. The most effective arrangement which I have tried is the following: Two small blocks of gas carbon, about a cubic inch in size, were fixed to the bottom of a thin wooden box, in such a manner that when the box was placed on end one of the blocks was about 1¼in. above the other. A small hole, ⅛in. diameter and ¼in. deep, was made in the under side of the top block. A piece of electric-light pencil, a trifle over 1¼in. in length, was then taken, and pointed at both ends. One point was inserted into the hole in the upper carbon block — the other was allowed to rest upon the flat surface of the lower block. The following connections were then made: — The upper carbon was connected with one pole of a small battery, and the lower carbon with one of two line wires; the second line wire was connected to the other pole of the battery; and to the distant ends of the double line wire was joined an ordinary Bell's telephone. This ridiculously simple apparatus is far more sensitive as a transmitting instrument than anything I have yet seen. The lightest touch with a camel's-hair brush, not merely on the instrument itself, but on the table on which it stands, produces a loud scraping sound. The tick of a watch is transmitted with undiminished loudness, and that of a clock several feet distant from the microphone is easily heard. Whispers are quite audible, and generally intelligible, though accompanied by a sort of buzz, which is somewhat annoying. My last test was this: Having placed the microphone on a table 10ft. away from the window, I went out upon the balcony and made a few remarks in an ordinary tone. Every word I said was distinctly heard at the distant station. The whole preparation of this experiment occupied about half an hour. **Shelford Bidwell.**

MECHANICAL POWER ON STREET TRAMWAYS.

[14365.]—I HAVE long been surprised that the subject of mechanical power on street tramways has not been discussed in the columns of your valuable paper, as there cannot be any doubt in the mind of any engineer that tramways will eventually become a most important feature of locomotion, not only in the midst of our large towns, but as "feeders" to the great main lines of railway. It is well known that, when railways were first introduced, great opposition was raised against locomotive engines. We can all see the great perfection to which locomotives have been brought. In the present day the same opposition is being made to locomotives on tramways, and I fail to see why a tramway locomotive cannot be brought to the same perfection as the railway locomotive. I hope to see a discussion in the ENGLISH MECHANIC on this most important subject by your engineering correspondents.

Tramway Engineer.

KNAPSACK TOURS.

[14366.]—"J. J. M." (letter 14314) is quite right when he describes the delights of these tours; his suggestions on equipment may be followed with confidence. Can he, or any of your readers, give any information about the knapsack itself? Has he tried the new one now being adopted in the army? I am told the soldiers prefer it to the old one. My experience of the old one is, that I should like something which allowed more freedom to the arms. I believe the cost of the new regulation knapsack, complete, is 7s. 6d. If I knew where one could be bought at this price, I should be inclined to invest by way of experiment. Perhaps the makers or vendors will take the hint and advertise in your columns. **R. G.**

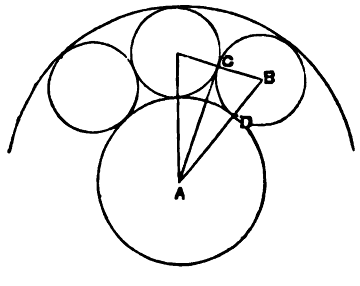
HANDRAILING.

[14367.]—ALLOW me to correct an error in my letter on "Handrailing" (No. 14272, p. 191, No. 684). Instead of "cube" read "prism." Also read "semiconjugate" for "semicongregate," and "plan" instead of "spin." Of course these mistakes are obvious to any reader acquainted with the subject. **Concoil.**

[Very likely, but the corrections are almost as illegible as the original MSS., and we are not sure that they are now quite right. Correspondents would add greatly to the value of their communications by writing very plainly all technical terms.—ED.]

THE MATHEMATICS OF THE ROLLER BEARING.

[14368.]—Perhaps the following little proposition may interest some of your bicycle-riding readers. It shows how to find the diameter of rollers when the number of them and the diameter of the axle are known.



In the figure the larger complete circle represents the axle, and the smaller circles three of the rollers. Let a = diameter of axle, n = number of rollers, x = required diameter of rollers. Then C B = B D = the sine of the angle C A B to radius A B; and it also equals ½ x; in like manner A D = 1 − sin. C A B = ½ a ∴ a : x :: 1 − sin. C A B : sin. C A B. But the angle C A B = $\frac{180^\circ}{n}$. Hence we have the following rule to find the size of rollers in any case:—

$$x = a \times \frac{\sin. \frac{180^\circ}{n}}{1 - \sin. \frac{180^\circ}{n}}.$$

F. Piper.

BICYCLING MATTERS.

[14369.]—"Ajax" (14306) is quite right in his idea of the real motion and action of the rollers in a roller bearing, but he must remember that the rollers fit very closely to each other, and grind and rub their fellows exceedingly as they are forced round to take up their alternating position at the top. On the whole I think that, although they do run a little easier on account of the rolling surface presented to the axle, they are not worth the extra expense and complication. I think Carver's hollow spokes very good, but if they could be drawn solid, as Druce draws out his steel backbones, they would be much improved, as at present they have a longitudinal division which allows the water and damp air to get in, and so rust away the interior. I believe plain rollers superior to cycles, as they do not wear shaky so soon, and there is very little difference in their running. Out of the fourteen varieties of roller bearings now in use I prefer Sibert's patent dumb-bell rollers and self-lubricating axle-box, which no doubt some of "ours" have not yet heard of. They are constructed as follows (see Fig. 1):—The axle-box is in two halves, like an ordinary Sheffield plain bearing, and is made very deep; inside this a loose double collar is placed, which is slightly smaller in its outer diameter than the box, and a little larger than the axle in its inner diameter. These collars are pierced with five pairs of slots opposite each other, into which the rollers fit. These rollers are exact miniature dumb-bells, and so constructed that the balls at the ends just fill the space between the axle and box, so that all the running is on the balls, the collars serving only to keep them apart. By making the axle-box so deep a large quantity of oil can be put in them, and they are guaranteed by the maker to run 3,000 miles without one oiling.

FIG. 1

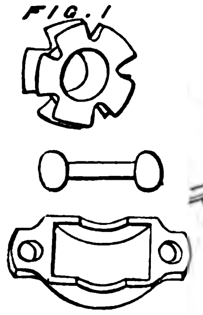
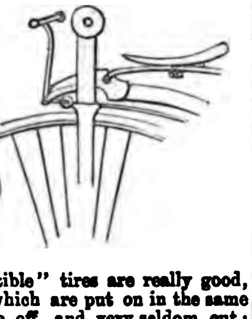


FIG. 2



Grout's "Indestructible" tires are really good, as also are Tupper's, which are put on in the same way. They never come off, and very seldom cut; the only objection to their use is, that a special spoke must be used with them, as they cannot be taken out to replace a broken one. The adjustable crank will be fitted by any maker at a charge of £2 2s., but it doesn't work easily, and when down is hard to get up again.

I think "X. X." (14308) is wrong in supposing backbones are made stronger than necessary. If he watches a friend's machine when riding over a rough road he will quickly see the strain which is brought to bear on that part. How is it, also, that we so often hear of backbones breaking off beneath the saddle? I myself know several instances in which this has happened.

"X. X." seems to put a good deal of faith in back bearings, but in my opinion the kind of bearings has very little to do with the running of the machine, provided they are not too tight, and are well oiled. I was riding with a friend last week, and he always went ahead when we let our machines go down hills. He rode a 54in., with plain bearings, whilst mine was a 56in., with roller bearings. His machine was a pound or two heavier than mine, but, on the other hand, I was the heaviest rider of the two. On thinking over the matter I came to the conclusion that the reason I was left behind was that I rode a higher machine and was some inches taller myself. I therefore presented a larger surface to the wind, which in my opinion was the cause of the difference, the bearings having nothing to do with it.

As I always ride in shoes I fancy "X. X.'s" style of brake (using the instep) would hardly suit me. The three brakes best to my liking are Simpson's "Safety Slipper" and the "Safeguard," both of which are ground brakes, and perfectly safe, as they are applied full power should the cord break; they also do not wear the rubber in the slightest. The other is a front-wheel brake, and, as many readers of this paper have no doubt not heard of it, I append a sketch (Fig. 2). It is called the "Reverse-action" brake, and is fitted to the "Superb." It is applied by pulling with the fingers of one or both hands, by which an enormous power can be applied, and at the same time the slightest unevenness of the road or wheel felt. In order that it shall not chill the fingers in cold weather, and to afford a better hold, it is fitted with a pair of very small horn handles.

56in. Superb.

[14370.]—I see our friend Mr. Striffler has come forward with a little more of his valuable information, and I trust he will give a letter on this year's machines. What does he think of Carver's hollow spokes? I saw one in a shop here in Bristol. They appeared to have an open seam along them; if so they certainly cannot be better than the solid ones, as the power of the latter to suspend would be the same, and I much doubt if it would stand more in a tangential direction, with an open seam. I see he has a very secure treadle by having notches in the back of crank. Have any of "ours" tried the patent shifting saddle, made by a Manchester firm, attached to the spring by links to move on pivots? When riding on a level road the links are in a line with the spring, keeping the saddle close up to the handles, but, when going down hill, by lifting the saddle a spring throws the links over half a turn, thereby shifting the saddle back twice the length of links. Do any of the makers use very fine wire, tightened by being wound upon screws in the hub of wheel? Could Mr. Striffler, or any reader, explain the manufacture of the weldless steel tube; what is the smallest size of journals makers use to front and back wheels, and distance apart of hubs, for a 52in. roadster? What of Mr. Striffler's roller bearings?

Young Mechanic.

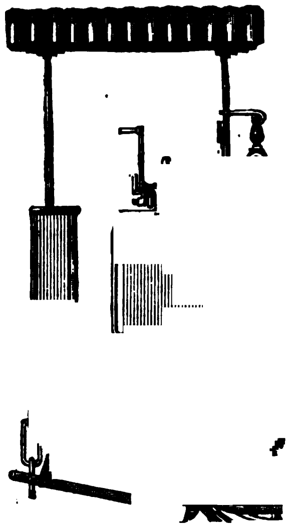
TANK LOCOMOTIVES FOR MINERA LINES.

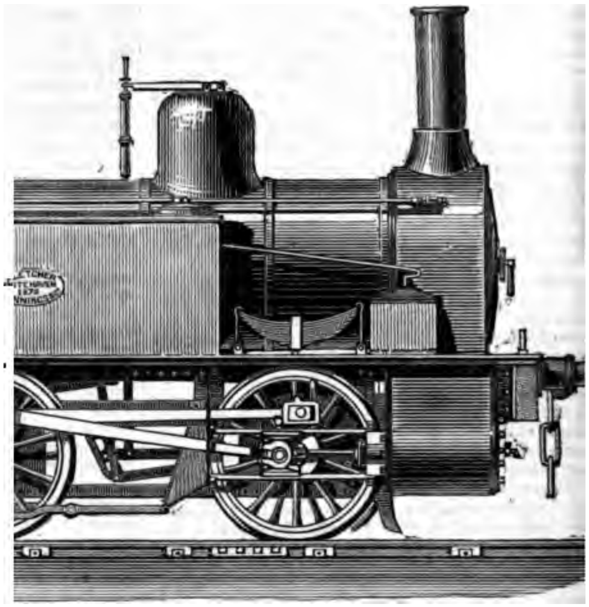
[14371.]—Tank engines for colliery and oth branch lines have not received much attention fro your correspondents; this is, no doubt, due to t fact that little improvement was made in their co struction. For many years it was a common pra tice to use any "old engine" for colliery a mineral lines, and also for shunting. But it h now become an established fact that it is far mo economical to have new tank engines special designed for this work. The drawing shows a fou wheeled tank engine of the new type, as improv by Messrs. Fletcher, Jennings, and Co. In the engines the materials and workmanship are of t same quality as in engines constructed for main-li traffic. The following are the chief dimensions this engine:—

	Ft.	in.
Diameter of cylinders (13)	1	1
Length of stroke (20)	1	8
Diameter of wheels	3	6
Wheel base	7	6
Length of boiler barrel	8	0
Diameter of boiler	3	4
Length of fire-box (copper)	3	4
Width of fire-box	3	0
Number of tubes (brass) ...	180	
Diameter of tubes	0	1½
Extreme length over buffers... ...	21	0

Weight of engine (empty) 18 tons.

The water-tanks hold 530 gallons, and the co bunker and the spaces at the ends of the tanks carr one ton of coal. The boiler is fed by two Giffard'





injectors, and the engine has all the usual fitting such as steam and water gauges, a Roscoe's lub cator, oil-cups, &c. In this particular engine t brake can be applied either by hand or by stea Other engines of a more powerful type are also und construction.

May 14. **C. E. S.**

G.W.R. LONG RUNS, &c.

[14372.]—In "Replies to Queries" (32558) of yo last number (Vol. XXVII., No. 685) of May 10 "H." mentions as the longest run in England wi out a stop, that of the 9 p.m. limited mail (ex Paddington, which, he says, runs through fr London to Bath (106¾ miles) without a stop. No as a matter of fact, I may tell him that this tr stops 5 times between the two places on the do journey, and 4 on the corresponding up one—4 for mails only, not being timed for passengers at al Now, can any of your readers explain the rea why the down mail stops at Didcot, whilst the u one runs through that station? Its stops are a follows:—

Down.		p.m.	Up.		
Paddington	dep.	9.0	Bristol	dep.	
36m. Reading	(a)	9.50	Bath (11¼ miles)	(a)	
—	(d)	9.52	—	(d)	
53 Didcot	(a)	10.19	24¼ Chippenham	(a)	
—	(d)	10.20	—	(d)	
56½ Steventon	(a)	10.27	41½ Swindon	(a)	
—	(d)	10.29	—	(d)	
77¾ Swindon	(a)	11.0	62 Steventon	(a)	
—	(d)	11.5	—	(d)	
94 Chippenham	(a)	11.30	65½ Didcot	pass	
—	(d)	11.32	82¾ Reading	(a)	
107 Bath	(a)	11.55	—	(d)	
—	(d)	11.57	118½ Paddington	arr.	
108½ Bristol	arr.	12.20			

ıx.) King's-cross, therefore, makes the
the kingdom—namely, to Grantham
cross), 105½ miles. But I was once
.R. driver that they occasionally had
ərborough in bad weather, with strong
ɔr water; and I have myself proved
f his statement, for one day last year,
he "Flying Scotchman" from King's-
20 minutes late at Grantham, there
igh and adverse wind at the time, by
ch we had to stop 2½min. at Peter-
ater. The engine was one of the 7ft.
I am not quite sure of the number, but
it was 267, load 10 coaches. As "H."
R. certainly run the largest number
trains, and not only the fastest
e might likewise add that they
exceptionally long runs compared
s, very few of them stopping between
eterborough. A G.W.R. driver once
bad weather he experienced difficulty
m Oxford to Paddington without a
.m. express from Oxford to London
mpton). How much for the truth of
er? **Prometheus.**

JOUS BRAKES—BARKER'S HYDRAULIC.

was quite unnecessary that I should
articulars about Barker's hydraulic
Midland Railway in my letter upon
' F. D. T." (page 220) will see that
reviously, page 148, I had mentioned
ker's brake being used between Bed-
ncras, and Bedford and Northampton

these trains consisted of an engine,
riages, and 2 vans, and it was the
Barker train" at the Newark brake
1875, after which it ran several local
short branch lines near Derby. In
train was stationed at Bedford, and
June it commenced to run to London
. During the latter month another
coaches were similarly fitted. This
n between Bedford and Leicester for
d for more than a year and a half it
ing upon the Bedford and North-

' (page 220) quotes the *Times* of
, 1876. Barker and Co. wrote to the
that they had stopped a train at 50
in 15 seconds, within 200 yards. It
inquiry that the speed had only been
50 miles an hour," and that the
inaccurately taken. Another trial
made with the same train on the
line before a party of engineers, a
r" and stop watches were used. It
sively proved that the first trial was

een rumoured that the two Midland
2 and 135, have Barker's automatic
not so. They have the No. 2 brake,
matic, and does not fulfil the Board
ons.

ention in conclusion that the evil-
who disabled this brake by sticking
e of the brake tubes a short time
nately, not yet been detected.

C. E. S.

IS DUE THE ACIDITY OF BICHROMATES?

difficult to find amongst the metals
ore interest than chromium when in
ith other elements and radicals.
with oxygen, forming (1) chromium
O_3; (2) chromium sesquioxide,
omo-chromic oxide, $CrOCr_2O_3$; (4)
ide. We have also reasons for
ill higher oxide.

oxides are basic, and yield corre-
es and salts; the third, a neutral
ding with the magnetic oxide of iron;
orms an acid with water.

in writing is to obtain the opinions
sted in chemistry on a subject that
attention for some time—viz., To
acidity of the bichromates? When a
ssolved in water, the solution is acid.
ue to free chromic acid passing into
$M'_2Cr_2O_7 = M'_2CrO_4 + CrO_3$, and
H_2CrO_4. This view seems to re-
m the following facts:—(1) If to a
ichromate, sulphuric acid is added,
boiled, oxygen is set free, thus:—

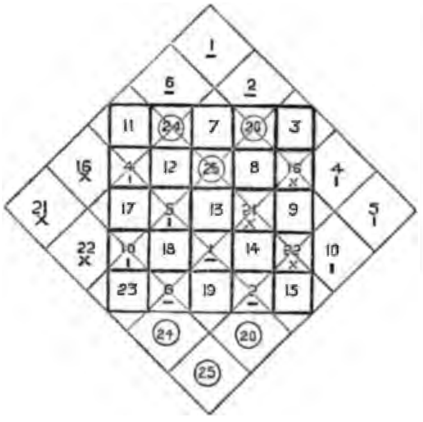
$$SO_4 = \overbrace{M'_2SO_4,\ Cr_2 3SO_4}^{\text{chrome alum}} + O_3 +$$

dding CRO_3 to sulphuric acid, oxy-
ree. (3) If the solution of bichro-
trated, we obtain CrO_3 on the addi-
lphuric acid (in excess). A part of
d combines with the monad element
M', giving $M'_2SO_4 + H_2CrO_4$, and
$H_2CrO_4 - H_2O = CrO_3$. I offer these views to the notice of the impartial chemist, trusting they may be worthy of some notice.

Holloway, N. **Fredk. W. Streatfeild.**

A CURIOUS FIGURE SQUARE.

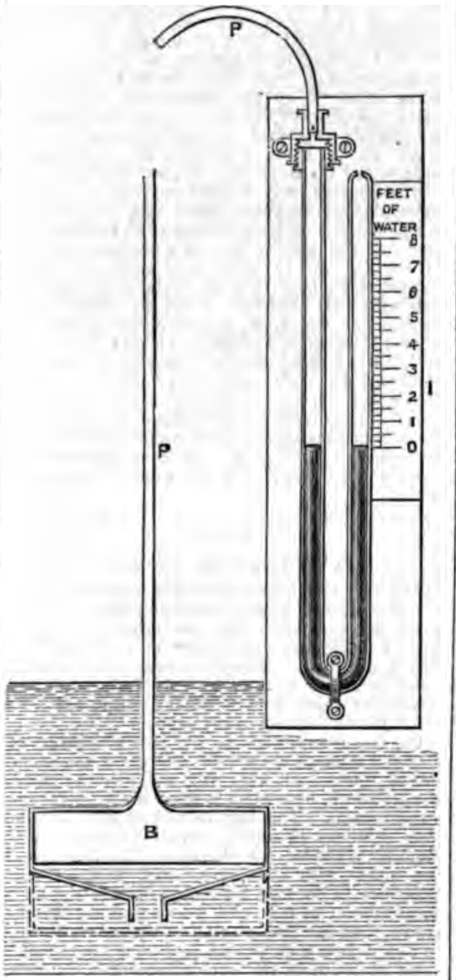
[14375.]—What is the principle of the following curious fact? Take an odd number (see diagram), say 5; make two squares as per diagram, number the top square of the larger square 1, and the others in order up to 25. Transfer the numbers at the top of the large square, 6, 1, 2, to the bottom of the small square; those at the bottom, 24, 25, 20, to the top; those at the right hand to the left, and at the left to the right. The numbers of the smaller square will now give the same result, 65, added horizontally or vertically. Also the two diagonals.



R. Miles.

AUTOMATIC SOUNDING.

[14376.]—The most important thing, without exception, on board a ship is to keep the water out of her, and it is very remarkable that in this age of invention the primitive method of ascertaining how much water there is in a ship's hold or tanks has not been superseded by some easier and more certain plan.



In looking back through the Patent-office records I find there has never been a patent granted for any self-recording sounding apparatus. There have been two or three patents for improvements to the present sounding rods, as every seaman knows the great difficulty in trying to sound in wet or rough weather; but, as these improvements were so slight, we have sailed along with the old tackle until some really good and simple method turned up. A new apparatus for indicating the depth of water, and particularly for showing the soundings on board a ship, has been mentioned in "Queries," and as your readers will see in the following description is, although very simple, yet quite novel in its application, and certain to supersede the old plan of sounding pipes. The "Patent Sounder," as this new apparatus is called, was brought out at about the same time as Sir W. Thomson's deep-sea sounder, and it is very remarkable that both of them are alike in principle, although differently applied.

The "Patent Sounder" consists in having at the bottom of each hold, tank, and compartment, an open-bottomed box, B, on sketch, and a small pipe, P, leading from each of these boxes to the cabin or chart-house, where an indicator, I, is connected to each pipe. When the water rises it enters the box, B, and compresses the air in it, and this compression is communicated through the small pipe to the indicator, which shows clearly the exact depth of the water. It will be seen that this apparatus is extremely simple. It is, nevertheless, very efficient and reliable, having been thoroughly tested at sea, and found to act perfectly in all weathers. The box, B, is so proportioned that change of temperature has no effect on the indications. In the roughest weather the gauge is never violently agitated, but always works steadily, and the indicator may be placed at any distance from the box.

If any of our amateur friends would like to rig one of these "Patent Sounders" up, either in their yachts or on shore from any cistern or tank, or make a tide gauge, and are willing to take our telephonic friends' advice and defy the patentees, I will be very glad to supply the dimensions and any details necessary. **Tyneside.**

SINGLE v. COUPLED ENGINES.

[14377.]—Your able correspondent, "C. E. S.," letter 13678, p. 314, commenting on my letter (13523, p. 216), remarks that my comparison of the speed of the G. N. and G. W. single engines with the Midland coupled ones "is no proof in favour of the single engines, as the gradients and weight of trains are far heavier on the Midland than upon either of the other lines." He does not represent my contention quite accurately. I paired the Midland and L. and N. W. together when comparing the speed run by coupled engines (of which those lines have some of the finest specimens) with the G. W. and G. N. 8ft. singles. This makes a considerable difference, for, while it would be absurd to compare the generally level G. W. with the Midland and its heavy gradients, the comparison would be all the other way in regard to the G. N. and L. N. W. Thus my comparison of the two pairs of lines was not an unfair one, and shows the single engines doing a mean speed of 52 miles an hour on the quickest runs between stations, against the coupled engines' 47. But I must point out further that the question to which I directed particular attention in my letter (13523) is not attempted to be met by "C. E. S.," but is quietly ignored, as the point had been previously, by all advocates of coupled engines—viz., (1) that it has not been shown that the coupled engines could run the G. W. and G. N. expresses (at 51 and 53 miles an hour) in time, or (2) that the G. W. and G. N. singles could not run the L. N. W. and Midland expresses (at 47 miles an hour) in time. This is the real point at issue, and until this is proved the advocates of coupled engines have not made out their case.

I admit that "C. E. S." has brought some excellent theoretical reasons and formulæ to show that at least 100lb. of tractive force is required to perform the "15-coach test," on which he so strongly insists, and his theory certainly appears to have been sustained by experiment. Still this only goes to prove that on a perfectly level line a coupled engine with 100lb. of tractive force, drawing 150 tons, would beat a single engine with less tractive power. But that does not answer my question, while I think experience does answer it in favour of the opinion I expressed in letter 13523—that the 8ft. singles could run the Midland and L. N. W. expresses in time, but that the coupled engines could not keep time with the G. W. and G. N. expresses, and I shall proceed to adduce some evidence in support of these views.

First, then, as to the work done by single engines. Although I have taken as a standard of comparison the respective speeds at which the quickest trains are timed in the tables, those speeds do not by any means represent the best work of single-wheel engines. On the G. W., 30 years ago, the expresses were timed at much higher speed than at present, and were run by the same engines as now take the Flying Dutchman. They ran to Swindon in 1h. 25min., including a stoppage of 2min. at Didcot (and the consequent loss of time by slackening, stopping, and starting again), or 2min. less than the Flying Dutchman now does it without having to stop at Didcot. Their timed speed—from start to stop—was 55 to 57 miles an hour between Paddington, Didcot, Swindon, Oxford, &c. The 53¼ miles—London to Didcot—was timed to be done in 57min., or at the rate of 56·05 miles an hour, and, as every one knows who has travelled much on the G. W., often was actually done in 47 to 50 min. both ways. The Great Britain (8ft. single), for instance, which is now running the Flying Dutchman, has started from Paddington and stopped at Didcot in 47min., nearly 30 years ago—*i e*, at the rate of 67·98 miles an hour, involving a maximum speed of fully 75), and other engines of her class have done the same thing repeatedly. As I mentioned in a former letter, I have timed the G. W. 8ft. singles at speeds of from 75 to 81·8 miles an hour, and this both ways between London and Swindon; while, on the other hand, I have known the midday express to keep time without once exceeding 57, and when late in leaving Swindon, the up express is known to have done the 77¼ miles often in 79min., probably even less, although I have no certain records to hand of the fact. Moreover, the trains were at times by no means light, but I should imagine, allowing for the extra weight of the broad-gauge coaches, quite up to the 150 ton standard, if not considerably above it. The work done by the G. N. 7ft. and 8ft. single engines has been dilated upon frequently in the ENGLISH MECHANIC. It has been said by coupled advocates that they "lose time up banks, and make it up by running down them at excessive speeds." Yet where is the proof of this assertion? The G. N., as is well known, has a heavy bank for the first 12¾ miles (to Potter's Bar) excepting for about half a mile between Hornsey and Wood Green. The first mile rises 1 in 105, the second 1 in 110, then, after 1¾ miles of moderate gradient, comes a steady unbroken rise of 1 in 200 for 8¼ miles, followed by 6 miles of similar descent, and then by alternate rises and falls of about 2 or 3 miles each—with one four mile level run—all the way to Peterborough. This 12 mile bank at starting is a heavy pull for the engines, especially the first 2 miles of 1 in 105 and 110, thus no very high speed is attained until Potter's Bar is passed, 19 to 20 minutes being allowed for the 12¾ miles, after which full speed is reached down the other side of the bank, and subsequently maintained. Numerous specimens of the running over this portion of the line have been given by correspondents, especially as to the 10 a.m., 2.45, and 8.30 p.m. down trains from King's Cross. The 10 a.m., with No. 48 (8ft.), and 11 coaches, is shown as reaching Potter's Bar in 17 min. 40 sec., or 1 min. 20 secs. under the working time. The 2.45. with No. 236 (7ft.), and 16 coaches, as reaching Potter's Bar in 19 min. 51 sec.; the 8 30 p.m., with No. 22 (8ft.), and 10 coaches, in 19 min., and with 16 coaches in 20 min. I myself have travelled by the 10 a.m. down express, and reached Potter's Bar in 18 min. The engine, if I remember aright, was No. 2, but I omitted to note this, and so am not certain. Another time, travelling by the up express leaving Peterborough at 1.15 p.m. (engine, I think, No. 94), with 16 coaches on, after passing Hatfield at 57 miles an hour, the speed had not decreased below 50 on passing Potter's Bar, after ascending the 6 mile bank of 1 in 200. No time thus was lost by these trains in running up the banks, or, if the 1 minute longer time taken by the 8.30 p.m., as mentioned above, and 51 sec. by the 2.45, in each case with 16 coaches, be regarded as loss of time, at any rate no excessive speed was run afterwards down the opposite banks to make it up. In the former case 60 miles an hour was the maximum down the banks, and in the latter case 56. I have never known the G.N. expresses, when starting in fair time, require to run at more than 60 miles an hour to keep time. Even in cases where they have started 3 minutes late from London, and as much as 10 minutes late from Peterborough, that speed generally has sufficed for keeping time, and, with a punctual start, 57 or 58 miles an hour. Again, I have seen them maintain the latter speed on an average up and down hill, not falling below 53 up hill, or rising above 60 down hill. It is true I have recorded cases in which, after a late start, the trains have attained a speed of 69 miles an hour running down the banks between Potter's Bar and Hatfield, and as much as 72 miles an hour down the bank from Potter's Bar to Wood Green—but that was quite exceptional, to make up lost time—and only went to show that a higher speed than that required by the time-table could be done if needed. The Prince of Wales' trip to Peterborough in 77 minutes, with No. 22, proves this, and many other instances could be adduced.

Now I do not pretend to say that the L. N. W. or M. R. coupled engines cannot do equally good work, but I simply ask:—If they can, why don't they? I admit the heavier gradients on the M. R. (I wish "C. E. S." would give us the sections, as he kindly did of the G. N.), but at any rate the L. N. W. has a much more level line than the G. N., yet, apparently, can only attain a very inferior rate of speed. Moreover, the very interesting comparative tables given by "Itzaex" (I should be glad if he would publish some more of various lines) of work done by single and coupled engines respectively on the L. N. W., is all in favour of the former. By the up Scotch express, a Bloomer (7ft. single), after full speed was attained, never exceeded 56·7 miles an hour, or fell below 44·3 miles an hour, while a Webb coupled engine twice fell off to 39 miles an hour up gradients, and increased to 60 miles an hour down the Tring bank. Similarly in his tables as to the working of the M. R. coupled engines, we find them falling off to 36 or even 35 miles an hour, ascending the Desborough bank, and running at 54 miles an hour down the Kibworth bank, while other accounts describe these engines as running 68, 70, and 72 miles an hour past Market Harborough—*i.e.*, down one of the above inclines, and "C. E. S." himself says he has timed them at 72½ miles an hour down one of those banks. Again, on 20th October last, a correspondent, "W. E. H.," recorded a trip of the 1.59 p.m. up express from Leicester to Kentish Town, with a train equivalent to 15 coaches, and one of Dübs and Co.'s new bogie engines (No. 1334) 7ft. coupled, cylinder 18 × 26, when we find the train running at 40 miles an hour from Harborough to Desborough, 60 miles an hour from Desborough to Kettering, only 36 miles an hour from Ilchester to Sharnbrook Summit, 60 from Sharnbrook to Oakley, only 38 from Harlington to Leagrave, and as high as 63·3 miles an hour from St. Alban's to Radlett, 60 being then kept up to Finchley-road. I notice also that the first 17 miles from Bedford occupied 28 minutes, and the train lost 3 minutes on the journey from that station to Kentish Town. I do not say that this is bad work, but in what respect is it superior to the work done by the G. N. single engines? Is it even by any means equal to the specimens given above? I willingly admit that I have no right to say the coupled engines could not run the G. N. trains in time, excepting on the ground that they do not maintain equal speeds on their own lines even under favourable circumstances, but I do contend that, on the evidence as yet brought forward, the single engines have the best of it. I have seen the L. N. W. Bloomers, the S E. 6ft. 6in. singles with intermediate shaft (old 134 and 138 class, Crampton's or Stephenson's, I forget which), and the G. E. 7ft. singles (old 97-102 class) do capital work with trains of 24 coaches, without requiring a pilot. For instance, taking the S. E., I remember the 12 noon up express from Dover, consisting of 24 coaches, with No. 138 (single, with intermediate shaft), being 12 minutes late at Redhill, and making up 7 minutes to London-bridge, doing 60 miles an hour down the banks, and never falling below 45 up the stiffest rise. The G. E. engine, too (No. 102, 7ft. single), took the 24 coaches on a slightly ascending gradient at a steadily-maintained 48. I know that both the above-named engines, and the G. N. 8ft. singles, have kept time with 20 coaches, and without varying so much as the coupled engines above quoted—viz., only between 45 and 60 miles an hour, instead of 35 to 64 or 72. I am no special pleader for single engines, but I ask "C. E. S," and the other able advocates for the coupled class, how they reconcile these admitted facts with their theories? Even on the Settle and Carlisle line, the G. N. engines certainly could run at least 45 of the 87 at 60 miles an hour (not deemed an "unsafe" speed even by "coupled" champions, who boast that their engines can do 75 safely), or in 45 minutes. If so, surely they could do the other 42 miles, even including the famous 14 mile bank of 1 in 100, in 75 minutes, which would make the time the same as that of the Midland expresses. I "pause for a reply," and am quite "open to conviction."

New Zealand. C. R. M.

JAPANESE WORKMEN.

[14378.]—THE following extract from an article in *Engineering* may help to discount certain "facts," which are apparently only too greedily seized by those who lose no opportunity of disparaging the British workman. Happily in your columns he has a fair field, and no one has there ventured to make statements which could be instantly disproved. The writer in your contemporary says:—

The Japanese coolies do not like wheelbarrows; they will take off the wheels, and carry the barrow like a sedan-chair, they will not run the barrow along a plank, but prefer to carry earth for forming embankments, &c., in bags or baskets, one suspended from each end of a pole, which is carried on the shoulder. The inferior physique of the Japanese, in comparison with Europeans, may, however, have something to do with their objections to the handy wheelbarrow, as it is well known that the best men are required for that portion of the navvy's work. In comparison with English labour, it would require three coolies to do the work of one of our navvies. The Japanese substitute for a spade is something like an elongated adze, used in a similar way, drawing the earth towards the user. The coolies are, as a rule, willing and obedient, easily managed, excepting in regular attendance at work, and some of them have great powers of endurance, especially in travelling long distances. Their rate of pay is from 9d. 1s. 1d per day.

The carpenters and joiners are much superior the coolies, and mostly are well-educated men; th rank high in the Japanese social scale; their to are few in number and simple in form, not adapt for work requiring to be true and uniform. T sawing and planing tools cut while the tool is bei drawn towards the workman, and the Japane carpenter will, if possible, arrange matters so that can sit down comfortably to his work; cross-cut a pit saws as here used are unknown, or at any ra not used, in Japan, and it is a most painful sig to see one man with a saw, in shape like a very lar butcher's chopper, cutting away at a large tre Planks and boards so cut are very seldom true an uniform in thickness. In putting up Japane houses, or in running up temporary sheds a buildings these carpenters are equal to any workme in the world. Straight, ordinary framing to patte they do very well, but cannot maintain uniformit truth, and squareness in their work, as they ha never been accustomed to work in with other trad like the European carpenter. A Japanese workm does not believe in substantial work; he thinks th to make things lasting would destroy future cha of employment. The principles of framing a trussing are not understood; the form of roofs i their theatres and houses is barbarous and primiti in the extreme, and shows a complete ignorance the most ordinary principles of construction. Th rates of pay for carpenters and joiners vary fr 1s. 3d. to 1s. 8d. per day. Hewers and dressers stone are plentiful in Japan, but very few can lay cl to the title of mason. Dry rubble work is done ve well in the country, but when mortar is used th men are not to be trusted; in flushing up we solid, and making level and true-courses and be they require constant and careful supervision; th wages are rather less than those of carpenters. Ti makers and layers, and plasterers are plentiful, b their work is not good; the plasterers mix stra instead of hair with their mortar. Bricklayers f bridges and stations required to be trained by European foremen; the men so trained were m tile-layers and masons, and at their best w remarkably slow. For the various ironwork requi for staging, &c., men were selected from the n ironworkers, and trained to European ways; m of these men have turned out good and really st workers, but they invariably want to work metal before the heat is up to welding. They tur out very useful under European girder-make riveting up the numerous bridges, and some them have received as much as 3s. to 3s. 6d. per wages.

There is more in the same strain, but I h quoted sufficient. In Sir E. Beckett's "Tr Unionism and Its Results" he says, "The Jap appear to be first rate carpenters. Perhaps we s see some of them." "I am glad to see my sug tion of Japanese carpentry so well seconded as it been by persons of greater experience than mine." am glad to see that Sir Edmund is so out-and- free trader, but I am afraid his wish is not likely gratified. I believe this Japanese craze arose the statement that the cabin fittings of the Cunard liner—the Gallia—were being made in J but I wonder how many people, especially lawyers, were deceived by that announce The steamers of the White Star line have at pr the most sumptuously furnished and elabo ornamented saloons and cabins: so— well, Jap work is all the rage. Verb. sap. Everything's business; but if the Cunard people wanted a fitted up in English style, you bet they wouldn't for the fittings from Japan; they go to the U States too often. Now, Chinese and Japanese men are remarkably skilful and clever in special lines—some of them; but if any one ima that Japanese or Chinese artisans will do more better work than Britons for the same wages in country, I am afraid he is likely to be mis Now as to German masons. Can any one say many of the face stones in the fronts of the New Courts were laid by Germans—whether it is that the only portion of front stonework during the strike had to be taken down, the men employed, though doubtless excellent men at their price, were not the best German

S. May

LATHE FLY-WHEELS AND TREADLES.

[14379.]—I AM sure every reader of "our shared the interest and delight with which I hailed "D. H. G.'s" welcome re-appearance pages of the ENGLISH MECHANIC. Of all the able communications on the lathe which we your columns, his, to my mind, are pre- distinguished by their accuracy, and the ease which he makes us understand the matters he on. I trust he will, as early as convenient, to illustrate the plan referred to in the sentences of his paper on page 231, and so additional favour on all of us. H. T. Scovell

METHODS FOR THE DETERMINATION OF THE RATIONAL FORMULÆ OF ORGANIC SUBSTANCES—THE ESTIMATION OF NITROGEN—THE HALOGENS, SULPHUR, ARSENIC, AND PHOSPHORUS INORGANIC MATTER.

[14380.]—At page 507 of the English Mechanic for February 1st, 1878, I have shown how the mpirical formula is obtained. To obtain the ational formula from the empirical formula it is ecessary to determine the specific gravity of the ubstance in the state of vapour, either by deterining the volume of a certain weight of the subtance when in a vaporous condition, or by deterining the weight of a given volume of the vapour. r the rational formula of an organic substance ossessing basic or acid properties may be detered from the weight of the acid combining with e basic substance, or from the percentage weight the base uniting with the acid. Or, when possible, forming a double chloride with platinum, and ating the compound to determine the percentage ight of platinum from which the rational formula ay be calculated. Or it may be determined by the compositions which the substance undergoes.

Suppose, for instance, we wish to determine ether CH_2O_2, which we have found as the empirical rmula for formic acid, is also the rational formula, take a glass globe having a capacity of 200cc. or 0cc., having a neck drawn out to a point. We igh the globe and introduce a sufficient quantity formic acid. The globe is plunged into an oil-th of a temperature of, say, 140° C., shown by a rmometer. The formic acid boils, vapourises, d expels the air, and issues from the point of the obe. When the rush of vapour ceases melt the int of the globe with a blowpipe, and observe the mperature of bath and height of barometer. Now move the globe, clean and weigh, and note the ight of the barometer and temperature in the lance case Then break the point of the globe der mercury, and determine the volume of merry which fills the globe. For instance, in the termination of the formula for formic acid the ight of the balloon and air was 24·8113grs., the mperature of the oil-bath was 140° C., the height of e barometer when sealing was 750mm.; the ight of the balloon filled with vapour was 24·8537; e temperature at weighing was 20°C, and the ght of the barometer at weighing was 740mm., d the volume of the balloon was 250cc. The 0cc. of air at 20°C and 740mm. become at 0°C d 760mm. 226·8cc. which is found by dividing 0 × 273 × 740 by 293 × 760. And as one litre f air weighs 1·2936grs. at the standard temperae and pressure, one cubic centimetre will weigh 012936grs., and 226·8cc. will weigh ·2934gr. Then e weight of the vapour of formic acid filling the be is 24·8537gr. + ·2934gr.—24·8113grs. equal to gr.

Again, 250cc. at 140°C and 750mm. become at C. and 760mm. 163·1 found by dividing 250 × 273 750 by 413 × 760. And 163·1cc. of hydrogen will h 163·1 × ·0000896, equal to ·01461376gr., , divided into ·3358gr., gives 23, which is the ific gravity of formic acid in relation to ogen as unity; therefore its molecular weight , be 46 in reference to a molecule or atoms of hydrogen. And by adding her separately the equivalent weights of the n, hydrogen, and oxygen in the formula, OHO, we obtain the number 46 Therefore, is the correct rational formula, and not $C_2H_4O_4$ ny other multiple of CH_2O_2.

e rational formula for organic substances le in water or alcohol may be determined by g to this solution some soluble metallic salt, base of which is known to unite with the ic substance and form a salt. When the salt substance has been isolated and washed from ing impurities and dried, a weighed quantity is ated, so that nothing but the metal is left.

the weight of the metal the molecular weight e substance can be found. For example, the al formula of acetic acid may be obtained by ing silver acetate by adding a solution of ic acetate to a concentrated solution of tic nitrate, when argentic acetate is formed. salt, being sparingly soluble in cold water, is ly separated from the potassic nitrate. When precipitate has been washed and dried, a given ght of it is heated in a crucible, when it is decomd, metallic silver being left in the crucible. The ht of the silver deducted from the weight of the tic acetate taken will give the weight of the radical combining with it.

incinerating 5 grammes of argentic acetate, gm. of metallic silver are left, and this ed from 5 gives 1·7673, the loss in weight. as 3·2325 : 108 the atomic weight of silver, 7673 : 59. To the 59 add 1 for the atom of which was displaced by the monad silver tate, and we obtain 60 as the molecular f acetic acid. By analysis the empirical CH_2O is obtained, but as the sum of 12 + = 30, just one-half of the number obtained, ble the atoms of each element, and obtain $C_2H_4O_2$ as the rational formula of acetic acid. And, as all acids contain one or more semi-molecules of oxatyl, we write it thus: CH_3COHO.

The rational formula for organic bodies, such as morphine, aniline, quinine, &c., which unite with HCl and form the hydrochlorate, may frequently be obtained by finding the weight of HCl which a given weight of these bodies absorbs, and saying as the weight of HCl absorbed is to 36·5 so is the given weight of the substance to its molecular weight, from which we can obtain the rational formula.

Again, these hydrochlorates often combine with $PtCl_4$, and form double chlorides, which on being heated leave platinum alone. Then say, as the weight of the platinum is to 197, its atomic weight, so is the weight of the double chloride to the molecular weight of the double chloride, from which the molecular weight of the given base may be obtained as well as its rational formula.

The rational formula may sometimes be determined from inference—thus it is found that, when chlorine acts on marsh gas the hydrogen is eliminated at four different steps, forming four different compounds, CH_3Cl, CH_2Cl_2, $CHCl_3$, and CCl_4, and the rational formula CH_4 is confirmed by the vapour density.

Again, when the hydrocarbon expressed by CH_3 is acted on by chlorine, six different compounds, C_2H_5Cl, $C_2H_4Cl_2$, $C_2H_3Cl_3$, $C_2H_2Cl_4$, C_2HCl_5, and C_2Cl_6, are formed. The rational formula is C_2H_6, and this is confirmed by the vapour density.

The vapour density of any substance may be found by dividing its molecular weight by twice 14·49 or 28·98, the weight of a given bulk of air compared with the weight of the molecule of hydrogen. Thus in the case of marsh gas, CH_4, the molecular weight is 12 + 4 = 16, which, divided by 28·98, gives ·552, which agrees with experiment. The molecular weight of methyl $(CH_3)_2$ is 24 + 6 = 30, which divided by 28·98 gives 1·035 as its vapour density.

Again, when the vapour densities are multiplied by 28·98 we obtain a number from which we can make up the rational formula, provided we know the elements that enter into its composition. Thus ·552 the vapour density of marsh gas or methyl hydride, multiplied by 28·98, gives 16. As this gas contains only carbon and hydrogen, there must be at least one atom of carbon, and in this case there cannot be two. There must necessarily be one of carbon (12) and four of hydrogen (1), making (16) the molecular weight.

When an organic substance contains nitrogen it is usual to determine the carbon and hydrogen in one portion, and the nitrogen in another.

When nitrogenous substances are burnt with copper oxide, compounds of nitrogen and oxygen are liable to be formed, and pass into the calcium tube and potash bulbs, and thus render the results obtained inaccurate. But by passing the products of combustion over heated metallic copper, before leaving the combustion tube, the oxygen unites with the copper, while the nitrogen passes onward through the apparatus unabsorbed. There are two methods of determining the amount of nitrogen in an organic compound, according as the nitrogen is all given off in the form of ammonia when heated with an alkali or not.

In estimating the nitrogen by the ammonia process a combustion tube is required of about 16in. long, and about four-tenths of an inch in internal diameter. A layer of oxalic acid, mixed with a small quantity of soda lime, is put into the remote end of the tube, occupying about an inch of the tube, and then about the same quantity of soda lime. Then the nitrogenous substance, mixed with soda lime, is introduced, filling about 8in. of the tube. Then fill up about 4in. of the tube with soda lime, leaving two for insertion of a plug of asbestos and the cork for the attachment of the U-tube, to which some standard HCl is transferred with water sufficient to fill up to a certain height. Then the combustion tube is placed in the furnace, and gradually heated, commencing at the end nearest the U-tube; and the remote end, containing the oxalic acid, is not heated until the evolution of gas has ceased. When it is heated, carbonic anhydride drives out before it all the ammonia remaining in the tube. The U-tube is removed, and the contained liquid is poured into an evaporating dish, and the bulb washed out several times. Platinic chloride is added, and it is evaporated to dryness, and digested with a mixture of alcohol and ether to remove excess of platinic chloride. The remaining double chloride of ammonia and platinum is weighed, when there will be 14 parts of nitrogen, taking 223 parts as the total weight, or 6·3 per cent. of the weight will be nitrogen; or the dried double salt is transferred to a crucible, and heated to bright redness, when for 197·2 parts of platinum we allow 28 parts of nitrogen, or 14 1-5th per cent. nearly. The ammonia method answers, except in cases where the nitrogen occurs in the form of nitric acid or cyanogen, when this element must be estimated by volume. This method is applicable in all cases. A combustion tube of about 32in long is taken, rounded like a test tube at one end. This tube is filled with some carbonate that, when heated, will give off carbonic anhydride, such as manganous carbonate, magnesite, or hydric sodic carbonate, some mercuric oxide. A weighed portion of the substance for analysis, with upwards of 40 times its weight of a mixture of oxide of copper and mercury, the rinsings of the mortar, a plug of asbestos, then about 4in. of cupric oxide, asbestos, and a layer of about 8in. of metallic copper. The end of the combustion tube is drawn out, and connected with a bent delivery tube, dipping beneath the mercury in the trough. When all is ready, the carbonate in the tube is heated to generate a current of carbonic anhydride to drive out all the air.

The metallic copper and copper oxide are heated simultaneously, and when the escaping gas is free from air insert the end of the delivery tube through the tubulure of the vessel, and heat the portion of the tube containing the substance that is being analysed until all except the carbonate portion of the tube is at a bright red heat, and the evolution of gas has ceased, when the carbonate is heated to expel the last traces of the nitrogen gas. The delivery tube is withdrawn, and the gas is allowed to remain over a potash solution to absorb every trace of CO_2; after which the pure nitrogen is transferred to a measuring tube, from which the volume is determined from the data that 100 cubic inches of nitrogen at 15½° C., and at a pressure of 30in. of mercury, weigh 30·15 grains, or a litre at 0° C., and 760 mm. weighs 1¼ gramme.

The halogens, including bromine, chlorine, and iodine in organic compounds, are determined by mixing the substance containing them with about 10 times its weight of caustic lime in a combustion tube, sealed at one end, and the remainder filled up with pure lime. The tube is closed with a cork, through which passes a short bent tube, dipping beneath some water in a vessel to prevent by pressure the escape of any of the halogens. Heat the tube until the water ceases bubbling. The contents of the tube are treated with pure nitric acid, and the liquid is filtered and treated with silver nitrate, which precipitates a silver salt of the halogen, which is washed, dried, and weighed, and from the weight of the salt the quantity of the halogen can be estimated.

Sulphur, arsenic, and phosphorus are determined by mixing potassic nitrate, sodic carbonate, and sodic chloride with the substance, and heating to redness in a combustion tube, when these elements are obtained as sulphate, arsenate, and phosphate. The sulphur forms sulphuric acid, which forms a salt with the alkali. Dissolve the residue in water, add HCl, then boil, and add $BaCl_2$, set aside for some time to form precipitate of baric sulphate, which, after several operations, is dried, ignited, and weighed, from which the quantity of sulphur can be estimated. When arsenic or phosphorus is present, it is determined by converting either into an ammonic magnesic arsenate or phosphate.

Hugh Clements.

Action of Oxygen upon Anatomic Elements.—Bert has been studying the toxic action of oxygen under high tension. He finds, by the indirect method of air confined under pressure, that the injurious effect of oxygen upon air-breathing vertebrates begins when its tension corresponds to a pressure of five or six atmospheres. The analysis of the gases contained in arterial blood shows that under this tension the colouring matter of the globules is completely saturated with oxygen, and that gas begins to be dissolved in the sanguine plasma. If the compression is long continued, the solution of oxygen becomes diffused through the tissues, and the organic oxidations are diminished, leading to an immediate reduction of the temperature of the body.

Compound Locomotives.—M. Mallet has presented a communication to the French Academy on the application of the compound system to locomotives on the railroad from Bayonne to Biarritz. The engine has two cranks, at right angles, driven by two cylinders, one on each side. They have a range of 0·45m., the diameter of one being 0·24m., the other 0·40m. Under ordinary circumstances the steam from the boiler passes first into the small cylinder, then into the large, where it acts expansively, and finally escapes into the chimney. But on starting, and whenever the engine is required to surmount an increased resistance, the steam may be admitted directly into the large cylinder, and the locomotive acts as an ordinary two-cylinder engine. The plan has been adopted in three engines, with four coupled wheels of 1·20m. diameter; the boiler has 45 square metres of heating surface, and acts with an effective pressure of 10kg. per square centimetre. They are employed in local traffic, on grades of 0·015. Their action is unexceptionable, their steadiness leaving nothing to desire, even at a speed of 40km. per hour, and the management being no more difficult than in ordinary engines. The draught, notwithstanding the reduction of the steam-jets to one-half, is ample, so that the boiler, in spite of its small dimensions, supplies the wants of the engine abundantly. As for the consumption of fuel, the gross cost per kilometre is 4kg. of Cardiff coal for trains weighing, 50, 60, or even 70 tons. The foregoing facts are derived from a service of 40,000km., performed since the system was adopted. They have, therefore, an important practical value.

REPLIES TO QUERIES.

*** *In their answers, Correspondents are respectfully requested to mention, in each instance, the title and number of the query asked.*

[31875.]—**Japanese Carpenters.**—To answer "Anxious's" query thoroughly would fill, at the least, several columns of the ENGLISH MECHANIC. I will, however, do my best to give him a short description of some of the principal tools which I have, during a residence of about ten years in Japan, seen in the hands of Japanese carpenters. Before commencing I must beg every indulgence for any technical errors I may be guilty of, being anything but a carpenter or mechanic. It is, first, necessary to explain that Japanese carpenters and joiners do most of their work, and especially fine work, in a sitting or squatting position, having before them, on the floor or ground, a thick, heavy slab of wood as a bench, and making frequent use of their feet and toes to hold the article they are at work upon—screw vices, &c., being originally quite unknown to them. *Saws:* Their saws (all of which cut on the pull) are very handy and efficient little instruments, varying from 9 to 24in. in length, and from 2 to 4in. in width. The blade of those used to cut across the grain has but very little difference in width through its entire length, while the width of the blade of those used for cutting with the grain is gradually decreased by about one-third towards its handle-end. The handle consists of a long rat-tail-like continuation of the back of the saw; on this a straight oval-shaped wooden handle is driven, which is just large enough round to be comfortably grasped in both hands. Different kinds of teeth are cut in these blades; those of the cross-grain saw are deep and narrow, the top of each tooth being filed off angularly, something like Figs. 1 and 2. These saws cut with extreme rapidity, and very cleanly. The teeth of saws to cut with the grain are triangular, being slightly smaller near the handle-end, like Fig 3. Sawyers use an instrument, almost square in shape, from 2 to 3ft. long, made of heavy metal, and having its pulling handle of wood adjusted to the iron handle, at a convenient angle for use, like Fig 4. There is also a small frame saw, used by comb-makers, which cuts both ways, cutting almost as cleanly as a knife. All their saws are made on the anvil, being beaten out from ingots of steel, the large ones used by sawyers having iron handles. *Planes:* Japanese planes are simple in the extreme, being merely a slab of oak, with an angular slit cut across at a spot about ⅔ its length from the bottom end. The most common size is about 9 × 2½in., and 3 × 1in. Into this slab the plane iron is fitted, the slit being so accurately cut as to dispense with the need of wedges to keep the iron in position. The iron itself, about 3½ × 2¼ × $\frac{1}{16}$ and ¼in., is used without any back iron (or, is it set iron?), and is only a piece of wrought iron, one side being faced with steel. These tools also cut on the pull, being used with both hands; one hand, generally the left, is placed on or behind the iron, and the other grasps the sides of the plane. Of course, these planes are made in various sizes, and to suit different work, such as flat, hollow, or convex, but the principle is the same for all. *Adzes and axes:* The adzes used by Japanese carpenters are also made with iron, faced on the lower side with steel. The cutting edge, which is sharpened to a bevel like a chisel, is from 2½ to 3in. wide. This tool is made with a square hollow socket, into which a wooden handle, bent to the proper shape, is fixed. This arrangement enables the Japanese to use the tool in two ways. First, in its normal way, to cut a horizontal surface, the handle being fitted at right angles to the cutting edge; and, second, as an axe to cut downwards. In this case the handle is unshipped, and the tool turned ¼ round; the handle being now reshipped is parallel to the cutting edge. The Japanese are very expert with this tool. They have also a peculiar-shaped, clumsy, and heavy-looking, broad axe, with a wedge-shaped cutting edge. This tool in their hands does good execution. In its manufacture steel is only used where absolutely necessary. *Chisels and gouges:* Their chisels and gouges are also made of iron, one side being faced with steel. On this account they have to be made thick and strong, which gives them a clumsy, unfinished appearance. The gouges are the exact opposite of English ones: instead of having a hollow or semicylindrical blade, they are made with a solid rounded one, giving, when cut across, a convex section. *Hammers:* Their hammer heads are of various sizes and shapes, and do not need description, except, perhaps, one used by house carpenters, one end of which only has a driving surface, the other end being drawn out to a point, with which holes are struck, into which nails are driven. Of course, this is only done on rough work. *Drills, bradawls, &c.:* Their boring tools for wood have triangularly-pointed heads, being fitted into long circular wooden handles. They are used by being twisted backward and forward between the open hands, a downward pressure being exerted at the same time. This is very tiring work. They have a few differently-shaped bits used in the same way. Foreign boring tools, such as gimlets, braces, and bits, &c., were originally unknown to them, but are gradually being adopted, and coming into use. *Measuring tools:* Their set or try square is made of two narrow strips of steel joined at right angles, and marked with their inches and tenths, being the only rule they make use of. In place of a chalk line they have a small apparatus, consisting of an open receptacle for holding cotton or paper pulp saturated with ink; behind this a reel is attached, on which a thin cord is wound; when a line is struck the cord is unwound from the reel, and made to pass through the inky mass, being then used like a chalk line, and leaving a clear, distinct, and indelible line. Other marking is also done with this ink; the end of a prepared piece of flat bamboo being pressed in it, and used in the place of a lead pencil. *Sharpening:* All their tools, after leaving the blacksmith's hands, are sharpened on whet-stones lubricated with water; of these stones they have great varieties, the best being quite equal to any to be got in Europe. Of circular grindstones they are quite ignorant. It is generally admitted that Japanese carpenters cannot do more or even as much work as an English artisan; but they are, undoubtedly, first-rate workmen, and in well-seasoned wood their work can hardly be surpassed; especially in that which requires great accuracy it is better done, and more artistically finished, than is the rule in Europe. Their wages average from 1s. 6d. to 2s. per day.—HERBERT A. STEVENS, Kobe, Japan, 26th March, 1878.

FIG. 1.

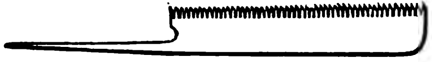


FIG. 2.

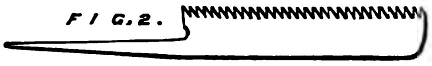
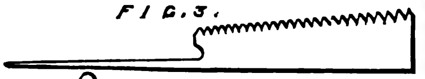


FIG. 3.



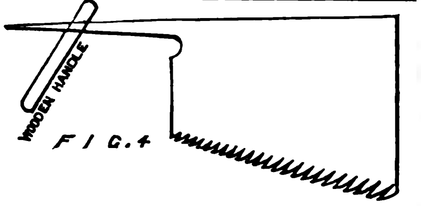


FIG. 4.

[32211.]—**Organ Pipe Feet (U.Q.).**—If "H. D. W." will send a rough sketch of what he wants, I will try to help him. I really do not know the shape of the feet at all.—TELESCOPE TELE.

[32415.]—**Compressed Air Chamber and Pump.**—I forward the following sketch of an apparatus for the compressing of air:—Fig. 1 is plan; A A A A A are the receivers, B B compressers, C C [illegible]umps and air or water valves, as the case may be, [illegible] tank for water. Fig. 2 is a vertical section not showing [illegible] same, A A receivers, B compressor. These [illegible] 6in. internal diameter, [illegible] inch thick, wrought iron.

FIG. 1.

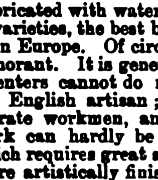


FIG. 2.

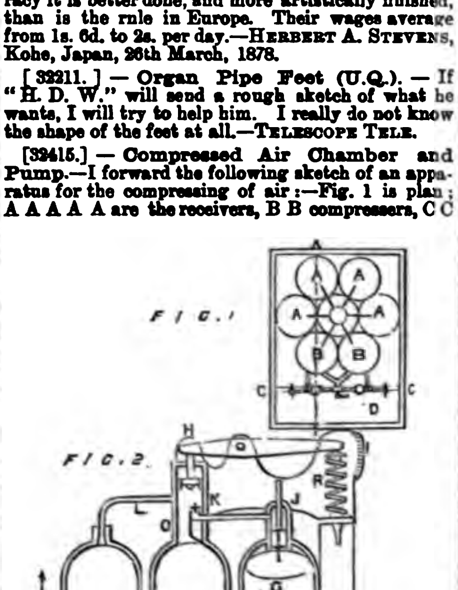
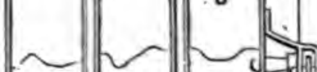


FIG. 3.



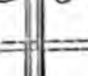


FIG. 4.

Tops and bottoms may be made of
with knobs at right angles, as show
screwed together, as shown, abo
bottoms. Have a pin cast upon
to bolt them to the bed plate, N
pump, and should be fitted with a
one inside the other, the large one f
about 1¼in., and the internal one ½in.
cistern, placed upon a pedestal, Q
lock the large ram when it has don
the small one is brought into pla
pressing by water; F, cross handle to
ing the pumps; G, compound w
register, as well as reverser, to the tw
H, pressure valve; I, the indicator
for carrying of it; K, non-return v
pressers; L, where the connection
for hose; M, stay plate for binder
other fittings, as pumps, lever br
gauge; R, the spiral steel spring. N
wound upon a ⅝ mandrel, and opene
wires, equal thickness of wire, and cu
and properly tempered, will take s
compress it. This puts upon a bracke
and leaves three to one, will give you
atmospheres. P is the bed plate. F
ram, one fitting inside of the other,
packed with a leather lace, the int
leather. The sides of the collar upo
is filed away, that when passed betw
horns, E, it may clear, and a pin is
to keep it there in position. When
while you will find you can make no
air you are working is so highly exp
cannot displace all the air between
valve and plunger. When you find t
your lever down, take the pin out, an
turn your ram, and the projections
the horns at E, then turn on the w
water into them, alternately air and
pressure is got you desire. Rus
wrought-lap welded tube I have tes
and four tons per square inch. The
about 5cwt. or 6cwt.—BEAVER.

[32519.]—**Cleaning Copper Cans**
soft soap and rotten-stone, made i
with water, and dissolved by gently
water bath. Rub on with a woollen
with dry whiting and rotten-stone.
leather and dry whiting.—E. J. H.

[32543.]—**Brush Varnish.**—Fill
bottle with shellac, and fill up w
spirit. Stir it at intervals till
may afterwards be coloured the sa
E. J. H. T.

[32558.]—**G. W. R. Broad Ga**
correspondent, "W. E. H.," wishes t
the engine 2013, which he saw tal
limited mail from Paddington a few
new or rebuilt one, I can tell him it i
engines 2001 to 2023 are the Bris
engines, which the Great Western to
mation with the B. and E. R. Co.
2007 are "bogie" engines, and the
exception of 2023 (as far as I know),
the G. W. 8ft. broad gauge, except
got 7ft. driving-wheel instead of 8ft.
west of Bristol to take the "Flyin
and other B. G. trains on. 2023 is a
I think they all have funnels like t
TAMERLANE.

[32572.]—**Chicken House.**—P
hurt the birds if it is thoroughly d
use zinc paints, which would be safe

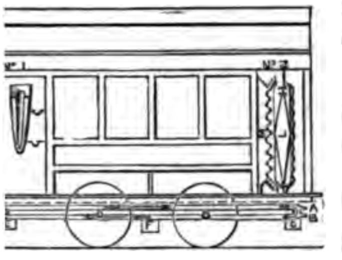
[32578.]—**Brakes (Barker's).**—
"C. E. S." (page 222), raises the qu
the brake now being fitted up on the
Railway is really self-acting. I hav
on the subject, and have ascertained
the system now actually in process
and to be shortly fitted to an engin
on the Great Eastern Railway, is r
(or self-acting), and is termed arrang
B. H., Solr.

[32579.]—**Pullman-car Trains.**—
Railway Company are running these
parts of their line. Would you infor
saw the train you mention, and perh
able to give you more information?

[32586.]—**Black Patches on**
The probability is that these marks
as "Gas" seems to conclude, by hot
rust from the bottoms of tinned
which rust, by combining with the ta
would form ink, consequently the bes
them would be to reduce the oxide
form by applying a solution of some
as salts of lemon or tartaric acid,
their recurrence fill the pores of the
wax and turpentine or French
DAVIES.

[32592.]—**Surface Condensation**
"Mongibello" and "A. W. E.,"
Vol. XXVII., what is proposed was
condenser. Here is a rough sketc
1 and 2 are the entrances or platfor
driver and conductor st[illegible] and. Of the
in them I will explain pr[illegible]sently. Th
entering at O passes a[illegible]ong, as show
to A, returning in B, t[illegible] ne water bei
E, the uncondensed va[illegible]r our passing
which is [illegible] of bo[illegible] air, through f

, boiler tubes, and out at chimney. ing your car to have a clear space and floor of 7in., you have plenty of ndenser 16ft. × 4ft., double, as shown; vanised iron, 20 gauge; corrugations, 1. apart. This will give you a con- ce of very nearly 300ft., with a weight). equally distributed over your floor. ave it lighter than that even, but I would gain anything by that. In one ter the metal the better. In doorway



mid transverse section and L, end at A n door No. 1 a taper hollow gusset for at H and I, M being air space between condenser, and L between the two con- aces, the supply of air being taken into ash-pan for combustion—hence, d circulation of cold air between and idenser. You will see that I have pon axle, but that will not so much g as I convey the idea. If your axles are the floor, make it in three bays, ore and aft. If your boiler is of the loco. em along the side of boiler; if vertical, ertical. They will take up very little loubt if you will get anything so simple . They can be put together with ¼ screws and nuts with screwdriver, with ape between to make joint. Easily es and repaired; to be made any size, lded to with the greatest convenience notice, and the expense nominal, n boilers.—Beaver.

'hosphorus.—"Tyneside" must add as in the shape of phosphate of some . It is the secret of making phosphor o description of this part of the pro- in the specification of the patent—a the hands of a clever lawyer, might ent.—S. M.

Refining Oil.—Seeing that D. E. s to refine oil for commercial purposes, be the proper thing to seek informa- xpert—and pay for it?—One Who GITIMATE Queries.

[armonium.—Yes. It is no difficulty; es of the reeds may have to be made RI Etienne.

egal Question.—"A." had better er into the hands of a solicitor at once, te, summon the landlord for the value as the landlord is obviously the repre- is tenant.—A. B.

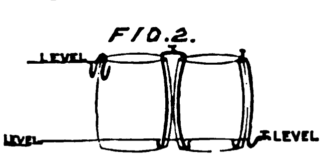
hutting out Sound.—Cannot "Stu- his ears with cotton wool?—Essar.

Printing Circulars.—If "Nemo" circulars he had better buy a press and a few copies only are wanted, and they . in MS., the papyrograph will do.—

Iaval Crews.—It depends a great deal e for which the vessel is intended. The ttle ships carried from 900 to 1,100 nodern representatives only 500, say. s sent out to cruise had a large com- en, and their modern representatives e, though they do not carry anything ber of guns.—Old Salt.

iphon.—It would appear the following of siphon is little known. I have used times, and for various purposes, the ears. It simply consists in having the ual legged siphon bent up as in Fig. 1.

FIG. 2.



ove is once charged, and the openings t will draw the liquid from a vessel, course, when the level of the liquid of the openings, but will start into if the level of liquid rises. Our chemi- ill find a glass tube, bent as above, very laboratory for decanting, as, when not be hung ready charged on a nail against me years ago I applied the principle to in water-butts in my wash-house, with not cutting the casks in any way below the water-line, obviating oosing and dropping—the common complaint about the connection of water-butts. It answers very well, and is a standing puzzle to most of my friends. Fig. 2 is the arrangement. I put a long turn-up on the overflow siphon—about 9in.—so that evaporation could take place to some extent without interfering with the stability of the water in the pipe. For charging the two long siphons I had a small gas tap soldered on the top of each, through which I sucked out the air, after which I screwed up the little nut or plug of taps very tight, so that they could not be opened by meddlesome fingers. The overflow I charged in a tub of water, and afterwards adjusted on edge of cask during a thunder shower, so as to keep the level about an inch from top when raining heaviest. I may only add that all three siphons have kept ready for action when called upon, and given no trouble whatever since the first charging. The siphon for laboratory use above mentioned could be improved by making one of the legs straight, and fixing to it a piece of rubber tube with a pinch tap. Arranged thus it could be carried about without fear of upsetting the balance of the water in the two legs.—Kyepish.

[32669.]—**Musical.**—Appunn's tonometer is the instrument inquired for.—Theophilus.

[32680.]—**Foul Closet.**—The air-pipe must be fixed on the top of the soil-pipe, clear of the trap. It would be better of lead, and soldered on. It ought, as mentioned, to be considerably larger—a 3in. pipe would give nine times the area of a 1in. A 2in. pipe ought to be sufficient. This would give four times area of present one. In addition to this have a smaller pipe—¾in. will do—tapped into the top of the container and carried to the outside of the building, taking care that both this and the larger one are fixed in such a manner that it would not be possible for water to remain in any portion of either pipe, and thus "trap" it. Examine the soil-pipe for yourself; it might not suit your olfactory nerves, but the fact of its not doing so would be more than repayment for the trouble. Plumbers are supposed to do many things that they never do. Their sins of omission and commission make a heavy account.—G. L., Southend.

[32710.]—**Organ.**—I beg to express my thanks to "Tonometer" for his kindness in replying to my query. By there being "no serious consequences" I presume he means that the tone will be none the worse. As it is evident the zinc will not keep its polish, we have determined to illuminate the front pipes. Will "Tonometer" or some other reader kindly inform me where (if anywhere) I can get patterns or designs for illuminating organ pipes? I am told that instructions, with designs, were given some years ago in the English Mechanic. I should be greatly obliged if some old subscriber will be good enough to tell me the numbers in which they appeared, that I may try to procure them.—C. C. C.

[32743.]—**Handbook.**—I thank "F. R. A. S." for his answer. The subject I want to study is, principally, stellar and planetary astronomy in its instrumental aspect, and also mathematically, if it does not require too much study.—Cornishman.

[32744.]—**Photo Lenses.**—Does "Perdu," in his reply on p. 223, mean that it makes no difference to the definition of a photo portrait combination if one set of glasses be out of centre to the other? I imagined otherwise.—Photo Cymraeg.

[32749.]—**Nautical Astronomy.**—In answer to part 4 of the above query, allow me to state that N.L. means the eastern limb, and not the nearest limb, as I stated by mistake in my reply on p. 248.—C. B. M.

[32749.]—**Nautical Astronomy.**—There has been a misprint in this reply, namely, tan. E M = sin. P tan. *d*; it ought to be tan. E M = sec. P tan. *d*. In part (4) of the same query I stated by mistake that N.L. meant the "nearest (or adjacent) limb." It should be altered to "eastern limb" (not "limits," as printed).—C. B. Mayne.

[32799.]—**London University Matriculation.**—I forgot, in my query on p. 201, to mention that I had the "Popular Educator" complete. Supposing that my aim is a Civil Service clerkship, would it be advisable to first pass the matriculation examination?—Vercingetorix.

[32800.]—**Grating Noise in Telephone.**—A loose connection will cause a grating; also using two uncovered wires if they touch each other, or by using one uncovered wire and earth connection if the wire touches any metallic substance in connection with earth. I had the same complaint to make, but noticing that it occurred when the wind was strong, I found that it was caused by the wire to earth touching a galvanised water-pipe when the wind caused it to move.—C. O. G.

[32805.]—**Underground Telegraph Lines.**—These are manufactured with wire and pipe together. Wire is not run through a length of pipe; but a long length of pipe is manufactured round a length of wire, of course.—Union Jack.

[32808.]—**Invisible Ink.**—I can give you half a dozen receipts for above. I expect the following is the one you want: Dissolve, in water, muriate of cobalt, which is of a blueish green colour, and the solution will be faint pink. Characters with it will be invisible when dry; but, when heated, brilliant green, fading again when cool.—Union Jack.

[32816.]—**Removing Indian Ink Blots, &c.**—I think chloride of lime, applied with a camel-hair pencil, would do for you.—Perdu.

[32843.]—**Musical Box.**—The pegs are the shape of the spill in a beer cask. They are driven in, and then cut to the right length. Bent pins can be carefully pulled out. The ends of broken ones can be sometimes pushed into the barrel, and then shaken out, or must be drilled out.—Pond.

[32856.]—**Battery for Electric Railway Signal.**—The battery shown in my diagram of the electric slot signal, page 528 of last volume, is a twelve-cell Daniell's trough battery. The size or number of cells varies according to the distance between the two signal-boxes. Some telegraph engineers prefer the Muirhead chamber form of Daniell's battery, and also the Léclanché's, for working electric slot signals. Whichever form of battery is employed care must be taken that the electric current is powerful enough to cause the electro-magnet, K, to maintain the weighted lever, J, in the vertical position shown in the dotted lines. If this is not the case it is impossible to lower the signal for a train to proceed.—C. E. S.

[32861.]—**Removing Cement from Iron Pipes.**—The cement joints are made by employing an admixture of sal-ammoniac, flowers of sulphur, and iron borings. This sets very hard; and the best means for disconnecting the joints is by using a small cross-cut chisel.—Black Witch.

[32863.]—**Electro Magnet.**—To "Wiesendanger."—The bell will be about 60 yards distant from communicator. No. 16 G. P. covered wire has been laid underground, with return wire, ready for placing bell in position. I hope these particulars will enable "Wiesendanger" to add to his reply on page 250. What battery power would he recommend?—Drill.

[32864.]—**Gold.**—The way to separate gold from the copper and other alloys it contains is by dissolving the whole in aqua regia (nitrohydrochloric acid). The gold, which will then be in solution as terchloride ($AuCl_3$), can be reduced to a pure metallic state, in the form of a brownish powder, by the addition of an excess of ferrous sulphate ($FeSO_4$), the reaction being

$$AnCl_3 + 3\,FeSO_4 = An + Fe_2\,(SO_4)_3 + FeCl_3$$

—Inquisitive.

[32864.]—**Gold.**—There are several methods by which copper and silver are separated from gold, and these are distinguished by the synonyms "wet" and "dry." Separation by one of the former methods in this instance will be most convenient. The alloy should be in a granulated form, to allow of its being the more readily acted upon. The alloy should be placed in a digester, together with about 1½oz. of nitric acid (free from chlorine); the temperature should then be carefully raised. The copper immediately attacks the acid, and a violent action ensues. The heat should be kept up until all action ceases. The liquid is to be decanted, and the residue, consisting of the pure gold, is washed and dried.—T. E. J.

[32864.]—**Gold.**—Reduce the metal to powder and dissolve it in aqua regia (made by mixing 1 part nitric acid with 2 parts hydrochloric acid) in the proportion of 1 part metal to 3 parts acid. Evaporate the solution to dryness, re-dissolve in distilled water, and add ferrous sulphate until the black precipitate formed ceases to fall. This black precipitate consists of finely divided and pure gold, and, on fusing, it may be obtained in one mass. 1 part of the metal will require 4 to 5 parts crystallised ferrous sulphate. The powder should be washed, first with pure hydrochloric acid and then with distilled water, before fusing. The following is the reaction between the gold and ferrous sulphate:—

$$6\,FeSO_4 + 2\,AnCl_3 = 2\,(Fe_2\,3\,SO_4) + FeCl_6 + 2\,An.$$

Or the metal may be powdered finely and treated with nitric acid, which will dissolve out the copper and leave the gold, which may be fused into a button. The former method, however, will produce the purest metal.—Theo. Pitt.

[32865.]—**Force Pump.**—Does "Young Engineer" require a drawing with dimensions for a force pump (as he simply states he wishes to attach one to his engine), or does he ask for directions for fixing one? Shall be happy to assist him.—Black Witch.

[32870.]—**Chemical.**—Put a = weight of mixed chlorides, b = total chlorine, x = weight of potassic chloride, y = weight of sodic chloride. Then we have—

$$x + y = a,$$

and also

$$\frac{71\,x}{149} + \frac{71\,y}{117} = b,$$

from which we obtain

$$x = \frac{10{,}579\,a - 17{,}433\,b}{2{,}272}$$

$$y = \frac{17{,}433\,b - 8{,}307\,a}{2{,}272}.$$

I answered a query like this a few weeks ago, but cannot now find the precise page.—Wm. John Grey.

[32870.]—**Chemical.**—

If m = weight of mixture of chlorides
a = ,, chlorine
x = ,, NaCl
y = ,, KCl

x and y may be found from the following equations:

$$m = x + y$$

$$a = \frac{35{\cdot}5}{58{\cdot}5}\,x + \frac{35{\cdot}5}{74{\cdot}6}\,y,$$

whence (roughly)

$$y = \frac{10m - 15a}{4},$$

$$x = \frac{15a - 6m}{4}.$$

—W. W.

[32874.]—**Coating for Bricks.**—Different brickmakers have different mixtures for colouring bricks and tiles blue, but the best that I know of is obtainable from the Silicic Paint Company, Buckley, at 5s. per cwt.—CORCYRA.

[32875.]—**Hooks and Eyes for Catgut Bands.**—There are several reasons for this annoyance. 1. The threads in the hooks may be imperfect or shallow. 2. The gut may be too small for the hooks. If the latter be the case the best plan is to insert a piece of wire, about ¾in. long, in the centre of the gut, so as to expand it, then screw on. I have never found this to fail.—BLACK WITCH.

[32875.]—**Hooks and Eyes for Catgut Band.**—Oil the catgut before screwing on, and let it be a very tight fit, and when it comes through burn the end with a piece of hot wire.—TELESCOPE TELE.

[32876.]—**Cutting Gauge Glasses.**—Use a three-square file, and keep saturated with turpentine or spirits of wine.—BLACK WITCH.

[32876.]—**Cutting Gauge Glasses.**—File a notch round the glass at the length required; then break off.—ULLSWATER.

[32878.]—**Relacquering and Bronzing.**—The dead gold is simply lacquering the articles as they leave the aquafortis. When brass is dipped it requires to be kept on the move, and directly it shows a white frothy appearance out with it and plunge in cold water, then out of that into another pan with water pretty warm; this helps to dry. Well shake, and dry off in sawdust. Heat on stove and lacquer. The deep colour you speak of is simply a deep-coloured gold, or, if I misunderstand your question, let me know the particular colour you require. The red is obtained by cutting strips of thin sheet iron, and twisting about your work in all directions, and dip in weak aquafortis. Then rub up with Spanish brown, instead of blacklead, or mix them according to colour required. Where you are wrong in relieving is, I should think, by using the green lacquer for the burnished parts. Lacquer all over first with the green, then pick out the different points you require with a smooth cutting scraper, and burnish with a little 4d. ale. There are, of course, different-shaped scrapers and burnishers to get into different-shaped crevices. Reheat and lacquer with pale gold. WM. WHELAN.

[32881.]—**Gas Holder.**—Cheap ones—japanned tin, with stopcock—are quoted at: 2 galls., 12s. 6d., 4 galls., 16s.; Pepy's ditto, 20s. and 26s., or copper, 40s. and 50s. There are also cheap ones of stoneware, but they are very heavy. If "F. A. B. J." is a worker in metals, and understands the principle of gas-holders, he ought to be able to make either of the above for about a quarter of the prices quoted, which are on the usual exorbitant scale of apparatus-makers. Making the joints and connections gas-tight is the chief point.—DAGHBERT.

[32886.]—**Pulsometer.**—The pulsometer is the most economical pump of the day. As to its using more steam than an ordinary pump in performing the same duty, such is not the case, for it can be driven with exhaust steam, so that it actually costs nothing in the working.—BLACK WITCH.

[32889.]—**Lathe Bearings.**—The best form of bearings "D. W. B." can adopt for a high-speed lathe are the parallel ones, and a tail-pin. I have one which is driven at a great speed, and never gives any trouble. In this system all fear of setting fast as in cones is avoided. I advise gun-metal or anti-friction metal for the bearings and steel mandrel.—BLACK WITCH.

[32894.]—**Canary.**—For the information of "T. C. H." I may say that I have a daughter who seems very fond of birds, she having a canary that seems to take a deal of her attention while away from school, and up to a few months had scarcely given her a song for twelve months or more. The bird seemed to be unwell, and seemed to be losing feathers almost weekly, having been fed principally upon canary, maw, and millet seeds, with a little green, such as dandelion leaf, &c. I had a friend who one day called, and our conversation turned upon canaries. I was advised to put the bird's feet in a little warm water for a minute or two, and let the bird have only the white canary seed for a while, and put an old rusty nail in its drinking water for a while. I did so, and in about a month the bird began to sing a little by degrees, and now sings as ever it did, though it is not in good feather.—B. J. S.

[32894.]—**Canary.**—Give the canary the following: A paste composed of bread pounded very fine, mixed with well-bruised lettuce and rapeseed, tempered with a little yolk of egg and water. Do not on any account give the canary any hempseed, as that is principally the cause of the moulting. The asthmatical wheezing that you complain of generally arises from a cold, or from having been neglected, or having too much hempseed, which, although the birds are very fond of it, is very injurious, and is over-heating. One of the best things for this complaint is watercress; put a small bunch in the cage every other day.—TELESCOPE TELE.

[32895.]—**Bicycle.**—I would recommend "Tangent Amateur" to have an ordinary roller brake upon his hind wheel. It is one which I have used for some years now in preference to any other brake acting on either the fore or hind wheel. I find it is quite to be depended upon, and can with safety trust myself down any hill with its assistance, and that of my legs. Brakes on the front wheel are very apt, upon a sudden application, to land you over the handles. As to the destruction of rubber by the roller brake on the hind wheel I cannot attribute the slightest damage of my rubber to the brake, and I have had my present machine upwards of a year. Certainly more damage is done by the brake to a fore wheel than by one to the latter.—T. E. J.

[32898.]—**Galvanometer for Use in Electroplating.**—Inasmuch as this is a matter included in my patent I can scarcely be expected to furnish particulars beyond those given in my specification. I may further inform the querist that the actual graduation involves so much knowledge of appliances that it is almost impracticable for any one to construct them.—SIGMA.

[32902.]—**Tanning Canvas for Barge Sails.**—This process has been fully described by me in No. 660 of the ENGLISH MECHANIC at p. 245. 31072—viz., in the number for Nov. 16th, 1877.—EAST ANGLIAN.

[32902.]—**Tanning Canvas for Barge Sails.**—"Colchester" had better go to the chemist's, and get some stuff called cutch; the price is about 8d. per lb. (that is what I give). I use it for nets as well as for sails. You will require about 1lb. of cutch for every 20lb. of sails; make a solution of the cutch. It must be hot water. Let the sails soak for two days in the liquor, wring, and put out to dry. It does them splendidly if done properly, and leaves nothing to be desired. It will tan anything—ropes, cords, sails, nets, &c.—TELESCOPE TELE.

[32903.]—**Geometry.**—The proof is wanting in the construction given in page 250. The problem is a particular case of the more general one: to construct a triangle equal to A B C and similar to D E F. Make the square. G H L K = A B C, and G M N O = D E F; take D P : D F :: G H : G M, and draw P Q equal to E F, then D P Q is similar to D F E, and D P Q : D F E :: $DP^2 : DF^2 :: GH^2 : GM^2$, but D P E = GM^2 :: D P Q = GH^2 = A B C.—W. G. P.

[32903.]—**Geometry.**—The following will serve "Enquirer":—(1) The area of any triangle being equal to half the product of one side, multiplied by the perpendicular from that side to opposite angle; and (2) any equilateral triangle whose length of side is 1, having the perpendicular from that side to opposite angle = $\sqrt{1^2 - \cdot5^2}$ = ·866 nearly, or area nearly ·433, while the areas of equilateral triangles are in proportion to each other as the squares of their respective sides; (3) the square root of quotient of area of "any triangle" divided by ·433 gives the side of equilateral triangle, whose area is equal.—BUTTERSHAW, near Bradford.

[32905.]—**Pumping Engine.**—The net diameter of the plunger would be about 28 inches, but it is usual to increase the area ¼ to allow for leakage, &c., which would bring the diameter to about 30¼ inches.—ARTHUR ALFRED.

[32905.]—**Pumping Engine.**—Multiply the number of gallons per stroke of pump by ·2043, and divide by length in feet, and the square root of the product will be the answer. The question proposed will be:—1·200 ÷ 5 = 240 × ·2043 ÷ 9 = $\sqrt{5\cdot448}$ = 2·334ft., or 28in. diameter of barrel.—J. R. W., Mapplewell.

[32905.]—**Pumping Engine.**—Let L = length of stroke in feet, N = number of strokes per minute, G = number of gallons discharged per minute, D = diameter of pump in inches. Then $D = \sqrt{\frac{G}{\cdot03400\ L\ N}}$ i.e., L being 9, N 5, and G 1,200, D will be 28in. nearly. This is net diameter; allow for leakage, "slip," &c. You will find this and other useful formulæ for pumps in the first-named of the books recommended to you in "Answers to Correspondents" in No. 685.—H. E. H.

[32905.]—**Pumping Engine.**—In reply to "Depty," "1,200 gallons per minute" discharged in five 9ft. strokes gives $\frac{1,200}{9 \times 5}$ = 26·66, or, say, 26·7 gallons per foot of stroke. And as the contents of a cylindrical vessel 10in. diameter 1ft. deep = 3·4 gallons nearly. As 3·4 : 26·7 :: 10^2 : 785·3 nearly for the square of required diameter (28in.) of working barrel—reckoning nothing lost. Or, by engineer's sliding rule, 3·4 on slide $\frac{B}{C}$ set opp. 10 on line D; opp. 26·7 on do. is ans., or D = 28in. diam., as before. Thus:—

	A	
On B/C	set 3·4	and opp. 26·7 on B/C
Opp.	D 10	is ans. 28 on D

—BUTTERSHAW, near Bradford.

[32905.]—**Pumping Engine.**—A pumping engine with a 9ft. stroke in the pump goes five strokes per minute and discharges 1,200 gallons per minute. 1st. 5 strokes = 1,200 gallons; therefore 1 stroke = 240 gallons which, multiplied by 277·274, the cubic inches in a gallon = the total quantity of cubic inches per stroke, which I have worked out to be 66,545·760, which divided by the length of stroke in inches and ·7854, of which the square root of the remainder will be the answer. Thus:—

$$\frac{240 \times 277\cdot274}{108 \times \cdot7854} = \sqrt[2]{784} = 28\text{in., or a little more.}$$

—R. PEARSON.

[32905.]—**Pumping Engine.**—The size of the working barrel will be 29in. in diameter, which, with a 9ft. stroke and 5 strokes per minute, will raise 1,286·65 gallons of water per minute theoretically, but allowing 6·73 per cent. for waste (or 86·65 gallons) will make the total 1,200 gallons per minute quantity discharged.—A PUMPER.

[32906.]—**Oval Measure.**—To find the area of an ellipse, multiply the length by the breadth and by ·7854. Thus, if your ellipse is 18in. by 12in., the area will be 169·64 square inches. Or else multiply the product of the semi-axes—in this case 9in. and 6in.—by 3·1416, giving a similar result.—H. E. H.

[32906.]—**Oval Measure.**—Length × breadth × ·7854 = area. The area of a fire-hole door 1ft. 6in. × 1ft. would be 1ft. 25in.—ULLSWATER.

[32908.]—**Refractive Power of Water.**—According to Ganot, p. 451, the index of refraction for water is 1·336, and for ice 1·310. He does not, however, state at what temperature the water must be to have this index; but he says that it has been lately shown that the index of refraction varies with the temperature, and that while with some substances the index increases with the temperature, in others the reverse takes place. It is not a universal rule that the index of refraction increases with the density—for instance, the index for water is 1·336, and for alcohol it is 1·374.—W. G. P.

[32911.]—**Fuller's Battery.**—Both questions must be answered in the negative. The advantage of the Léclanché is that there are no different solutions to pass into each other, so that the porous pot is of use only to sustain the mixture of carbon and manganese mechanically. It is much the best in both cells to have the zinc in the middle, and so to obtain a larger negative surface.—SIGMA.

[32913.]—**Model Cutter.**—The details would occupy too much precious space to be inserted; so "Poor Joe" had better study his subject and copy carefully, working to scale. Unless he has a good stock of patience he need not begin, as the writer was two years in building a model brig, carrying 16 guns, with orlop, main, and middle decks, companion ways, with proper stairs, poop, and forecastle, wheel and rudder answering to it, being worked by small pulleys under poop; capstan, life-buoys, blocks and sheaves, dead-eyes and stanchions for bulwarks, all patiently made by the writer. The keel, to begin with, was 2ft. long, 3in. broad, and 1in. thick. The stern-post was one solid piece let into the upper edge, and firmly screwed; the stem ditto. The keel was then cut away on its upper edge forward to midships, where it is now ½in. after the planking, and 2in. at stern-post, as we shall call it. Ribs of ash, ¼in. square, softened in the boiler, bent to the proper form, and tied with twine till set, are let into the upper edge of keel, 2in. apart, diminishing from midships to stern. Beams of oak, made of a piece 1in. thick, 9in. long, and 6in. wide. The ends are bevelled away from the centre on one side, and a line drawn exactly along the thickest part, then gauged ¼in. One beam at once is cut; the longest will be ¼in. thick at the cords, the shortest more, as they must be cut at both ends to preserve the symmetry of the deck. The planks for hull, ⅛in. thick, and ¼in. broad [illegible] most, but tapering to the stem and stern, must fit in a groove on each, and be secured with copper nails, using a small sprig-bit. When both sides are equal in height and level with beams, the nails all clinched, the ends of ribs cut off, &c., the deck planks may be laid. They must be fine pine, 3-16in. thick, and gauged ¼in., may be cut with a knife, and carefully dressed to be slightly narrower on the under side, then nailed to the bearers. They should project [illegible] round ¼in., and their edges covered with a strip of copper, rounded and polished, 1-16in. thick, and 3-16in. or ¼in. broad. Both hull and deck must be levelled with a rasp, and all nail-heads removed, finishing with glass paper. The keel also must be worked away to ¼in. thick, and a strip of copper nailed on its whole length. A good eye is needed [illegible] preserve the lines and curves on each side equal. The hull must now be painted a priming coat at [illegible] when dry, all crevices made up with hard putty [illegible] few more coats, then polish with pumice-stone [illegible] few more, and polish again, till the outline [illegible] then a flat coat, and varnish with carriage varnish. The deck may be French-polished previous to [illegible] on the bulwarks. Many details are perforce omitted. —G. B.

[32918.]—**Electric Pen.**—The idea is erroneous. No change takes place in the solutions themselves when electric currents pass, but only at the surfaces of contact, as, at the point of the style, the metal of which combines with one part of the solution. Intermediate papers would, therefore, not be affected. —SIGMA.

[32920.]—**Capillaire.**—Capillaire is a syrup prepared by adding sugar and orange-flower water [illegible] infusion of the fern Maidenhair (species *Adiantum pedatum*), or by pouring boiling syrup over the fern. It is used as a pectoral medicine in lung diseases.—H. R. R.

[32924.]—**Telescope.**—If the eyepieces, giving [illegible] are powers of 180 and 250 used by "Tot[illegible]

, there can be but little doubt that it is at is in fault. Before throwing it away, might look at ι Lyræ. If he sees four istinctly he may get some service out of ι; yet even if he does succeed he will have bad bargain if he does not see some of tests which have been given in the [ECHANIC. To resolve ι Lyræ is quite power of a good 2¼in. telescope, which for £5.—W. G. P.

Red Colouring for Syrups.—Boil 1oz. th half teaspoonful cream tartar, strain. s.

Red Colouring.—It does not neces- r, because there are others with which and red currant syrups can be flavoured, h syrups should be so flavoured; and the rups made with the fruit is vastly supe- t made with an artificial material, and e distinguished. They are undoubtedly ways. One might with equal justice there is no French brandy because a ts of flavouring English spirit. For a atter there is nothing so harmless and cochineal.—Os.

Mensuration.—A cubic yard = ·02909 eet. "John," in working out his second 5 × 4·75 × ·7854 × 35 × ·02909), is out ning, as he is working it in the first part cube and finishing as cylindrical feet. r (4·75² × ·7854 × 35) ÷ 27, and he will h a discrepancy. 27 = number of cubic bic yard. Secondly, in the formula area diameter, 1 = ·7854. If the diameter of ne foot the area is ·7854 feet; if two feet, , and so on. The one may be taken as s, or any other lineal measure. ·7854 = or ratio of circumference to diameter.— nend.

Mensuration.—Your error arises from product of 4·75² × 35 by ·7854, thereby cubic measure. A few remarks will you right. The diameter of the well, ltiplied by depth, gives the number of feet; this multiplied by ·02909 gives the cubic yards. If you multiply the number al feet by ·7854, you reduce them to cubic d in order to get number of cubic yards, ·037; or, more correctly, divide by 27. A foot is to cubic as ·7854 to 1—conse-

$$\frac{\cdot 7854}{27} = \cdot 02909. \quad \frac{1}{27} = \cdot 037.$$

ttle ambiguity about your second ques- he formula simply means that if the any circle be squared, and the product by ·7854, you get the area in square ROSCOE.

Mensuration.—"John" has written for "base" in rule for finding solidity He has also given a wrong value to the foot, which equals a cubic yard × cubic foot × ·7854; thus his mistake multiplying by ·7854. He might, how- e diameter, multiply by ·7854 and by divide by 27 (the number of cubic feet yard). His second question may be us: Given a circle of the diameter 1, that circle = ·7854.—H. F. R.

Cement for Aquariums.—¼lb. best ground in oil; ¼lb. red lead, dry; ¼lb. y; the two last kneaded into the first. ow 1¼lb. of the best of putty for resist- It will soon become hard and continue lass should be bedded in it, and when hed, put away for a fortnight; then h shellac, dissolved in methylated spirits . to half a gill—put into a bottle and l be ready in an hour. It may be coloured, with a little vermilion. One coat, wher- is any putty or metal exposed, will be nd will dry in a few minutes. Your tank eak after this if the frame and glass are . B.

Cement for Aquariums.—10 parts by tharge; 10 parts plaster of Paris; 10 white sand; 10 parts finely powdered mix when wanted for use into a pretty with boiled linseed oil. This hardens r, but it is better not to use the tank till days. It resists the action of salt water. Mix 3lb. finely powdered Venetian red, with 1lb. oxide of iron, and add as much as will reduce it to a stiff paste.—

American Dried Apples.—The way dried in America is as follows:—The pared, cored, and either quartered or ed is the better way), and threaded with a strings, and dried in the sun, I believe a rying apparatus with a small furnace is used for small fruits, such as blackberries erries, which when dried keep very well nice "sauces," as they are called when h water in the winter—a cheap and nice serving such fruits. Whether apples are that way I cannot say, or whether our n in this country is hot enough to dry the open air, I cannot tell either; but I he apples were finely sliced and placed in a , and some means taken to reflect or con- the sun's rays, as, for instance, sheets of bright tin, that apples might be dried in England.—AMERICUS.

[32931.]—**American Dried Apples.**—The process is different from that of the Normandy pippin. The strips are run upon threads, and just hung to dry by the sun and air.—SIGMA.

[32932.]—**Birdlime.**—Boil the middle bark of the holly 7 or 8 hours in water, drain it, and lay it in heaps on the ground, covered with stones for two or three weeks, till reduced to a mucilage. Beat this in a mortar, wash it in rain water, knead it till freed from extraneous matter, put into earthen pots. In four or five days it will be fit for use. An inferior kind is made by boiling linseed oil for several hours until it becomes a viscid paste.—AMERICUS.

[32932.] — **Birdlime.**— The best, easiest, and cheapest way to make birdlime is to boil linseed oil, until it is about the consistency of thick syrup.—FLOAT.

[32934.]—**London B. Sc.**—Your correspondent, W. H. Escott, does not seem to have a very clear idea of what is wanted for the London B. Sc. Whether previous examinations are unnecessary or not, he will have to pass two of them before the final one for the degree, unless he is a graduate of Sydney or Melbourne, which I presume he is not. In the first of these two examinations he will require more than an elementary knowledge of three languages, besides English. Learning from a catechism, too, seems to suggest the idea of "cram," and that, if a question is set off the beaten track, he will be unable to answer it. I don't know, either, whether it prepares him for the practical examination in chemistry and biology if he takes those subjects. But it will be time enough to inquire on these matters when he has passed the two previous examinations.—OWEN'S COLLEGE.

[32934.]—**B. Sc., London.**—It would appear from the wording of this query that W. H. Escott, having made himself master of "Pinnock's Science Catechisms," considers that he has knowledge sufficient to justify the University of London in conferring a degree upon him. He further seems to think that some special exception ought to be made in his case, whereby the great acquirements to which he has attained by reading through a few catechisms may avoid any "unnecessary (?) and troublesome" tests. I do not wish to appear hard on the querist, but if he had thought for a moment before penning his query he would have seen that the very object of the preliminary examinations which the candidate must pass is to prevent any one stepping in and taking the degree without any previous training, as Mr. Escott apparently wishes to do. He should write to the Registrar, University of London, Burlington-gardens, W., for a copy of the regulations relating to degrees in Science; he will then find out exactly what he must do. I may mention that if he presents himself for matriculation in June next and succeeds at every examination he will not be able to append B. Sc. to his name until October, 1880.—R. S.

[32942.]—**Interest.**—If "J. W. B." asks this question with any idea of making such an arrangement, the following will show him what is practically the amount of interest, without going into any mathematical difficulties:—£50 repaid in weekly instalments in ten weeks is equal to £50 repaid in a lump sum at the end of 5½ weeks; therefore, £10 paid for the use of £40 for 5½ weeks is a little over 236 per cent. per annum. The interest in the other case, calculated roughly in the same way, is £8 16s. 3½d. per cent. per annum.—M. H.

[32942.]—**Interest.**—This question presents itself in two forms. We will suppose that during the first 8 weeks the principal (£40) is paid, and that the interest (£10) is paid in the remaining 2 weeks. Now it is evident that for one week you have the loan of £40, for one week (the next) you have a loan of £35, and for another week a loan of £30, and so on, while for the last week you have only a loan of £5. Now, in order to get at the value of the various items, we will say that a loan of

For 1 week.		For 52 weeks.
£40	is equal to	£0·769
35	"	0·673
30	"	0·576
25	"	0·480
20	"	0·384
15	"	0·288
10	"	0·192
5	"	0·096
		£3·458

Calculated in this way your loan of £40 would equal another loan £3·458 for one year, and for this you pay £10. This would be 289·18 per cent. per annum. Instead of dividing the principal into 8 portions, and paying the interest afterwards, suppose we divide it into 10 payments of £4 each, and pay one-tenth of the interest each week. That is the method given in some loan society circulars. They say, "Divide the loan by the number of instalments, and add to each a certain sum," which they specify according to the time over which the loan is to extend. On this principle you pay £1 for the loan of £40 for one week, next week you will pay a similar amount for the £35 which you hold, while at the end of the 10th week you will pay £1 for the loan of £4 for that week. The following table shows the rate of interest per annum paid on each sum, said interest being paid on the sum in hand at the end of each week:—

weeks.		£.		Per cent. per annum.
1	...	40	...	130·00
2	...	36	...	144·04
3	...	32	...	162·24
4	...	28	...	185·64
5	...	24	...	216·32
6	...	20	...	260·00
7	...	16	...	325·00
8	...	12	...	433·16
9	...	8	...	650·00
10	..	4	...	1300·00
				3796·40

The mean value of this sum is, therefore, 379·64 per cent. per annum. Which of these methods is the more correct (if at all) I cannot presume to say. I cannot altogether see the reason for the great discrepancy between the two results. Perhaps my figures are wrong; but, still, there must be a difference, as, in the first case, the interest is not supposed to be paid till after loan, and in the other it is paid pari passu.—Os.

[32942.]—**Interest.**—The method of ascertaining the simple interest on sums of money payable by regular instalments is to take the average time the money remains at interest. In the first example the payments extend from one week to eight; adding these together, and dividing by two, we get 4½ weeks for the average time, and the sum may be stated thus: As £40 × 4½ weeks : £10 :: £100 × 52¼ weeks to the answer £289 13s. 7¾ $\frac{6}{11}$d. The second example is of exactly a similar character; the first payment is at one month, the last at 21 years, the average 10 years 6½ months. The principal is £175, the interest £162 1s., as £175 × 10 years 6½ months : £162 1s. :: £100 × 1 year, to the answer £8 15s. 8$\frac{4}{13}$d.—A BARRISTER.

[32943.]—**Rose Colour.**—The vagueness of many of the queries has often been pointed out, but they do not seem to mend much. Does "Apothecary" want a transparent, semi-transparent, or opaque colour? He "has tried various substances;" why not have briefly named them, when the causes of failure might have been pointed out? Of course heat alters many colouring matters, or quite destroys them, yet the temperature proposed to be used is not mentioned, except by "pretty hot." He does not say whether the substance is an article of food or for outward application to the body, &c., yet colours are poisonous, or dangerous for particular purposes, or harmless, according to what they are used for. And, worse than all perhaps, no indication of the nature of the substance to be coloured is given, though an apothecary should know how colours vanish, change, or appear on mixture with various chemicals. I don't see how any useful answer can be given.—DAGHBERT.

[32943.]—**Rose Colour.**—"Apothecary" does not state what he wishes to colour—whether oil, spirit, water, &c. For oil or wax, alkanet root will give him any shade from pink to dark red, according to the quantity used, and, so far from heat destroying the colour, it requires a little heat to extract it properly. For spirit or water the aniline dyes or cochineal will give him any shade. I should prefer the latter, as it is perfectly harmless. The querist should, however, adopt a more appropriate signature, as an "Apothecary" would have known all this.—Os.

[32945.]—**Reducing Aperture of ¼in. O.-G.**—When the resolving power of an O.-G. is very great it is almost of necessity accompanied by a corresponding want of penetrating power. When you want to examine so large a thing as a cheese mite the best way is to get a general view of it as a whole by means of a lower power, say ½in., and then to examine the parts in detail with a higher power. It is not possible to get a very good view of all parts of an object of that size simultaneously with a high power.—W. G. P.

[32946.]—**Telescope.**—In this query an error was made. After the words "to mount them," should be added, "to make a higher magnifying power eyepiece."—RAILROAD.

[32947.]—**Blacking.**—Treacle and ivory black, of each 7lb. These are to be well mixed. Add two quarts of boiling water, and mix again, then 2lb. 10oz. of oil of vitriol (sulphuric acid) should be gradually poured in, the mixture being meanwhile well stirred. When these ingredients have been well incorporated add one pint of sweet oil. This will make "paste blacking." If the liquid preparation is wanted add sour beer or stale vinegar. This will make as good a blacking as you could wish. If you want to make it for sale you can purchase the bottoms or refuse of treacle casks from grocers, &c. The other ingredients are cheap also if purchased in the right places. —Os.

[32947.]—**Blacking.**—The following is a very good blacking:—Treacle, 1½oz.; ivory black, 1½oz.; sperm oil, 3 drams; oil of vitriol, 3 drams; vinegar, ½ pint. Mix 1st, the ivory black, treacle, and vinegar, then separately sperm oil and oil of vitriol, and mix the two together.—A. E. I. O. U.

[32947.]—**Blacking, Day and Martin's.**—Bone black in powder mixed with sperm oil till thoroughly incorporated, sugar or molasses mixed with a small portion of vinegar and added to the mass; oil of vitriol is next added; when all effervesence has ceased more vinegar is poured in till the mixture is of proper consistency. Another:—Ivory black and molasses, each 1lb.; sweet oil and oil of vitriol each ¼lb.; mix the first three, then add gradually the vitriol diluted with thrice its weight of water, let it stand for three hours, then reduce to a proper consistency with water or sour beer.—AMERICUS.

[32948.]—**Preserving Larvæ.**—The larva to be preserved must first be emptied of its contents by gentle pressure. The skin is then fixed by means of a piece of bent watch-spring on to the end of a glass blowpipe. Procure an empty preserved-lobster tin, cover the top with tin or wood, make a hole in the side large enough to admit skin of larva and end of blowpipe, heat the tin by means of a lamp, blow gently to distend the skin, and hold inside tin until dry.—NOT ELECTRICAL WALLASEY.

[32948.]—**Preserving Caterpillars.**—The method is, after having emptied out the inside, gradually to dry the skin in a hot-air bath, at the same time inflating it to its natural size by means of a piece of glass tubing drawn out to a fine point, through which a current of air is passed. Some very interesting papers upon this subject have lately been published in the pages of the *Entomologist*—by far the most complete in all details being that by Messrs. Golding-Bird, in the number of that journal for September, 1877.—INQUISITIVE.

[32950.]—**The Phonograph.**—To MR. SHELFORD BIDWELL.—I have no doubt that Mr. Geo. Fox's phonograph is so far properly constructed. It is difficult to distinguish any great difference in the forms of the dots or "pits" with the unassisted eye, though they become plainly visible under a microscope. The instrument may be roughly tested in its present stage by rotating the indented tinfoil under the point of the iron diaphragm. The result will not be nearly so good as when a second diaphragm is employed; but words ought to be easily distinguishable. If Mr. Fox is doubtful as to what ought to be the appearance of the indentations, I shall be happy to send him a piece of indented tinfoil (if he will advertise his address) as a specimen. By all means let him proceed with his work. With a little patience and perseverance success is certain. Any further questions on the subject will be gladly answered.—SHELFORD BIDWELL.

[32952.]—**Photographic.**—You do not make your glass sufficiently hot.—OS.

[32955.]—**Catching Night Moths.**—Smear a tree with some very stiff treacle and sugar, and a little beer, to attract the insects by scent. They will come more readily if a light is placed near—especially if it can be so arranged for it to shine through the sticky substance. Do not, of course, place it so near as to injure the insect when caught. Take a look round just before going to bed, so as not to let anything remain too long held.—MOTH.

[32955.]—**Moths.**—To do what "X. Y. Z." asks would be to write a book on "Lepidoptera." He will find all the information he requires in either Stainton's or Newman's works.—NOT ELECTRICAL WALLASEY.

[32961.]—**Excise.**—Subjects of examination obligatory: Handwriting, orthography, arithmetic to decimal fractions, and English composition. Optional subjects (which, as competition is keen, you would be wise to take up): Higher arithmetic, including mensuration, square and cube root, &c.; geography, especially that of the British Isles. If living in London, I would advise you to attend the special class preparing for this examination held at King's College; those attending the class have been very successful. Age of candidates, 19 to 22. Pay on entering, about £95 per annum; after about two years, a fixed salary of £95; in about two years more, £115, rising by £5 yearly to £130; then £140, rising by £5 yearly to £200. There are also higher appointments, with salaries up to £800.—H. F. R.

UNANSWERED QUERIES.

The numbers and titles of queries which remain unanswered for five weeks are inserted in this list, and if still unanswered are repeated four weeks afterwards. We trust our readers will look over the list, and send what information they can for the benefit of their fellow-contributors.

Since our last "Telescope Tele" has answered 32211; W. H. Davies, 32586.

32367. Flock or Wool-cutting Machine, p. 23.
32369. Paper Paste, 23.
32374. Non-Absorbent Material, 23.
32375. Rules for Choir, 24.
32382. Globes, 24.
32383. Cutting Steel Discs, 24.
32385. Yarmouth Sou'-Westers, 24.
32386. Centre-board Boat, 24.
32393. Legal, 24.
32401. Indigo Refining, 24.

32608. L. and N. W. "Bloomer" Engines, p. 127.
32609. L. and N. W. Cornwall, 127.
32610. G. E. 7ft. Engine, 127.
32614. Sailing Boat, 127.
32616. Agricultural Chemistry, 127.
32622. Ship Measurement, 127.
32627. Spoiled Brass Bedstead, 127.
32628. Butter Cleaning and Remaking, 127.
32633. Making Range Boiler, 127.
32634. Regulating Gas Meters, 127.
32641. Sizing, 127.
32646. Matt Sizing, 128.
32657. Civil Service Examination, 128.
32664. Artificer, 128.

QUERIES.

[32962.]—**Twilight.**—I should be greatly obliged for information as to how I can calculate the exact amount of daily twilight in London. Is there any publication containing it?—X.

[32963.]—**Polar Bands.**—What are they? They are regularly mentioned in the United States meteorological reports, but the term is unfamiliar to me.—X.

[32964.]—**Sc. and Art Examination.**—Will any of the readers of the ENGLISH MECHANIC inform me what books are suitable for self-instruction to enable one to work up for Honours 7th Stage Mathematics, Science and Art Department, the principal subjects for which are differential and integral calculus, differential equations, and the calculus of finite differences?—LEARNER.

[32965.]—**Author Wanted.**—Will any of your readers inform me of the name of the author of the following lines?

"—— and knew not but the Ganges rolled
"Near as the neighbouring Thames ——."

—W. P. MENDHAM.

[32966.]—**Solution of Caustic Soda.**—Will any of our chemical readers assist me to make a solution of caustic soda of such strength that 1,000 grains of solution would neutralise as much sulphuric acid as would contain one grain of sulphur?—NOVICE.

[32967.]—**Hematine turning Brown.**—In titrating dilute sulphuric acid, over which a stream of purified coal-gas had passed, I find the hematine used for colouring turns nasty dirty brown instead of pink. Will any one say what impurity is present to cause this?—NOVICE.

[32968.]—**Steam in Small Boat.**—Small steam-engines are now so generally employed that I should think it would not be either difficult or expensive to use one in a small pleasure boat, say a yawl 20 or 30ft. long. My idea would be to make a small engine and boiler, able to drive the boat at least as fast ar four oars would, which, together with a pair of paddles with their boxes, fitting on the gunwale, might be easily and readily placed in the boat, and again removed to use oars when desired. Any firm who would supply such an arrangement at a small cost would, doubtless, be largely called upon.—AQUARIUS.

[32969.]—**Bronze Tea Urn.**—Would any correspondent of the ENGLISH MECHANIC inform me as to the process of cleaning and rebronzing the above, which has been standing in a damp place, and in consequence has become full of little verdigris specks?—COPPERSMITH.

[32970.]—**Solid Stencil Ink.**—Will some one favour me with instructions for making a solid stencil ink or a water colour that will be cheap, made in a cake?—TODMORDEN.

[32971.]—**Chestnut or Oak.**—Is there any means of distinguishing between these woods when nearly 800 years old? It is a disputed point whether the beams in a building of that age are chesnut or oak. It was formerly surrounded by a chestnut forest. There are very few cobwebs on the beams though many between them, and I am told that spiders rarely attach their webs to chesnut. Would any difference in the microscopical structure be noticeable at so great an age? If so, what are the peculiar characteristics of each?—HEREWARD.

[32972.]—**Grafting Stockings.**—Is the art of grafting stockings extinct? A lady who has several pair of silk stockings requiring new feet will be glad to hear how to do them.—E. J.

[32973.]—**Screw-cutting.**—Will any reader assist me by giving me the rule for cutting from two to eight threads upon one bolt? For instance, I want to know how to cut five threads upon one bolt 2½ pitch.—F. BOTTOMLEY.

[32974.]—**Sheet-Steel.**—Could any correspondent inform me how the scale can be removed from sheet-steel otherwise than by the use of acid?—S. J. R.

[32975.]—**Carbon.**—What is the best method of converting coke dust or powdered coke into hard carbon pencils for the electric light?—W. K.

[32976.]—**Grindstone for Razors.**—I hear that the best are obtained in Greenwich. Will some reader kindly say if this is so, and what they are composed of?—J. STEWART.

[32977.]—**Indelible Ink.**—For some time past I have been trying to make an indelible ink from aniline. After numerous failures I succeeded in making an ink from hydrochloride of aniline and gum arabic in one solution, and ferrocyanide of potass in the other. As soon as these solutions are mixed they form a thick substance, which, when stamped on linen, &c., won't wash out. This ink, so far, is good enough, but it gets a brownish shade and does not look well. I tried the recipe given in Vol. XXVII., No. 683, p. 176. I used the greatest care in weighing the chemicals, &c., and am sure I got the ones mentioned in the recipe, as I got them from Manchester. Notwithstanding, the ink is a failure, owing, I suppose, to a misprint in the recipe. When mixed the ink is not a greenish fluid but a yellowish brown. It does not turn a dark blue when put into soap and water, but washes out, except it be heated first, and then it turns an ugly faded blue. There is an excellent ink made by Blackwood in two preparations, one aniline and the other a pinkish blue. This, mixed with the hydrochlorate of aniline, forms a beautiful ink, but it won't stand heating; but that is no matter as 12 hours' exposure to the air renders it fast. I should be much obliged for a hint as to the cause of the recipe not succeeding, or any hint on making an aniline ink for stamping.—THOMAS WILSON.

[32978.]—**Wheel Cutting Machine.**—Will our friend, "X. X.," who sent the drawings and description of a wheel-cutting machine, please send a few hints about cutting skew or diagonal teeth, and say if you have to twist the tool askew; and, if so, how would the strap run? A few words on making the tools would oblige. Would a machine like the drawings do for a wheel 2ft. 6in. dia.? The height would be, of course, according to height of slide.—X. X. X. X.

[32979.]—**Eyepiece for Telescope.**—To MR. LANCASTER.—Can you inform me how I can make an eyepiece (to telescope) so as to utilise in its construction a plano-convex ¼in. focus? The power of eyepiece to be about 55 or 65 (100 to 1in. of O.G.).—A. SELLS.

[32980.]—**Leather Strapping for Chairs.**—Will any reader inform me how the Londoners make leather strapping such as is used for morocco-covered chairs? It is not pared and turned over on calico as some is, but simply turned over with the raw edges, and being so thick I should like to know how they do it so true.—W. H. W., Sheffield.

[32981.]—**Electric Bells.**—I have made several successfully, but still do not understand them. Say a distance of 80 yards (1 unit), and a 3½ bell is to be made by the best man in London, how would he settle size of magnet, of wire on it, of length of wire (resistance in it), the size of Léclanché cells, and number to be used, and in what way would he alter his plans if his customer said he wanted a louder sound from it, or a larger bell altogether, or one for 800 yards, &c., &c. What is the best working resistance to put against a pint Léclanché, and what is the greatest resistance one will stand for a circuit and magnet together, the armature of which is a relay to an electric thief alarm, served by another battery, or can I get a better cell for the constant work from 10 p.m. till 7 a.m. daily?—BELL.

[32982.]—**Sleeping on the Back.**—I should be much obliged if any readers could recommend some simple apparatus or method to prevent the writer sleeping on his back, a position which his medical adviser says it is very desirable he should avoid?—BACHELOR.

[32983.]—**Spherical Aberration of Object-Glasses.**—Will not some of your correspondents give in your paper technical information in regard to the construction of achromatic object-glasses for telescopes? The mere handwork of working the glass is known to us all, but what is desired is to know how the spherical aberration is corrected; for no matter how carefully the curves are computed there is a residual correction which has to be marked only by "local touches." Suppose we use Foucault's method, how are we to find upon what one of the four surfaces the "ring" belongs? Nothing to my knowledge of a technical character has been published since "Putzal's Dioptric" in 1829.—CLARENCE STERLING.

[32984.]—**Anhydrides.**—Hugh Clements in letter (14216) speaks of and notates aceto-benzoic anhydride, and benzo-cinnamic anhydride. Are these definite chemical bodies? and can he kindly give briefly their characters, reactions, and derivatives, or refer to authorities for such data; because in the context they are otherwise spoken of as "Mixtures of Anhydrides" and as such, I fancy, they are separable by distillation or otherwise. His aceto-benzoic anhydride contains the elements of aceto-benzoic acid. Is it that which splits up into acetic and benzoic oxides. Or is it a mixture of the two anhydrides?—ONE IN A FOG.

[32985.]—**Canoes and Canoeing.**—Will "E. H. J." or some of our friends say whether it is practicable to divide a double-bladed paddle in the centre of shaft and refix it with a screw or other suitable joint, so that the blades may be set at an angle to avoid catching so much wind when paddling against a stiff breeze? If so, what would be the best, ligthest, and strongest joint? Half the paddle would be very convenient to steer with when sailing. It could be used in a crutch fixed to side of canoe in the same manner as an oar when rowing.—SEA K[illegible]

[23986.]—**Headache in the Water.**—Having a wish to learn to swim I commenced about two years since, [illegible] was always prevented by a distressing headache as [illegible] as I entered the water, which generally lasted till [illegible] day. I have entered the water in various ways—[illegible] head-first, feet first, sideways, &c., but always with [illegible] same distressing result consequently have not been [illegible] to go in the river more than four or five times during [illegible] summer. I am now 18 years of age, and should very [illegible] like to practice this coming season. If any reader [illegible] give me advice that will be useful, I shall feel [illegible] grateful.—J. N. B.

[32987.]—**Water Colour Boxes.**—Can any correspondent give me any information as to the composition and the method of applying the white enamelling, [illegible] is used inside moist water-colour tin boxes.—A[illegible] DOUGLAS.

[32988.]—**Books on Botany.**—I beg to thank [illegible] Proctor and "A Fellow of the Royal Astronomical Society" for recommending me books on geology [illegible] time ago, and now should be much obliged if they [illegible] inform me what are the best books for the study of [illegible] wild flowers. I have only Oliver's "Lessons in [illegible] tary Botany," and had thought that Hooker's "Student's Flora of the British Islands" was what I wanted, but find it is out of print, with no prospect of another edition being published at present, although most of the [illegible] sellers of whom I have inquired say they are often [illegible] for it.—E. M. M.

[32989.]—**Dimensions of Tank.**—A tank in [illegible] form of the frustum of a cone is 20 feet in diameter [illegible] the top, 15 feet in diameter at the bottom, and 6 feet [illegible] perpendicular depth at the centre. Will some of your readers kindly inform me by what rule any of the intermediate diameters can be accurately found—say at [illegible] foot in depth?—GAUGE.

[32990.]—**Alabaster, to Polish.**—Would any [illegible] "ours" kindly inform me how to polish an alabaster slab?—BOTHWELL.

[32991.]—**Kiln Blast.**—Would any practical [illegible] of the MECHANIC kindly inform me how to raise a [illegible] for ventilating a kiln about 20ft. square, giving dimensions and where to be placed, and oblige?—A DUSTY MILLER.

[32992.]—**Gold Leaf.**—I should be much obliged any reader would inform me how to handle gold leaf, cut it to the requisite size for lettering books, with too much waste? I waste nearly a whole leaf for lettering piece. Also how to put gilt letters on w paper or other coloured lining papers of books? also the best way to rub off the superfluous gold?—J. A

[32993.]—**Musical Box.**—Can any reader oblige telling me the cause of the disagreeable jarring [illegible] often heard in musical boxes that have been in use [illegible] time? I shall be glad to learn if there is any effectual and easily applied remedy for the same?—DISCORD.

[32994.]—**£5 Telescope.**—Many thanks "F. R. A. S." and Mr. Lancaster for their kind reply. When I read "F. R. A. S.'s" reply I felt rather down-hearted, as I did not expect anything so strong. I was sure that I had a first-rate telescope, but now I find I mistaken. On the edge of the large glass there is a uroisir? I suppose that is the name of the glass. When I look at anything on the is misty—there are no colour fringes. It ght except the mistiness. Where should the e placed—one near the eyepiece, the other glass, or where?—TELESCOPE TELE.

namelling Tin.—I should like to know enamel tin white, or paint it to look like L.

leaching with Sulphur Fumes.—struct an apparatus for using sulphur, so e strongest effects of bleaching possible? pecting very powerful bleaching would be of o me.—ANXIOUS.

pinning Wheel.—Will any kind friend gh to give me a description of the old-nning-wheel, and how it was worked?—ILE.

honograph. — Will "Speravi" (32408, help me? I have constructed a phonograph ylinder, containing 8 threads to inch, and a agm 3in. diameter, the short steel point ect to the centre of it. I can obtain the n the tinfoil in a very marked manner when from which I utterly fail to produce more usical note, varying but little in pitch or "Speravi" please say what is the probable e, and say if he uses one or two diaphragms, t results, if he fixes point direct on the how? I should also like to know how to the cylinder evenly, as I find that in strain-cylinder it always sinks into the grooves he result being a very uneven surface, the quence often tearing it.—L. NEWTON.

urious Apparatus or Chemical Toy. ss tube about 6in. long, with a bulb at each ns a red liquid which, when not only lying d in the hand, moves up the tube in jerks. ours" please explain the cause, what liquid scientific name?—J. MOORE.

ransit of Mercury.—Would your valued "F. R. A. S.," or Mr. Proctor, kindly the formula used in the *Nautical Almanac*, ling the time of the transit at places distant ch? In the bracketted terms I am much ERTSON.

arriage Charge.—On their marriage a llowed his wife a charge on his property, to er support in case of his death. The pro-l, and her interest is only good whilst her e endures. They now discover it would be al benefit to sell their interest in the pro- trustees to the marriage articles say no, onsent lest they should become liable for rge. Under these circumstances the wife e up all claims to her charge, and I wish to n legally do so, or how she can manage to usband their interest in the land, for were ld with her charge in prospective it would ne to the buyer, and, of course, much less ined for it by the seller.—ONE WHO HAS D ASKS HELP.

afe Working Load of Timber.—respondent give me a rule in simple arith-ng the load that may be safely placed upon tch fir 8in. square, and supported at each eet apart?—L. D.

elenium Plate.—How could I construct te such as used in Mr. R. Sabine's galvanic ed in the ENGLISH MECHANIC for May 12th, LTA.

hotography.—I have made a pretty good a, and have a common convex lens, which ir image on ground glass. Would any one me if this common lens would be sufficient hic purposes, or should I require a combina-nses, as is generally used? A hint or two on vould be thankfully received by—A HIGH-R.

ntermittent Downward Filtration —I shall be very much obliged if any of will inform me what preparation of the essary at the Merthyr Tydvil sewage farm, the sewage being turned upon it for Dr. Frankland's system of Intermittent iltration? Any information as regards ound, and nature of subsoil, best adapted e, will be thankfully received.—WALLACE

French Polishing Violin. — Will some one versed in violin matters, give the olins cannot be French-polished instead of . W. N.

iolins.—I have four violins all in good reader tell me which is by best maker and s by Perry, Dublin, 1802; next is by e address and date are illegible; another ines, the address also illegible, but the date ; another by Aug. With Gleer, manufac-kirchen, in the Saxon Voigtland.—AN OLD

hoto Varnish.—Will some photographer arnish is used on photos? I want a varnish l hot-rolling by a photographer's press, for varnished millboard 4ft. long by 4in. wide. the press being heated by gas would dissolve paper varnish, which is, I think, a shellac otographic varnish will not do what varnish

isulphide of Carbon Test.—What is in the estimation of sulphur in iron sul-this test?—B. W. H.

iding.—I should be glad to know how I upright seat in the saddle. I ride a good hat I lean too much on one side. How can s? I have tried lengthening one stirrup his feels uncomfortable.—G. S. A.

uffs.—Would any correspondent tell me a set of buffs for polishing knife blades?—IND.

rickmaking.—I am about lining some h sheet brass, previously lined with mole-skin. I am a little puzzled how to lubricate them with water. I find that if I make holes they get filled with clay. Will some reader of the MECHANIC give advice?—W. H., Salford.

[33013.] — **Wood Cutting Machinery.** — How many superficial feet of planking (Scotch fir, red or yellow pine) will a circular saw cut up per hour, or a day of ten hours, and the horse-power expended in performing the work? The same query with regard to vertical saws, mentioning the number of blades in frame. What is the best work on wood-cutting machinery?—BON-RAJ.

[33014.]—**Ouncil.**—I have an ouncil consisting of a long spring coiled spirally inside a brass case, on the outside of which is a pointer, travelling along an index weighing down to 10lb., it bears a name engraved "Avery's improved spring-balance." Of the first three notches on the scale the pointer takes no account; it begins to act at the third pound, falsely showing that three pounds are weighed instead of one. If I bend the pointer then it becomes wrong again as the weight exceeds ten or more pounds. At present it is correct with weights beyond 10lb. I have opened it, and it seems fresh and uninjured. I wish some friend to tell me how to regulate it. I feel sure there is an easy way to do so.—E. B. F.

[33015.]—**Mining.**—Would any reader be so kind as to answer the following? 1st. What do you consider the most suitable kind of winding engine for deep shafts and large outputs? 2nd. Which do you consider the most suitable kind of winding ropes as regards safety and economy? 3rd. Give a description of the most suitable kind of drum and pulley for round wire-ropes, the minimum size of each, and the least angle between the drum and the pulley requisite for safety and economy. 4th. Describe what you consider the most efficient apparatus for the prevention of over winding, and also for the suspension of the load in shafts in case of the rope breaking. —PRACTICE.

[33016.]—**Nickel.**—Would you kindly inform me how to prepare ammonio-sulphate of nickel—also ammonio-chloride of nickel? Mr. Sprague says in a back number that platinum decomposes the solution; does he mean that a platinum wire supporting the articles to be plated will decompose the solution? Can you tell me where betuline can be obtained, also the ammonio-sulphate of nickel in quantity?—FRITZ.

[33017.]—**Tuning the Violin.**—I have commenced the study of the violin, and, as is usual with most beginners, find the first difficulty to consist in learning to tune it. Are there any scientific rules extant for tuning it other than that which appears to depend upon the impression made upon the musical ear by the co-vibration of the strings in 5ths? Can also any mathematical rule be given by the authority of which the harmonious vibration of the strings in 5ths, when in tune, can be infallibly affirmed, or is the power to apprehend this inherent in some persons and not in others? How may the musical ear be best cultivated, or, to speak phrenologically, the organ of tune be best developed, so as to render keener and more acute the power to distinguish and appreciate nice distinctions in musical sound?—A TYRO.

[33018.]—**Excavating.**—Will some practical engineer among the readers of the MECHANIC assist me in calculating correctly for the following (giving the modus operandi), so as to form a sure check against the reckoning of my employer's agent? I engage to do some excavating according to the following dimensions:—The perpendicular depth in the centre is to be 17 feet, the diameter at the surface is 456 feet, and the diameter at the bottom is 405 feet. How many cubic feet of earth have I to excavate in the whole work? And, as the payments (18 in number) are to be made on the completion of each perpendicular foot excavated, what number of cubic feet will be included in each payment? Some of your readers accustomed to such calculations may possibly not have time to work out minutely the whole question; in such case I shall be thankful for a short formula.—EXCAVATOR.

[33019.]—**Spectroscope.**—Will Mr. A. C. Ranyard (letter 14267) explain what an integrating spectroscope is. Perhaps, too, he will explain what is meant by different orders of spectra. I trust he will be very plain in his description, so as to be understood by an—IGNORAMUS.

[33020.]—**Lacquer.**—Will any of "yours" tell me what the lacquer used on chemical balances, microscopes, &c., is composed of? I have a model I wish to lacquer. The common lacquers will not do.—CLARE.

CHESS.

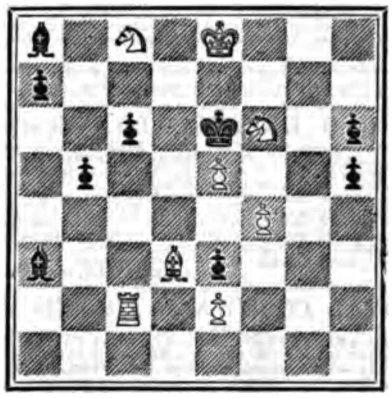
◆

ALL Communications intended for this department must be addressed to J. PIERCE, Copthill House, Bedford.

PROBLEM CCCCXXV.—BY SPERO.

(British Chess Players' Association Tourney Problem).

Black.

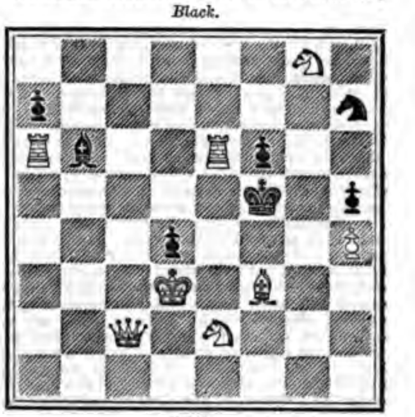


White.

White to play and mate in four moves.

PROBLEM CCCCXXVI.—BY H. M. PRIDEAUX.

Black.



White.

White to play and mate in two moves.

SOLUTION TO 422.

White.	*Black.*
1. R to R 7.	1. Kt takes R (a).
2. R to Q 6.	2. Anything.
3. R or Kt mates.	
	(a) 1. B takes P (b).
2. R to K B 7.	2. Kt covers.
3. Kt mates.	
	(c) 1. Q Kt moves, or B to Q B 6.
2. R to Q R 3.	2. Anything.
3. Mates.	

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ANSWERS TO CORRESPONDENTS.

◆

HINTS TO CORRESPONDENTS.

1. Write on one side of the paper only, and put drawings for illustrations on separate pieces of paper. 2. Put titles to queries, and when answering queries put the numbers as well as the titles of the queries to which the replies refer. 3. No charge is made for inserting letters, queries, or replies. 4. Commercial letters, or queries, or replies are not inserted. 5. No question asking for education or scientific information is answered through the post. 6. Letters sent to correspondents, under cover to the Editor, are not forwarded; and the names of correspondents are not given to inquirers.

The following are the initials, &c., of letters to hand up to Tuesday evening, May 21, and unacknowledged elsewhere:—

A. NORFOLK.—J. Epps and Co.—R. C. Roberts.—W. R. Birt.—W. S. Travis.—H. Horncastle.—J. and H. Grace.—H. C. Key.—R. N. C.—W. B.—Americus.—A. T.—Colloid.—J. S. T.—E. J. D.—W. D.—J. Lewis.—A. F. C.—G. L. P.—Juvenile Telescopist.—P. O. Telegraphist.—G.—Argus.—W. G. P.—Aamdal.—Bod.—Helme.—Percy Leake.—A. B. M.—Try Again.—A. H. S.—E. Mawe Smith.—A. Clarkson.—E. C. Stables.—W. Gorse.—A. Woolsey Blacklock.—Adowleet.—Edward W. Furrell.—X. X. X.—Joseph Jewsbury.—Robert Langton.—Horizontal Slide.—H. P.—Nota Bene.—J. Barlow, Southport.—Fred. J. Jackson.—Cat.—Subscriber.—J. R. Warren.—Omicron.—Jack Straw.—C. O.—Wm. Ashurst.—F. Baker.—Chromo.—Springs Branch Ince.—Kapt.—N. Sirch.—S. Taylor.—Diatonic.—T. Mitcheson.—Auctioneer.—Chas. Whaley.—English Watch Co.—F. R.—E. L. P.—A. A. Watkins.—Arithmetical Ignoramus.—Chester.—Jepepy.—F. T. J.

A., NORFOLK. (Please send.)—W. WHELAN. (Thanks for your congratulations. Continue your practical replies, and we will look after "the grammar," though we see very little to correct as yet.)—G. A. (Any caustic preparation which will not affect the colour used will do; for instance, a saturated solution of hydrate of sodium or potassium. We cannot give the numbers and dates of the specifications asked, but a good abstract of M. Zuccato's was given by a correspondent in letter 8306, p. 177, of Vol. XX., Oct. 30, 1874.)—RIFLE CADET. (A good series on the subject, entitled "The Amateur Bandmaster; or, Hints on Arranging and Scoring for Various Instruments," was commenced in No. 517, Vol. XX., and continued in subsequent numbers.)—FAUNA. (Write Lockwood and Co. for a catalogue of their "Weale's Series.")—T. D. J. (We do not know what you mean by "botanic beer;" numerous recipes for herbal and other beers appear in back vols, see indices.)—E. J. H. T. (See "Useful Notes" on p. 252 of last No.)—A. B. (The matter is a commercial one on which we can neither give nor invite opinion.)—APPRENTICE. (You will find a list of the Science Schools in any London directory. There is a good one at Lambeth.)—PENANCE POINT. (The client can demand the drawings.)—ARCANUM. (It has been proposed before to adopt such a scheme as you suggest, but for many reasons it would only be successful in isolated instances. The replies are for the benefit of the great mass of the readers as well as the individual querist answered, and if he wants to place himself in communication with the correspondent replying to him he can easily do so at a small expense by advertising his address.)—J. P. (Your only course is to seek the aid of a capitalist.)—Nervous Chip. (A healthy action of the stomach and bowels, mental and bodily relaxation, and above all exercise in the open air, are the desiderata in cases of nervousness. Alcoholic liquors should be avoided, and simple tonics such as quinine may be taken—preferably under medical advice.)—Rev. M. Hankey. (You had better advertise in the "address" column, but it is, of course, possible that the correspondent who replied may not now notice your announcement. We have no other means of placing you in communication with him.)—Boot Manufacturer. (Several recipes for blacking appear in this number. We know of no preparation that will give a polish without rubbing. 2. Nothing that checks perspiration can be beneficial, and the remedy for the unpleasantness you complain of consists in frequently washing the feet rather than the application of any acid.)—Hercules. (Leroy's is the best we know of; see their advt.)—Bony. (The Secretary of the Admiralty, but that official has received probably a dozen plans of the kind per day since the Vanguard foundered, so that he is pardonably incredulous by this time about schemes which "persons think are new ideas.")—Saul J. Roc. (No words were ever written to it. It is what its name declares it to be—a march.)—S. B. C. (He died suddenly—at least so we were informed. His latest contributions were not of a character to render the adoption of his signature advisable, and your request seems a peculiar one.)—Enquirer. (We cannot give or write an opinion as to the commercial value of articles. The fairest way would be to submit the glass to an optician.)—Pebble. (Mr. Lancaster gave full directions for polishing pebbles in reply 28681, p. 19, No. 625 (March 16, 1877.) Formulæ for solutions for gold plating are given in numerous back vols. Many new subscribers like yourself who write "please not to refer me to back volumes as I have not access to them" seem to forget that the back numbers are to be purchased separately, and that it is unfair to expect us to re-occupy valuable space with old matter. New subscribers should obtain the numbers containing the indices to the past dozen volumes and they would probably be surprised to find on how many subjects they can obtain information at the cost of a few pence, without troubling themselves to send queries which have been asked and answered over and over again.)—Gregory. (Further particulars are given respecting the microphone in this number. Your first query can only appear as an advt. Probably Stanley, Tolman, or some of the other advertisers of such apparatus would supply your requirements.)—Ruach. (We cannot recommend you to whom to apply; several such advertise in our columns.)—Springs Branch Inch. (Instructions for making soaps appeared on pp. 320, 386, 327, 241, and 462, Vol. XXVII.)—Schola D. (An aphlogistic lamp is one in which the wick, of platinum wire, is kept constantly red hot by the slow combustion of alcohol, heated by the wire itself.)—D. W. L. (The first canal recorded in history was that dug by orders of Sesostris (B.C. 1500) which connected the Nile with the Red Sea. It was reopened 900 years later by Pharaoh Necho, and again about 300 B.C. by Ptolemy Philadelphos. It was finally abandoned when Vasco de Gama circumnavigated the Cape of Good Hope. The first canal dug in Europe was probably that dug by Xerxes across the Isthmus of Athos; the first in England, the Caerdike, cut by the Romans. The largest canal in the world is the Imperial Canal of China, 821 miles long, with its connected rivers giving a navigation of 2,000 miles, and connecting 41 cities. It was commenced in the seventh and completed in the ninth century.)—Stearine. (We hardly think the industry has remained in such a "stationary" condition as you say, but doubtless the general adoption of gas and in a still greater degree of paraffin and the other mineral oils, has interfered with candle-making. Not, after all, however, to such an extent, difference in the times being considered, as did the Reformation—an event which at the first glance might not be thought capable of influencing a trade industry. Yet it did so, for we find the consumption of wax candles and the keeping of bees decreased considerably in the sixteenth century. That this may well have been the case will be seen from the statements of some writers respecting the number of candles burnt yearly in the churches. In the Castle of Wittenburg and its church alone, for instance, 35,750lb. of waxlights were burned yearly.)—Manus. (We are not much concerned about "signs of aristocratic descent," and have found generally that people who prided themselves on the smallness and symmetry of their hands were unwilling to do much work with them. That the form and action of the hands and fingers may frequently indicate to some extent the character of their owner is perhaps feasible. Some interesting remarks—a few of them a trifle fanciful, perhaps—will be found in a letter from "Pioneer," No. 13509, which appeared on p. 212 of the E. M. for Nov. 9, 1877. Your signature, by the way, is that of an old correspondent from whom we have not heard for some time. Curiously enough, we once replied to him on a similar matter. See letter 9334, p. 381, No. 535.)—Flower Maker. (Artificial grapes are blown from melted rosin and afterwards dusted with powder blue.)—Northern Watchmaker. (A description of the American Combination Lathe was given in reply 22608, p. 438, No. 537.)—Auctioneer. (Land surveying is scarcely to be learned from "simple books," or acquired "without the aid of a teacher." It is an important profession, and can only be learned by study and practice under a master of the art. Very good series of articles have appeared from time to time in the *Building News*, to which we refer you; see pp. 17 to end of vol., Vol. XVI., and the succeeding six volumes. Spon and Co., 41, Charing-cross, publish several valuable little handbooks—principally reprints of articles that have appeared in the journal mentioned, but they will be of comparatively little use to a novice like yourself.)

J. R., Phono.—Your queries are advts.

C. B. Smith, T. E. J., J. R. W., Mapplewell, Black Witch, A. B. C., Arthur Alfred, and others have replied to queries already similarly answered.

Letters by G. Pinnington, W. Burns, T. Bayley, Alexis R., "Destructive Distillation," and S. Stokes, are in type, but were crowded out.

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apparent failure of the experiment
light up the area in front of the
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vill probably prevent anything be-
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should not have the benefit of its
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ay be most satisfactory in the end,
e the publication of Prof. Tyndall's
o the Trinity Brethren, the makers
Gramme assert that they have con-
y improved that machine, and a
improvement may be supposed to
en made with the Siemens. The
, the Jablochkoff, and some other
have been recently introduced, so
e dynamo-electric machine, which,
ıeapness and simplicity, is to render
lighting universal, may be shortly
l. It is unfortunate that the com-
ppointed by the Franklin Institute,
t upon the various machines offered
for sale, failed to attract more than
ers to the competition, and, but for
of a Gramme, the labours of the
ee would have been confined to an
tion of the respective merits of
chines of the brush and Wallace-
types. The report, when published
vill, however, attract attention, and
ıld lead to a competitive trial of
l machines it will materially help
improvement. It may be taken for
that a dynamo-electric machine,
y a steam or gas engine, will be
rator of the electricity that is to
in any public system of lighting,
first question to be answered is
the electric system is cheaper than
the paper by Dr. Higgs and Mr.
read at the Institition of Civil Engi-
e page 498, Vol. XXVI.), it was
ıat the cost of the light, as used
s. Siemens' works, was only half
gas; but if the relative intensities
lights were to be considered, the
ıs as 20 to 1. There can be no
, then, that the electric light is
than gas, if we can take advantage
ll power, but at present it is not
ar that it is cheaper than gas can
for lighting up factories and work-
The actual cost of making good
ting coal-gas is under 2s. per 1,000
t, and it is contended that when
ıg the cost of the two illuminating
he one being purchased, and the
nerated on the premises, the gas
e taken at its prime cost. Such an
t cannot, however, be put forward
ly of ratepayers; if by means of
y the streets can be illuminated
aply and more thoroughly than by
are not likely to look further than
actually paid for gas as to what its
ght be. M. Jablochkoff is still working away at his method of dividing the current, and if he should succeed in perfecting his candles the difficulty will be solved. At present we may say that electricity is at a disadvantage in lighting small spaces, or where numbers of small lights are required, and gas is at a disadvantage where large spaces have to be illuminated—a large number of gas-lamps failing to do much more than render darkness visible in such a place as Trafalgar-square. So far, it may be said that the rival methods are equal—each holding its own special position firmly; but when we come to examine deeper into the subject, the advantages of electric lighting far outweigh those of gas. Suppose, for instance, it is a large workshop where a flood of diffused light is required, the electric lamp, even if it costs as much as the equivalent of gas, has the important advantages that it does not vitiate the atmosphere, and does reduce the risk of fire. In bridge and ship building, dock-constructions—in fact for all extensive operations of a similar kind, the work can be carried on by night almost as well as by day. By means of the electric light the photographer can work by night, and in all places where it is necessary to be able to distinguish colours with accuracy, gas must unquestionably give way to the electric lamp. The latter is the only light that can be employed with any satisfaction in illuminating picture-galleries, and already some portions of the Louvre have been fitted up with it—a fact which suggests to the trustees of the British Museum the possibility of increasing the usefulness of the treasures under their care without running the risks that undoubtedly follow the use of gas. It is unnecessary to speak here of the many and diverse purposes for which the electric arc is peculiarly adapted, such as submarine illumination; but we wish to call attention to the advisability of making a series of experiments with the machines and apparatus at present available—at all events for the illumination of large spaces. Who is to provide the funds for the purpose it is difficult to say; the Corporation might, but no other public body has any money which could legally be expended in the manner suggested. But, considering the importance of the subject, we venture to suggest that some of the railway companies might undertake the work, and test the value of the electric lamp in the illumination of one of the large termini to be found in London. The cost of gas in these places must be enormous, and yet not one can be said to be really well illuminated. For obvious reasons an abundance of light is required in such places, and, from experiments made elsewhere, a few electric lamps would not only be more economical, but vastly more efficient than the hundreds of gas-jets at present employed. A Siemens machine, worked by a steam-engine indicating 10 horse-power, gives a light equal to 14,800 candles, or practically as much as can be obtained from 1,000 burners consuming gas at the rate of 5 cubic feet per hour. The cost of gas to supply 1,000 burners at 2s. per 1,000 cubic feet would be 10s., whereas the cost of the electricity would not exceed 5s., thus showing an economy of 2 to 1 in favour of the electric lamp. It must, however, be remembered that the nature of the light renders the illumination much more effective than can be obtained from an equal number of "candles" when gas is employed. Perhaps, however, the most accurate estimate that has yet been made is that obtained by a comparison of the relative cost of illuminating one of Messrs. Siemens' shops at their telegraph works. Here the cost of gas, which was supplied by a company, amounted, at 3s. 9d. per 1,000, to £135 for 120 burners consuming six cubic feet per hour. The interest on the cost of fixing pipes, &c., wear and tear is put at £9, so that the total cost was £144 per annum. Three dynamo-electric machines, with lamps, &c., complete, cost £250, and reckoning interest, &c., at 15 per cent., the item is found to be £37 10s., which, added to the cost of coals, carbons, attendance, &c., £35 4s., makes a total of £72 14s., showing an economy of 2 to 1 in favour of electric lighting. The gas-lamps, however, yielded only 2,400 candles—nominally not actually, each burner being supposed equal to 20 candles, whereas the three machines each produced a light equal to about 5,000 candles, showing an advantage, from the point of view of light intensity, of 6 to 1 in favour of electricity. It must, however, be pointed out that the percentages charged for interest, &c., are rather arbitrary, and that the gas is charged at the price paid for it, while the electric light is put down at its prime cost. At the same time it must be noted that while any one who has a steam-engine and shafting can readily produce the electric light, costly plant and suitable premises would be required to manufacture coal-gas. Where electric lighting is employed, however, the apparatus must be capable of generating all the light during the time that the illumination is required, whereas a gas plant is continuously worked, and stores up the lighting agent until it is required. Even under this disadvantage, however, it is doubtful whether the capital outlay would exceed that expended on gas-works, and where power is already laid on the cost of that needed for working the dynamo-electric machine must be practically very little, for there are few works where there is not an excess of power, and in such cases the difference would be scarcely perceptible in the weekly coal-bill. What is wanted, however, is a direct competitive trial under circumstances in which all sources of expenditure can be accurately checked. A gas-engine offers a ready means of ascertaining the cost of power, and affords facilities for experimenting with the electric light in any suitable locality. The makers of the Gramme machine claimed to have obtained much better results than those recorded by Mr. Douglass, the engineer to the Trinity Board, and, as the question appears to rest between the Gramme and the Siemens, it is possible that a public trial might be arranged, if beyond the trial there was a probability of the light being permanently adopted. Our Government has fully recognised the merits of the Siemens machine, and has given an extensive order for apparatus for use on board ship and in fortifications, and there is no doubt that if the difficulty with the carbons—that is to say, with the lamp itself—could be satisfactorily settled, the electric light would be used very extensively indeed.

REVIEWS.

SOME INDIAN METEOROLOGICAL OBSERVATIONS.

Instructions to Meteorological Observers in India, being the First Part of the Indian Meteorologist's Vade Mecum. By HENRY F. BLANDFORD, Meteorological Reporter to the Government of India. Calcutta: 1876.

Meteorology of India, being the Second Part of the Indian Meteorologist's Vade Mecum. By HENRY F. BLANDFORD. Calcutta: 1877.

Tables for the Reduction of Meteorological Observations in India. By HENRY F. BLANDFORD. Calcutta: 1876.

Report on the Meteorology of India in 1875. By HENRY F. BLANDFORD. Calcutta: 1877.

IT is not our intention to criticise each of the above-mentioned works separately, but rather to regard them as the latest utterances of meteorology from India—the easternmost focus of research in this particular branch of science. Two circumstances have contributed to render these utterances of high scientific value. India is a country possessing physical features eminently calculated to constitute a section which, to use Balfour Stewart's expression, can be put "under a meteorological blockade," and its Government has appointed to this important work a gentleman who not only possesses an intimate knowledge of meteorology, but also a thorough acquaintance with those branches of science best calculated to elucidate it. "It is a safe prophecy," he says, "that, given a few earnest and intelligent workers, this country [India] will one day play a part second to none in the advancement of rational meteorology. As England is an epitome of stratigraphic geology, so is India an epitome of atmospheric physics; and while it presents within itself the most varied conditions of form and surface, and, together with its seas, the great primary contrast of continent and ocean ranging through nearly 30 degrees of latitude, and during five months of the year bathed in the intense radiation of a vertical sun, it is, so to speak, a secluded and independent area. On the north the Himalaya shuts in the lower half of the atmosphere, and constitutes the natural limit of the monsoons; on the south an only less defined meteorological frontier exists in the zone of all but unvarying barometric pressure of the equatorial belts."

This quotation will furnish the reader with an idea of the physical basis on which Indian meteorology is to be built; the author further tells us that "the knowledge of climate is only the first and immediate outcome of the work. Our business," he says, "is to go beyond the mere collection of statistics, to ascertain the *why* and *wherefore* of phenomena; it is *physical meteorology* and not merely *climatology*," that he seeks to elucidate. How far he has succeded a perusal of the works above specified will best inform the reader. Our own opinion is that they rank amongst the highest class of meteorological literature, and should find a place in every meteorological library.

In his introduction to "Instructions to Meteorological Observers," the author alludes to phenomena which in India are familiar and striking, but are of subordinate importance in extratropical countries, and *vice versâ*. In order to compare Indian with European meteorology, Mr. Blandford recommends Buchan's "Handy Book and Introductory Text Book," Loomis's "Treatise," and Herschel's "Meteorology," which he regards as unequalled for thoroughness in a physical point of view. A comparison of American with European meteorology, and these again, with Indian and Australasian (when observation in the last-named region shall have sufficiently advanced), would greatly promote the advance of the science in its widest aspect. Such comparisons, however, require minds of no ordinary calibre; minds possessing a large amount of patience and self-sacrifice—qualities which are seldom found; minds that are content at the commencement of an investigation (it may be in youthful days) to take a subordinate position, with a determination to labour on against every obstacle that presents itself. Such minds are rare, but they mostly succeed; they study well the characteristics of the minds already engaged in the line of research they have chosen, and are thus fitted to rise step by step in the ranks of true cultivators of science.

Under the Red Ensign. By Thomas Gray. London: Simpkin, Marshall, and Co.

"*Under the Red Ensign*" is an address to British boys who may be anxious to enter the naval or maritime service of their country, whether as "rough boys," apprentices, or midshipmen. It is also an address to parents, containing advice and instructions which may be of considerable value to them. Mr. Gray, of the Board of Trade, is an authority on the subject, and has written this little book with the view mainly of keeping boys who go to sea out of the hands of crimps and their associates. It is not an attempt to teach boys the art of seamanship, but it is full of good counsel and of clear directions for ordering their conduct and behaviour, which, if followed, cannot fail to meet with certain reward. The kindly warnings and advice of Mr. Gray should not be lost upon sailors, who are only too often mercilessly fleeced by landsharks. The appendices contain forms, facts, and figures of value to parents and guardians, for, besides the terms of apprenticeship in different ports, full particulars are given of the work done by the various training ships from the Worcester and Conway, the gentlemen's floating colleges, to the prison or reformatory ships. We should be glad to know that every boy who has entered, or thinks of entering, upon a seaman's career is not only in possession of "Under the Red Ensign," but has determined to model his conduct according to the teaching of Mr. Gray.

The Lake Dwellings of Switzerland and Other Parts of Europe. By Dr. Ferdinand Keller. Translated by J. E. Lee, F.S.A., F.G.S. London: Longmans.

English students of pre-historic man are much indebted to Mr. Lee for his careful translation of this classical work by Dr. Keller, which in its second edition has been much enlarged, and in many parts re-arranged. Mr. Lee, in fact, has practically edited the book, and has incorporated all the scattered notices of the early settlements of the semi-civilised Lake-dwellers which could be deemed trustworthy. In doing this he has had the assistance of Dr. Keller, and the consequence is, as we have said, that English-speaking students have now a new and complete account of all the Lake dwellings and early settlements that are known. A quarter of a century has barely elapsed since the attention of antiquaries was first directed to the subject, for, although the remains of pile dwellings had been discovered in the Lake of Zurich so long ago as 1830, it was not until more than 20 years afterwards that the discovery was followed up with any zest. Whatever may have been the origin of the race of Lake-dwellers, it is certain that they had very early appreciated the advantages of sociability, and were a pastoral people, intent on obtaining what comfort they could, and seeking to protect themselves from enemies in the shape both of their fellow-men and the beasts of the field. Pile dwellings exhibit degrees of skill in construction, and show very plainly the improvements which followed the introduction of superior tools; but no difference whatever is to be discovered in the general details or in the plan. When tools of bronze and iron were introduced the dwellings were built more substantially, and in deeper parts of the lakes; but there is no reason to imagine that the later builders were other than the direct descendants of the early Lake-dwellers, who, it is supposed, had migrated from Asia. They posessed the most important of our domestic animals, and cultivated wheat, barley, and flax, none of which they could have found in Europe, while their obvious endeavour to live together in permanent abodes is proof that they had long known the advantages of a settled mode of life. It is believed, then, that the builders of the Lake-dwellings were a branch of the Celtic population of Switzerland, but that the earlier settlements belong to the prehistoric period. The fact that huts built on piles over the surface of lakes are met with in various parts of the world, even in Central Africa, helps to show that this method of protecting a dwelling must have a very ancient origin. The work, which is divided into two volumes—one of text, the other of plates—is a complete epitome of the discoveries that have been made, and of the explanations that have been offered in connection with this interesting branch of antiquarian research.

Boiler and Factory Chimneys. By Robert Wilson, A.I.C.E. London: Crosby Lockwood and Co.

This is a useful little work by a gentleman who is in the habit of thinking out his subject before he ventures into print. To many persons it may appear that the building of a chimney for a boiler furnace is a mere question of good bricklaying, but, as a matter of fact, many important questions must be decided before the bricklayer can be set to work. The height and the area of the chimney will depend primarily on the number and kind of boilers employed, but several other factors must be considered if a really satisfactory result is desired, not excluding the prevailing direction of the wind and the general atmospheric temperature of the district. When the size of the chimney has been determined, its shape and the form of the cap require study, and then last, but not least, its stability must be seriously considered. All these points are examined by Mr. Wilson, who also writes a chapter on lightning conductors, and gives us some interesting figures in connection with notable chimneys. The highest known chimney is that at Mr. Townshend's Works, Port Dundas, which, with the exception of the spire at Strasburg, the Great Pyramid, and the spire of St. Stephen's, Vienna, is the loftiest building in the world, rising to a height of 454ft. from the ground, the total height of the brickwork, &c., being 468ft. This book forms an excellent supplement or complement to the author's "Treatise on Steam Boilers." We should mention that Mr. Wilson furnishes, by way of frontispiece, a useful table of dimensions of chimneys from 30ft. to 300ft. in height.

Rock Blasting. By G. G. Andre, F.G.S., Assoc. I.C.E. London: E. and F. N. Spon.

Within the past few years a complete change has occurred in the systems formerly employed in blasting rocks. The introduction of the power drill, and the demonstration of its capabilities supplied by, amongst other works, the Mont Cenis tunnel, revolutionised the old methods, and the more expeditious and more effective plan is now almost universally employed, to the exclusion of the hand drill, where large masses of rock have to be moved. The stronger explosives used nowadays also facilitate the work. The book before us is, then, a descriptive account of the modern methods of rock-blasting, and at the same time a practical treatise for the use of mining engineers and others. The various tools employed are described and illustrated by Mr. André, who furnishes much useful information of a technical kind of great value to the young engineer or the foreman of the works. The chapter on the explosive agents used in rock-blasting is similarly full of information, while those on the principles and the operations of rock-blasting, illustrated as they are by figures and plates, render the work a complete vade-mecum for those engaged in blasting for industrial purposes.

Industrial Chemistry. Edited by B. H. Paul, Ph.D. London: Longmans.

This work is a translation of Payen's

is de Chimie Industrielle," made,
er, through the German edition of
ann and Engler. It is intended as a
ıl for use in technical colleges or
s, for which purpose it is well
d, while it will always be found of
assistance by manufacturers. The
d of treatment is carried out in a
atic manner—conciseness, with, how-
ulness as to important details, being
ject of both author and editor. Thus,
der the head of "Nickel" we have first
lines on its history, followed by para-
s on its occurrence, characters, pre-
n, uses, and compounds. The
al chemical substances and the chief
ries based upon chemistry are treated
imilar manner, illustrations being
d wherever needed. Besides the
of the original work we have from
of the editor several chapters on
neral chemistry of the metals and
rgical operations, as well as some
branches of industry. The present
contains nearly 1,000 pages and
700 engravings, and is full of infor-
for those engaged in the production
ufactures based upon chemical re-
.

Scientific Basis of Music, by W. H.
M.A., M.B. (London: Novello), is
Messrs. Novello's Music Primers,
need scarcely say forms an excellent
ction to the study of the more
te works on the subject. Indeed, it
ething more than an introduction,
carefully read will give musicians
chnical knowledge of the basis of
rt, which at present many of them
Several primers are, we believe, pub-
and the series will place within
of the musical world a cheap and
library of the art.—*Dry Plate Photo-
for Amateurs*, by J. L. Hughes
ool: T. Fuller), is a tractate of 30
in which the author gives simple and
directions for outdoor photography.
ates have, however, been improved
h within the past few months that
stion whether the process described
. Hughes will have a much longer
*low to take out Patents in England
broad*, by E. Edwards (London:
ls and Co.), is a trustworthy epitome
Patent Law, giving directions to
rs for the taking out of letters
in this country and abroad.—*The
t's Pocket-book and Diary for* 1878
n: "The Country" office), speaks
lf. It is well got up. The calendar
s events in the bicycling world, and
is appended of last year's events.
is a complete blank diary for runs,
ne for engagements, and a column
h memoranda. A list of clubs, and
ety of information interesting to
ts will help to make this pocket-
favourite with the knights of the

have also received *A Handbook on
nd Silver*, by an Indian Official
n: Longmans); and *Local Taxation
Rating of Machinery*, by T. F.
(London: Knight and Co).

PTICAL STRUCTURE OF ICE.

RISED light, it is known, affords a
ful means of studying the structure of
a plate of the substance, about 1 ctm.
e examined with a polarising micro-
ings often appear if the plate is at
gles to the optical action. If no rings
, let the microscope be illuminated
chromatic light, and there appear either
or irregular fringes of crystals. In the
ase the direction at right angles to the
n be obtained by suitable section-
In the second, one may assure one-
h Norremberg's apparatus of the con-
ystallisation of the ice.

By means of these methods (we learn from *Naturforscher*), M. Bertin has recently studied the structure of ice under different conditions. In the ice cones which in winter hang at the mouths of pumps, the crystallisation is of confused nature; and also in the hoar frost which forms on the windows of our rooms, and which at first is untransparent, but in thawing becomes transparent.

When the water freezes in a glass vessel exposed to cold air, the ice forms first on the walls in the shape of needles or leaflets, which partly penetrate obliquely into the liquid, partly expand on the surface of the water. The first ice layer which forms on the surface is without consistency, and its crystallisation is confused. One may observe this by attentively watching canals or basins of water beginning to freeze. But whenever this layer has become solid, or when its thickness has reached a few millimetres, it gives beautiful rings, indicating that the ice lump is a single crystal whose axis is at right angles to the surface of the water, as Brewster observed in 1817. The formation of ice on the walls may be prevented by guarding these against cooling —as, *e.g.*, by placing the vessel in the larger one, and filling the interval with sand. The ice then forms exclusively on the surface of the water, and its axis is vertical—it is then at right angles to the surface of cooling. Is this, however, always the case? To decide this point M. Bertin let water freeze in two rectangular wooden troughs, in which one side was of glass. In one trough the glass wall was vertical, in the second it was inclined 45°—that is, the outer normal to this surface was inclined 45° to the horizon. The vessels having been filled with water, and covered with wooden covers, were placed on a very cold day at a window looking northwards, and the two glass surfaces exposed to the radiation of space. The water in the interior soon began to freeze against the glass, and, after a few hours, pretty thick ice plates could be detached, which, in their middle portions, were quite regular, and showed very beautiful rings. The ice had thus, in the first vessel, a horizontal axis, whereas in the second the axis made an angle of 45° with the horizon. In neither was it vertical, but in both at right angles to the glass—that is, at right angles to the surface of cooling.

Special apparatus, however, is not required to demonstrate these facts. If water be allowed to freeze in a tureen on a clear winter night, the tureen will most commonly be found covered with an ice layer on the bottom, on the walls, and on the surface of the water. The ice of the bottom has, like that of the surface, a vertical axis, but the ice of the walls will be found to have its axis at right angles to the walls.

The following, then, is M. Bertin's general law:—The axis of ice is at right angles to the surface of cooling. Ice produced artificially always shows a confused crystallisation. Young glacier ice, also, presents no distinct orientation of crystals. In old glacier ice, on the contrary, there is an almost perfectly vertical arrangement of the crystals.

ASTRONOMICAL NOTES FOR JUNE.

The Sun.

Day of Month.	Souths.	At Greenwich Mean Noon. Right Ascension.	Declination North.	Sidereal Time.
	h. m. s.	h. m. s.	° ′ ″	h. m. s.
1	11 57 32·93a.m	4 36 54	22 4 57	4 39 20·63
6	11 58 22·97 ,,	4 57 26	22 40 40	4 59 3·42
11	11 59 20·23 ,,	5 18 6	23 6 26	5 18 46·22
16	0 0 22·31p.m	5 38 51	23 22 4	5 38 29·01
21	0 1 26·84 ,,	5 59 39	23 27 25	5 58 11·80
26	0 2 31·17 ,,	6 20 26	23 22 26	6 17 54·59

At 2 p.m. on June 21st the Sun is said to enter Cancer, and this is the instant at which Summer is supposed to commence. It is also the longest day, the Sun remaining for 16 hours and 34 minutes above the horizon of Greenwich; and, of course, only 7 hours and 26 minutes below it. Twilight, however, persists during the whole of this time; and, in fact, there is no real night in June at all, as the Sun is never 18° below the horizon even at midnight. Between the 19th and the 23rd is an excellent time for determining the Meridian by the method of equal altitudes, the Sun's declination remaining sensibly constant during the time he is visible. The utter absence of spots, or other signs of solar disturbance, is as marked as ever.

The Moon

Is New at 1h. 47·9m. a.m. on the 1st; enters her First Quarter at 3h. 54·6m. a.m. on the 8th; and is Full at 11h. 51m. at night on the 14th. She will enter her Last Quarter at 7h. 15m. p.m. on the 22nd; and be New, for the second time this month, 30·7 minutes past Noon on the 30th.

Day of Month.	Moon's Age at Noon.	Souths.
	Days.	h. m.
1	0·4	0 18·3 p.m.
6	5·4	4 54·3 ,,
11	10·4	9 3·8 ,,
16	15·4	1 53·0 a.m.*
21	20·4	4 53·6 ,,
26	25·4	8 22·1 ,,

* Morning of 17th.

The Moon will be in conjunction with Mars at 9 p.m. on the 3rd; with Jupiter at 6 a.m. on the 18th; with Saturn at 4 a.m. on the 3rd; with Venus at 11 a.m. on the 27th; and with Mercury at 2 a.m. on the 30th.

Occultation of Mars, and Occultations of (and a Near Approach to) Fixed Stars by the Moon.

Day of Month.	Name of Star.	Mag.	Disappearance.	Moon's Limb.	Angle from N. Point.	Angle from Vertex.	Re-appearance.	Moon's Limb.	Angle from N. Point.	Angle from Vertex.
			h. m.		°	°	h. m.		°	°
3	Mars		9 59 p.m.	Dark	39	74	10 39 p.m.	Bright	289	321
5	π^2 Cancri	6	8 54 ,,	Dark	44	84	9 48 ,,	Bright	261	301
10	75 Virginis	6	†7 39 ,,	NE by N	148	143				
16	ϕ Sagittarii	3½	2 15 a.m.	Bright	86	98	3 26 a.m.	Dark	304	326
16	h^1 Sagittarii	6	10 17 p.m.	Bright	94	64	11 31 p.m.	Dark	288	268
16	h^2 Sagittarii	4½	10 52 ,,	Bright	41	14	11 28 ,,	Dark	343	322
20	e^1. Aquarii	6	1 57 a.m.	Bright	105	84	3 13 a.m.	Dark	138	128
21	B A.C. 7986	6	3 12 ,,	Bright	163	146	4 15 ,,	Dark	268	262
28	χ^1 Tauri	5½	1 42 ,,	Bright	119	87	2 29 ,,	Dark	266	230

† A near approach.

Mars

Is much too close to the Sun to be at all fairly seen; but may probably be caught as a reddish star after sunset. An ephemeris of him would needlessly occupy space.

Jupiter,

Viewed with reference to his meridian passage, is a morning Star all through June. He rises, however, before midnight at the beginning of the month, and between 9 and 10 o'clock at night at the end of it. He has, though, great (and increasing) South declination, and is but poorly placed for the observer.

Day of Month.	Right Ascension.	Declination. South.	Souths.
	h. m.	° ′	h. m. a.m.
1	20 38·5	18 58·1	4 0·5 „
6	20 38·0	19 1·2	3 40·3 „
11	20 37·1	19 5·5	3 19·7 „
16	20 35·9	19 10·9	2 58·9 „
21	20 34·4	19 17·3	2 37·8 „
26	20 32·7	19 24·6	2 16·4 „

The short retrograde path indicated by the above ephemeris lies wholly in an uninteresting region in Capricornus.

Jupiter's Satellites.

Day of Month	Satellite.	Phenomenon.	——
			h. m. s.
1	I	Sh I	1 53 0 a.m.
1	*II*	*Tr I*	2 44 0 „
1	*I*	*Tr I*	3 0 0 „
1	*II*	*Sh E*	3 27 0 „
1	*IV*	*Sh E*	12 28 0 p.m.
2	I	Oc R	2 33 0 a.m.
2	*I*	*Tr E*	11 47 0 p.m.
2	*II*	*Oc R*	12 21 0 „
3	III	Oc R	1 16 0 a.m.
8	*II*	*Sh I*	3 9 0 „
8	*I*	*Sh I*	3 46 0 „
9	II	Ec D	1 2 24 „
9	*I*	*Tr I*	11 14 0 p.m.
9	I	Sh E	12 34 0 „
9	III	Ec R	12 40 51 „
10	III	Oc D	1 13 0 a.m.
10	I	Tr E	1 34 0 „
10	*II*	*Oc R*	2 42 0 „
16	*I*	*Ec D*	2 56 33 „
16	I	Sh I	12 8 0 p.m.
16	II	Ec D	12 25 35 „
17	I	Tr I	1 1 0 a.m.
17	III	Ec D	1 17 15 „
17	I	Sh E	2 28 0 „
17	*I*	*Tr E*	3 21 0 „
17	I	Oc R	12 35 0 p.m.
18	II	Tr E	11 40 0 „
19	IV	Tr E	2 31 0 a.m.
24	I	Sh I	2 2 0 „
24	*I*	*Tr I*	2 46 0 „
24	*II*	*Ec D*	2 59 34 „
24	I	Ec D	11 19 17 p.m.
25	I	Oc R	2 21 0 a.m.
25	*I*	*Sh E*	10 50 0 p.m.
25	*II*	*Tr I*	11 5 0 „
25	I	Tr E	11 32 0 „
25	II	Sh E	12 38 0 „
26	II	Tr E	2 1 0 a.m.
26	*IV*	*Ec D*	10 31 55 p.m.
27	*IV*	*Ec R*	2 46 37 a.m.
27	*III*	*Tr I*	9 52 0 p.m.
27	*III*	*Sh E*	10 47 0 „
28	III	Tr E	1 29 0 a.m.

Ec. Eclipse; Oc. Occultation; Tr. Transit of Satellite; Sh. Transit of Shadow; D. Disappearance; R. Reappearance; I. Ingress; E. Egress. The printing of a phenomenon in *italics* indicates that its visibility is rendered doubtful, either by the brightness of the twilight or by the proximity of Jupiter to the horizon.

Mercury

Is a Morning Star during the whole of June, and is fairly well placed for the observer during the first half of it. He attains his greatest elongation West (24° 2′) at 7 p.m. on the 2nd.

Day of month.	Right Ascension.	Declination North.	Souths.
	h. m.	° ′	h. m.
1	3 1·4	13 22·8	10 22·3 a.m.
6	3 21·3	15 7·1	10 22·5 „
11	3 46·8	17 16·6	10 28·3 „
16	4 18·0	19 36·4	10 39·8 „
21	4 55·2	21 48·7	10 57·2 „
26	5 38·2	23 30·7	11 20·4 „

Mercury will thus travel from Aries, through the entire breadth of Taurus into Gemini. He will be North of ι Tauri on the 16th, and of μ Geminorum on the 30th; but his path will not carry him so near to any conspicuous stars as to the two we have named.

Venus,

Like Mercury, is a morning Star during the entire month. She is fairly well placed for the observer, but is becoming rapidly more gibbous, and is decreasing in angular diameter, so that she is becoming much less interesting as a telescopic object.

Day of Month.	Right Ascension.	Declination North.	Souths.
	h. m.	° ′	h. m.
1	1 43·5	8 20·0	9 4·6 a.m.
6	2 4·5	10 11·2	9 6·0 „
11	2 26·0	11 59·9	9 7·7 „
16	2 48·0	13 44·5	9 9·9 „
21	3 10·4	15 23·7	9 12·6 „
26	3 33·3	16 55·8	9 15·8 „

Starting thus from that region of the heavens where Pisces, Cetus, and Aries are conterminous, Venus will cross Aries and travel into Taurus; without, however, passing near a single conspicuous Star.

Saturn

Is a morning Star, but is scarcely yet in a favourable position for the observer, inasmuch as he is at no great height at sunrise, and should, of course, be looked for some time before this. He is in quadrature with the Sun at 6 a.m. on the 24th. His ring is now distinctly fusiform in shape, and, after a lapse of more than 14 years, we once more see the Southern side of it.

Day of Month.	Right Ascension	Declination South.	Souths.
	h. m.	° ′	h. m.
1	0 8·5	1 25·3	7 29·8 a.m.
6	0 9·7	1 18·7	7 11·4 „
11	0 10·8	1 13·0	6 52·8 „
16	0 11·7	1 8·2	6 34·2 „
21	0 12·5	1 4·3	6 15·3 „
26	0 13·2	1 1·4	5 56·3 „

Saturn thus describes a short arc in that absolutely barren region in Pisces to the East and South of the, so-called, First Point of Aries.

Uranus

May be caught, after sunset, at the beginning of the month. Our Ephemeris only extends to the middle of it, as the planet is now rapidly approaching the Sun.

Day of Month.	Right Ascension.	Declination North.	Souths.
	h. m.	° ′	h. m.
1	9 53·0	13 39·0	5 12·7 p.m.
6	9 53·5	13 36·0	4 53·6 „
11	9 54·1	13 32·6	4 34·6 „
16	9 54·8	13 28·9	4 15·6 „

So that he will never depart very far from ν Leonis.

Neptune

Will scarcely re-appear for the purpose of the observer, before the late Autumn.

Shooting Stars

Are rare in June. They may be looked for on the 6th, and again on the 20th; but the light nights alone are unfavourable to their detection.

Greenwich Mean Time of Southi Eight of the Principal Fixed Stars Night of June 1st, 1878.

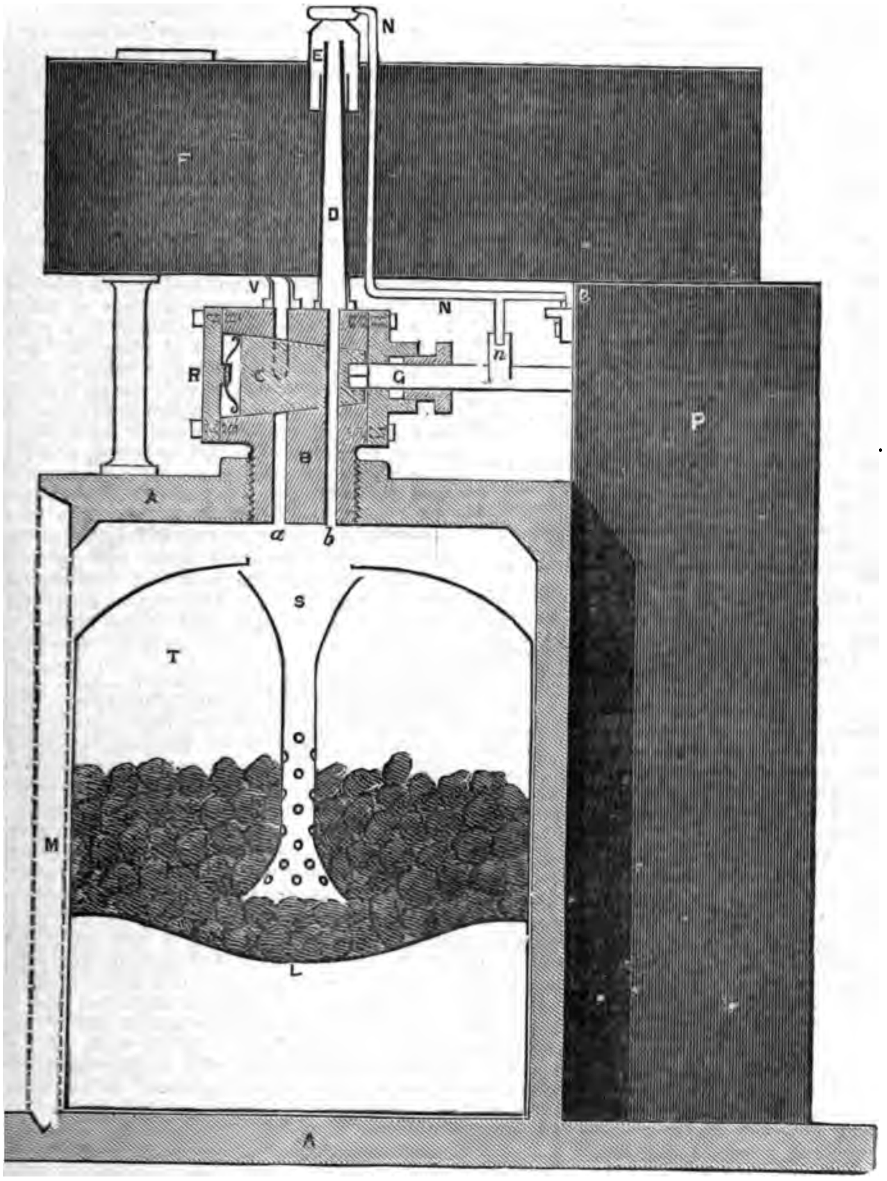
Star.	Souths.
	h. m. s.
η Ursæ Majoris	9 1 57·
Arcturus	9 29 14·
α Libræ	10 3 11·
α Coronæ	10 48 27·
α Serpentis	10 57 10·
Antares	11 40 43·
α¹ Herculis	12 27 44·
α Ophiuchi	12 47 52·

The method of determining the Loca Time of Transit of either of the Stars above list will be found on p. 60 of Vol. and that of finding the instant of its M Passage for any other night in June o of Vol. XXII.

HOLMES'S INEXTINGUISHA SIGNAL LIGHTS.

IN the annexed engraving we give a sectional view of one of Mr. N. J. H self-igniting and inextinguishable signa for which he has recently obtained patent. We have previously called at to his floating lights, which may be sen on suitable rafts or projected from ho so as to form a circle of lights around Their construction is described below, particulars here given will show th invention is capable of modification to to special purposes. The improved me producing signal lights consists in gen phosphuretted hydrogen gas from pho of calcium in a closed vessel under p and by means of an automatic disc arrangement obtaining flashing sig definite duration and at fixed intervals In the arrangements of parts one form signal apparatus may be described as —A strong closed vessel, A A, is em into which the proper proportion of pho of calcium inclosed in a suitable recept is inserted through the movable s which is so fitted as to be capable o closed up air-tight by means of eithe nuts or pressure bars. Upon the to vessel, A, is securely fixed a screw plug a mechanical arrangement, C, for th matic admission of water into the int the vessel, T, and emission of the gas It consists of a peculiar-formed tap, C, double functions, one being to open communication, *b*, between the interio chamber, T, and the external air, by w gas evolved may be discharged thro tube, D, and the other being the ad into the chamber, T, of a fixed qua water by means of the cavity, *a*, the *b*, being closed when the water containe cavity, *a*, is admitted, and the water co cation being shut off when the gas ex open. The quantity of water admit the amount of phosphuretted hydrogen are each regulated by the dimensions o spective apertures, *a*, *b*, through the plug, C, of the tap. Thus for eve charge of gas only the equivalent of admitted sufficient to develop the n charge, the duration and frequency discharges or automatic functions b gulated by the speed of revolution plunger, C, of the tap.

A reservoir of water, F, is in connecti the one aperture, *a*, by means of the (on the top of the reservoir is a hole the escape of any gas that might ente servoir from the cavity, *a*); the exit fitted with a cap, E, to carry off the the phosphorus, is attached to the othe The plug, C, is kept in its place by the of a circular spring. By removing plate, R, the plug, C, can be wit Motion is given to the plug, C, by mea connecting shaft, G, which enters the the plug, C, through a stuffing bo shaft, G, is in connection with the mo tained in the box, P. Attached to th G, is a cam, *n*, which gives an osc motion to the arm, N, carrying a piece substance at its end, so that on each re of the shaft the arm is drawn over orifice, and brushes away the oxide o horus. The phosphuret of calcium is conained in the movable chamber, T. The water s it drops from the cavity, *a*, passes down the abe, S, and comes into contact with the phoshuret of calcium at the bottom of the mass. is a bottom plate perforated with holes round s edge, so that the decomposed phosphuret of lcium when burnt out may subside into the ceptacle below. The chamber, T, is inserted ito the case, A, by removing the side, M, hich is afterwards clamped into its place by eans of either pressure bars or screws, so as hermetically close the interior against the cape of gas. By this arrangement it is easy produce flashing signals of different periods duration and intervals of recurrence, and terminable at any required number of hours, om one to twenty, according to the weight phosphuret of calcium introduced into the amber, T, and at the same time to automatilly control the duration, intensity, interval of currence, and period over which such rerrence of signals shall occur.



r. Holmes has also patented an improved truction of floating distress signals. In improvement the case containing the phosret of calcium is cylindrical, and fitted with ight covers securely soldered down. In centre of both these covers the necessary orations are made, the one for the emission e evolved gas, and the other for the adion of the water. These two holes are rely closed by two metal strips soldered them, so that upon the tearing away of e strips when the signal is required for use, holes become exposed. Over the water of the lower cover inside the case a alar metal plate fluted round the edge, and htly smaller in diameter than the case, is securely soldered to the bottom plate. By this arrangement when the lower hole is open the water will enter the interior of the case by the fluted channels. A metal air float is inserted into the interior of the case of the requisite dimensions to give the necessary buoyancy to the signal when thrown into the water. Space is left between the surface of the float and the sides of the case, sufficient to allow of the passage of the phosphuretted hydrogen gas, and the float is kept in position by rests fixed to the interior of the case.

CHIEF PHENOMENA OF THE THREE PRIMARY STATES OF MATTER.

By J. Douglas Scoffern.

Part II.—The Gaseous State.

FOR the reason assigned in my introductory article—namely, that these bodies display the simplest conditions to which we can apply experimental investigations—I purpose in the first place to consider a few of the leadin features which gases present.

For convenience I shall express all results in terms of the metrical system, excepting, perhaps, some cases in which it may appear desirable to effect a comparison between it and our own cumbrous methods of expressing the qualities of weight, capacity, and extension.

What, then, is a gas? It may be defined as a fluid possessing elastic tension, and of such a nature as always to completely occupy any form of containing vessel, no matter how large it may be, or how small the weight or original bulk of vapour introduced. Hence, a vapour differs very materially from the nature of an ordinary liquid—such as water, for example.

Now, air, oxygen, hydrogen, chlorine, nitrogen, carbonic acid, and other members of the non-metallic* substances are amongst the number of "elastic fluids" with which we are acquainted at the present time.

Atmospheric air, however, is scarcely, perhaps, entitled to the rank of a true gas. It is purely a mechanical admixture of, in the main, two elements—oxygen and nitrogen—conjoined with a variable quantity of carbonic acid. The measure of 1 litre (or a cube of 3·937 English inches in the side, and equal to 1·7637 imperial pints, or to 61·024 cubic inches) of ordinary air would be made up of oxygen 210, and of nitrogen 790 parts by volume. By this statement we are to understand that a mechanical combination of these two elements in the proportions here given would present all the ordinary characteristics of pure atmospheric air—that is to say, it would admit of being breathed with impunity, and would support combustion.

Under the usual conditions, the amount by volume of carbonic acid present in the air is found by experiment to range between 3 and 6 parts in every ten thousand of air submitted to examination; traces of other gases are also usually present, particularly in certain states, probably resulting from electrical disturbance in the higher regions. It will be necessary to know what a litre of dry air, free from carbonic acid, weighs at 0°C., and a pressure of 760 millimetres of mercury in the barometer. We usually find this weight is stated at 1·2932 gram; my own experiments have resulted in a slight excess—namely, 1·2937 gram—but for our present purposes this possesses no importance whatever. As a general rule, we find that the atmosphere contains also watery vapour to the extent of about fourteen parts in every 1,000 volumes; we might include, too, minute solid particles, such as the spores and seeds of plants; but I content myself with remarking, that of this character are the so-called "motes" constantly to be seen in the path of a sunbeam let into an otherwise darkened room. But we will at once pass to other and, to us, more important inquiries. Repeated and careful experiments have clearly shown that all the actual gases fulfil certain important conditions embodied in what are termed the "Gaseous Laws;" and I propose in the next place briefly to consider what these conditions are. The first of the "Gaseous Laws" tells us that the volume of a portion of gas varies inversely as the pressure to which it is subjected. It was first enunciated by Robert Boyle, and published by him in the year 1662, in connection with his work entitled "New Experiments, Physico-mechanical, &c., Touching the Spring of the Air." In or about the year 1676, however, Mariotte established the same doctrine in his treatise "De la Nature de l'Air." He carefully verified the statements put forward by Boyle, and hence the general expression for this law—that of "Boyle or Mariotte." The preceeding law is not perfectly fulfilled by any actual gas; but this point is for the present beside the question at issue. The second law of gases was discovered by Charles (Professor of Physics at the Conservatoire des Art et Métiers, Paris, born 1746, and died 1823, renowned for having been the first to employ hydrogen in balloons), but is more commonly spoken of as the "Law of Gay-Lussac or Dalton." We may define it as follows:—The volume of any gas subjected to a constant pressure will expand on being raised from the freezing to the boiling point of water by an invariable fractional part of itself.

Suppose, then, that we take any bulk of air measured at the standard temperature and pressure, and call it unity; let us assume that we take exactly one litre. The careful researches conducted by MM. Regnault and Rudberg, Prof. B. Stuart. and others, teach us that a volume of air at constant pressure expands from 1 to 1·3665 between 0° C. and 100° C. Thus 60 cubic inches of air at 0° C. would become almost exactly 82 cubic inches at 100° C., because as 1 : 0·3665 :: 60 : (3·665 × 6) = 21·99; and (60 + 21·99) = 82 cubic inches. As this represents the expansion for 100° C., it is clear that the increment for only 1° C. can only be the one-hundredth part of this—that is, 0·003665, and this is expressed as the "co-efficient of the expansion of gases." This decimal is equivalent to the vulgar fraction $\frac{1}{273}$, and we see that 1 volume of a gas at 0° C. becomes 1·003665 volumes at 1° C.: conversely also, the following holds equally good:—

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* We are not, of course, in any way concerned with the recent experiments of MM. Pictet and Cailletet, and are free therefore to speak of hydrogen as a "non-metallic."

273 volumes of air or hydrogen at 0° C.
= 274 " " 1° C.
= 275 " " 2° C.
= 276 " " 3° C.
= 273 + *t* " " *t*° C.

Further, it is necessary to state that the decrease in bulk of any volume of vapour is also strictly in conformity with the above general law—that is to say, 293 volumes at 20° C. would become 273 volumes at 0° C. Bearing in mind the ratio with which we are concerned—that of 273 to 273 + *t*—we can easily solve such a question as this:—Given 1,000 cubic centimetres of hydrogen at 0° C.; what would be the volume of the gas at 20°? As just stated, the increase is in the ratio of the numbers 273 and (273 + 20), and we at once determine the required result proportionally as follows:—273 : 293 :: 1,000 : (1,000 × 293) ÷ 273. Next, let it be required to find the decrease sustained by an equal volume of vapour measured at 20° when cooled gradually to 0°; and it is equally evident that this will be determinable in this way:—As 293 vols. at 20° : 273 vols. at 0° :: 1,000 vols. at 20° : *x* vols. at 0°. The required bulk at 0° is therefore equal to (1,000 × 273) ÷ 293, or to 931·74 volumes. Conversely also this result can easily be verified by proportion in this manner:—273 : 293 :: 931·74 : *x*, where *x* = (272,999·820 ÷ 273), = 999·99 volumes; and the latter is mathematically equal to our primary measure of the vapour at 20° C. It follows in like manner that if we measure a litre of any gas at 20°, and wish to foretell its expansion when brought to a temperature of 50° C., we must in that case reason in a precisely similar fashion. Let us take as an example, therefore, the volume last given—that of 1,000cb.c. of a vapour at 20° C. We at once see that 273 + 20, or 293 measures at 20°, become 273 + 50 (or 323) volumes at 50° C. Hence, as before, solving this question by proportion, we say:—As 293 vols. at 20° : 323 vols. at 50° :: 1,000 vols. at 20° : *x*, and *x* here is equal to (1,000 × 323) ÷ 293; = 1,102·389 vols., at a temperature of 50° C. Similarly, we can prove the correctness of the last result, re-calculating it to the primary bulk at 20°. Thus:—

As 323 vols. at 50° : 293 vols. at 20° ::
1,102·389 vols, at 50° : *x*,

and *x* here is equal to (1,102·389 × 293) ÷ 323, or (322,999·977 ÷ 323), or, finally, to 999·999 of the original 1,000 parts taken. Seeing that in calculations connected with gases we agree to compare all final results at the Standard Temperatures (that of 0° Centigrade, or 32° Fahrenheit), it will be very requisite to obtain a determinate expression for this operation, and I cannot supply my readers with a more elementary formula than that which I am about to introduce. Make v = volume of a gas at any given temperature, t, on the centigrade scale, and let V = volume of such gas at 0°C. Then volume of the gas at the "Standard temperature" will be always represented by $\frac{273 \times v}{273 + t}$: that is, $V = \frac{273v}{273 + t}$. From what I have demonstrated above my readers will experience scarcely any difficulty in regard to this question when I proceed now to dismiss the subject in the following terms: The required bulk of a vapour at the standard temperature of reference is found by multiplying the observed volume by the denominator of the fraction expressing the "co-efficient of the expansions of gases," and then dividing the product by such denominator plus the observed temperature.

But we must now examine the law of Boyle or Mariotte, and learn a few facts relative to the behaviour of gases under varying circumstances of pressure, and we shall, perhaps, do well to glance at the phenomena themselves of atmospheric pressure. I need scarcely say that the average weight of the superincumbent air which, at the level of the sea presses upon any body placed there, is such that it will exactly support the downward pressure of a column of mercury equal to 760 millimetres. Moreover, when it is borne in mind that the metre is equal to 39·37 English inches, we at once see that the above is equivalent (0.760 × 39·37) = 29·92in. When we speak of a normal pressure, therefore, we mean some close approximation to the above height; and when we allude to a standard pressure we actually indicate that precise height and no other. Although at the sea level the atmospheric pressure supports 760mm. of mercury, the decrease is so rapid as we ascend above the surface of the earth that, at an altitude of about 5·5 kilometres or 3·437 English miles (assuming, as we may, that 8 kilometres = 5 miles) a column of mercury measuring but 380mm. would be sustained in the manner already stated. Perhaps a few homely illustrations of this phenomenon may prove of interest. If we carry a carefully constructed barometer from the level of the Thames to either the top of St. Paul's or Hampstead-hill, the column of liquid metal stands about half an inch lower than at the first level, and thus marks an ascent of about 500ft.; but on Mont Blanc it falls to one-half of the usual height—or to 380mm.—in this way proving the latter elevation to exceed fifteen thousand feet. I may also add that in a famous balloon journey performed by Du Luc many years ago, and at a period when aëronautical science was in its cradle, the barometer sank to below twelve inches or 304·8mm., and indicated the then great elevation of twenty-one thousand feet or 3·977 miles. We are taught then, by the law of Boyle, that any volume of a vapour at a given pressure becomes half such a volume at twice that given pressure; conversely, too, one volume at a given pressure will expand to two measures if the pressure be halved—to three measures under a pressure equal to one-third; and so on always. In the next place as vapours are invariably compared together at the standard pressure, I proceed to give an extremely simple formula for performing the necessary reduction in question.

Let v = observed volume after correction for temperature; let p = pressure in barometer at time of observation; and let V = required volume at 0° C. and 760mm. Then $V = \frac{p \times v}{760}$. Or, in words, we say that the standard volume of a vapour is found by multiplying its observed bulk (previously reduced, if necessary, to standard temperature) by "pressure at time of observation," and then dividing this product by 760.

Suppose, next, that we make for ourselves an example as follows:—We actually observe a vapour to occupy a space of 100cc. at a time when the barometer stands at 730mm.; the temperature is, and remains throughout, the standard one of 0° C. Required, the true volume at standard pressure. It is evident at a glance that in this case V = (730 × 100) ÷ 760, or (73000 ÷ 760); and, finally, that the latter is equal to 96·05cc.—the volume at the pressure of reference—the gas having sustained a decrease equal to (100 − 96·05) = 3·95cc. by the additional (supposititious) pressure of 30mm. of mercury. I will, in the next place, offer an example embracing the two-fold calculation for standard temperature and pressure conjointly. We measure out, say, 100cc. of a gas at 10° C., and at a barometric pressure of 740mm. Required, the true volume at 0° C. and 760mm. Let us perform the reduction in two stages, and supply the necessary proofs as we proceed.

(*A*). To correct for temperature:—The formula "V = 273*v* ÷ 273 + *t*" results in the following proportion: 273 + 10 : 273 + 0 :: 100 : *x*cc., in which *x* = (27300 ÷ 283) = 96·466 = 96·47cc.—the volume of our vapour at 0° C. Proof of the preceding: We have just seen that 100cc. at 10° became reduced to 96·47cc. at 0°; therefore, also conversely, 96·47cc. at 0° should increase to the original bulk of 100cc. if raised through 10° of heat. But, as the volume 96·47cc. will increase by the $\frac{1}{273}$rd of itself for every single degree, it is evident that it must increase by the amount $\frac{10}{273}$rds of itself when it is subjected to ten degrees of heat. Hence 96·47 at 0° = (96·47 + $\frac{10}{273}$ × 96·47cc. at 10°; = 93·47 + (964·7 ÷ 273) at 10°; and 964·7 ÷ 273 is equivalent to 3·530. Next, adding the latter to the observed volume at °, we obtain (96·47 + 3·53) = 100·00 cc., as required by the case.

(*B*.) To correct for pressure:—The formula, V = *pv* ÷ 760, furnishes the data for the calculation now remaining. From it we learn that V = (740 × 96·47) ÷ 760; = (71387·8 ÷ 760); = 93·931 cc., or the actual bulk of our vapour taken at the standard pressure. To prove the latter result we must reason in this fashion:—Because $V = \frac{p \cdot v}{760}$, therefore $v = \frac{760 \cdot V}{p}$, and consequently, in the present case, v = (760 × 93·931) ÷ 740; = 96·469—that is, 96·47 cc., or the volume of vapour prior to effecting the reduction for pressure. Feeling satisfied my readers can now easily grasp the simple methods of determination employed in the calculation of standard gas volumes, I proceed to the consideration of the theoretical zero of temperature, or that condition in which, if a body were placed, it would be absolutely devoid of all traces of heat whatever; and I will show that this, too, is a matter of extreme simplicity. We must first, however, examine the nature and construction of the simplest kind of air thermometer. Let us suppose that we have a long straight tube of uniform bore, closed at the lower extremity, and open at the top; and that it contains a portion of air or some other kind of gas only restrained from mingling with the atmosphere by reason of a short column of oil or mercury allowed to glide freely along the tube.

I must suppose, too, that we contrive to retain the pressure constant throughout our investigation. We will first surround our air thermometer with ice and melting ice; and we will imagine that the lower margin of the oil or mercurial plug stands exactly at a point against which (suppose it at about half-way up the tube) we must scratch a mark to indicate "Freezing"—that is, we write on it 32° F. and 0° C. respectively. In the next place we will surround the thermometer with steam escaping from water which is boiling under a pressure of one atmosphere, or a pressure of 29·905in. of mercury; and we will suppose that the lower margin of the sliding plug now stands at a point higher up the tube (say at about a clear one-third above our previous record). Against the latter we will scratch 212° F. and 100° C., thus representing the "boiling" point upon each scale. Now, to finish such a thermometer, we divide (say) the interval upon the right-hand side between 32° and 212° F. into 180 equal degrees; upon the left hand side we similarly divide the space between 0° and 100° C. into 100 equal degrees. We also adopt similar measures below 0° and 32°. For instance, at 32° below "freezing" on the right hand side we may write 0° F.; while at 37·9° below the latter itself—that is, below zero—we mark −37·9° F. and −38·8° C., and at these minus degrees we may also add "mercury freezes." At minus 220° F., or 140° C., occurs a remarkable halting-place, which is termed "Natterer's Lowest Observed Temperature." But at the bottom of the tube, what must we write there? We can readily solve this problem if we approach it in a fitting manner. The original volume of air employed may be called unity, and we know that at 212° F. and 100° C. it had increased in the ratio of 1 to 1·3665, this being the value of the "coefficient of expansion of gases by heat;" or we might say that the distance from the bottom of the tube to 0° C., or 32° F., must represent unity, and that the space between 0° C. or 32° F., and 100° C., or 212° F., must represent the 0·3665th part of unity—that is (1·0000 ÷ 0·3665), and it represents, therefore, the 1-2·7285th part of unity. Also, as this space contains 212 and 100 degrees respectively it clearly follows that unity, or the whole space between 0° C., 32° F., and the bottom of the tube, must contain, in accordance with each scale, the number of degrees indicated by [(180 × 2·73)* − 32] = minus 459·13° F., and by (100 × 2·73) = minus 273° C. This, then, would be the true reading for the zero of absolute temperature. From the foregoing we also learn that the value o the "co-efficient of expansion" is $\frac{1}{460}$ upon th Fahrenheit scale of temperature. We know

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* If we retain the whole value we get − 459·13° F., an − 272·85° C., expressive of the "absolute Zero;" but it better, perhaps, to work (as at present) with the actua "co-efficient of expansion."

now that a body possessed of no heat at all would certainly be below −273° C., but we can scarcely say how much below.

I propose, in my next paper, to discuss a subject of considerable interest—namely, that property termed "diffusion of gases."

(*To be continued.*)

THE ORGAN: A COMPREHENSIVE TREATISE ON ITS MANUFACTURE, PROCURAL, AND LODGMENT.*

By JOHN WATSON WARMAN,
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PART I.—GENERAL TREATMENT IN MANUFACTURE.

z. THE writer would never, unless in the most exceptional cases, advocate anything higher than preceding. It must be borne in mind that large bodies of ignorant persons should not be trusted with the praises of the Sanctuary at all if their proper and effectual musical control be impracticable; it is nothing short of an offence to the Deity to turn four or five thousand average congregational Psalm-smiters loose into such a building as say Lincoln Cathedral, and set them singing the Old 100th to the accompaniment of such an Instrument as that at present standing there. It is obvious that nothing short of a cohort of Stewards beating the time—say two in a bar *risoluto*—on the backs of the laggards, would here insure anything but a draggling roar. To attempt to control such a mob by any practicable wind-pressure whatever will be simply foolish. The only methods are to use well-known tunes &c. *only* with extreme caution; to instruct as much as possible; to assist with properly-trained Brass or other Orchestral Instruments; to let the Organ itself be of ample size and *reasonable* pressures; and, above all, to obtain absolutely homogeneous control over the entire mass by providing *more than one Organ*. Two or more effective Instruments, each with complete ordinary Action of its own, but with additional Electric Action to bring in communication with the Organist at one set of keys—these, and these only, and *not* a tremendous wind-pressure, furnish the real solution of the problem of united Cathedral utterance—that is, such unity as the slow speed of sound itself will ever allow of.

[14, a.] CONCERT ORGANS. With regard to large Instruments, the preceding with reference to Cathedral Organs will be quite sufficient. It must be remembered that the Concert Instrument has, as a rule, less need of forcing than the former, first on account of the much smaller space and auditory, even in really large Halls; secondly, because it has now a chance of being listened to; thirdly, because it is used, as a rule, only with trained performers; fourthly, because of the often better acoustic character of the building—I mean, not as to effects simply ethereal or sweet, but as to capability of restraining and *enforcing* the effect of the sound-waves.

b. With regard to smaller Instruments more will depend upon circumstances. The single Tuba of a moderately small three-Manual Organ might in certain cases be as strong as in the largest Instrument; so also the various imitative Stops, whatever be the size of the Organ, may well be winded sufficiently strong in all cases to effectively supply in the Orchestra the place of those particular instruments. Thus the little Organ of one Stop representing the Hautboy may be on 3in.; larger Instruments, with one or two (imitative) Stops, may have a 3in. and a 5in.; and so on, the fact of the Organ possessing but two or three Registers making not the least difference, only that such an Instrument will be all but useless to fulfil the general purposes of the Organ.

c. REEDS. The increase of pressure for Reeds may be set broadly as one-third of the lighter; thus, supposing the Flue-work of the Great be on 3in., its Trumpet, &c., will be on 4in.; of course, in the Solo Organ a greater increase is advisable, as already pointed out; and on the Choir the author does not recommend any increase at all as a rule, for variety is as essential among the Reeds as among the Flues, and one most effective way of ensuring this is by different pressures. The Reeds in portions of the Leeds Organ before mentioned are on 1in. heavier than their corresponding Flues.

d. AUGMENTATION OF TREBLE. The rule of one-third of the lighter will be very useful in this case unless there be two increases, in which case each increase should be, say, one-fifth the preceding lighter; thus, a Great commencing with 2½ would have its middle 3 and its top a trifle over 3½. The Organ of St. Denis, Paris, by C. Coll, has its Treble, or a portion of it, 1in. heavier than the Bass. The softer portion of Solo of the Leeds Organ also has an Augmentation of Treble of 1in.

e. MOTORS. *Draw action.* No very powerful force will, as a rule, be required here. If Willis's method (or any other employing exhaust) be used, of course the power will be limited to ordinary atmospheric pressure, quite sufficient in ordinary cases, as the area of the Diaphragm can obviously be increased at pleasure. Use will soon show what pressure will suffice, and weight can be given accordingly.

f. *Composition action.* It is here that the greatest pressure is required, even when the Draw-action is, as it always should be in large Instruments, either Pneumatic (or some other suitable Motor) or a mere Valve, as in the Puppet Chest. The pressure for the Albert Hall Composition Motors is, I believe, 30in.

g. *Touch-action.* The pressure for the Touch Pneumatics will depend, firstly, on their size structure, and number and nature of the Pallets they have to open: 4in. may be considered about as light as it is, as a rule, advisable to use for a Pneumatic; the Manchester Cathedral Organ, already referred to, has 5in., and the Crystal Palace 6in. Still there are Pneumatics on lighter winds; the large Instrument belonging to Thos. Spratt, Esq. (*see* next para.) has its Pneumatic—for two Manuals and octave movement—on a 3¼ wind.

h. MISCELLANEOUS EXAMPLES. *General only, and without Apportionment in most cases.* The following are believed to be correct, but absolute exactness is not guaranteed, as the figures are merely taken from miscellaneous printed accounts:—

Bombay (India) Town Hall. 40 S.S., 3 and P: 2½ to 5 (Bishop).

St. Mary of Sacred Heart, Boston, U.S. 45 S.S., 3 and P.: all Pipes to 3½ (Johnson, Westfield, Mass., U.S.).

St. Alphonsus, New York. 45 S.S., 3 and P.: Manuals 3, Ped. 3½ (Hook and Hastings, Boston, U.S.).

Mr. N. Holmes's Organ, Regent's Park, London. 65 S.S., 4 and P.: Echo *half an inch*, Choir 2, whole of Gr. and Sw. Flue 4, Swell Reeds and Ped. and Solo 6 (Bryceson).

Corn Exchange, Kilmarnock. 31 S.S., 4 and P.: 2 to 7, latter for Tromba and some other Stops (Forster and Andrews).

Manchester Cathedral. 40 S.S., 4 and P, 8 to Tuba and Har. Flute, 5 to Pneumatic, all rest 2¾ (Hill).

Panopticon, London. 60 S.S., 4 and P.: Six pressures (Hill).

St. Sulpice, Paris. 66 S.S., 4 and P.: 3, 3 full, and 6 (Cliquot, Paris, Rebuilt by C. Coll).

Mr. T. Spratt's Organ, Vassall-road, London, S. 49 S.S., 3 and P.: 2¾ Man., 3¼ Ped. and Pneumatic (T. S. Jones and Courcelles).

Liverpool Town Hall. 100 S.S., 4 and P.: 3½ to 20, Solo is 15 and 20 (Willis).

London, Albert Hall. 111 S.S., 4 and P.: 3, 4, 6, 8, 10, 24, and 30 inches (Willis).

St. Peter's, Eaton-square, London. 64 S.S., 4 and P.: 3½, 4, 5¼ (Lewis).

St. Mary's (R.C.), Newcastle-on-Tyne. 34 S.S., 3 and P.: Manuals, 3½, Pedale, 4 (Lewis).

(It will be seen that some of these have been already given.)

i. MORE EXACT INFORMATION. In conjunction with Specifications, the foregoing will be sufficient to indicate the best pressure in all instances where Organ is *commensurate*, building of proper *acoustic* capabilities, and Instrument itself properly *placed*. In cases where these are not existent, a little more pressure will generally be beneficial. More precise information will be given in future more particular and minute treatment of the Instrument.

*** RESERVOIRS.

j. By this term is here meant those receptacles which receive a storage of wind to be used out in exact quantities, the inlet or admission of such wind being in all cases governed by an Automatic Valve (to be directly described, l. next); it is the presence of this valving which constitutes the difference between a Reservoir and a Receiver, the latter *rising* and *falling* with the supply or consumption, the Reservoir remaining continually *full* (that is, theoretically so; see farther on.) It will be obvious that Concussion-bellows are not here comprehended, their use and action being quite different.

k. The general description and action of the Reservoir is as follows:—It is simply a Receiver without Feeder, generally of smaller size and rise than a regular Receiver (*see* a little on); the Valving is so arranged that when the Reservoir has risen a certain height the communication with the Feed is cut off by the closing of the Valve—that is to say, nearly so. The Reservoir is thus—except on a sudden demand—always nearly fully inflated.

l. The Reservoir is usually weighted ¼in. lighter than the Receiver in connection with it (the latter *must* be weighted somewhat the heavier), and the action is as follows:—When the Feeders are actuated the wind immediately passes into the Receiver as usual, but finding a vent (Trunk) leading to a less heavily-weighted Top-board inevitably raises the latter in preference; and continues to do so until the Automatic Valving closes, when of course any further feed *must* inflate the heavier pressure, that is, the ordinary, or No. 1 Receiver (to which the Tell-tale is always attached). Speaking exactly, the action is thus: if the Reservoir be *full* the Automatic Valving must be *closed*, consequently the heavier pressure cannot affect what passes from the lighter or Reservoir pressure to Pipes; if the Reservoir be *not full* the Valvings must be open, and thus the additional force of the heavier pressure *expended* in raising the Top-board of the Reservoir. Thus, in fact, the Valving is always a little open, and the heavier pressure is, by its influence, inevitably attenuated just the amount of the difference between the two pressures; and so the heavier, although it drives wind through the lighter, can only do so at the requisite reduced force.

m. The Reservoir will thus be seen to be a simple Receiver, automatically trapped, and communicating by Trunk with the Receiver of an ordinary Bellows. It must be strictly borne in mind that the communicating Trunk must in *all* cases, *particularly* with a small Reservoir (*see* o. next), be of ample size.

n. The exact *position* of the Reservoir is subject to variation from circumstances; where height can be commanded it is generally best placed over the Receiver. The communication between the latter and the Reservoir has sometimes been made by Trunk formed like the Bellows of an Accordion, but to this there are certain objections. (*See* WIND-TRUNK). At other times the Reservoir is at the side of the Bellows proper, sometimes some distance off. More is said on these points farther on. (15, e.)

o. With reference to the *construction and size* of the Reservoir some difference of opinion prevails. First, as regards number of folds: it will be obvious that with the Reservoir always full there is no need either for compensating rib or considerable rise; one fold, therefore, will in most cases do. It will, however, sometimes happen that there occurs a great *sudden* demand upon the Reservoir, and in such case it is liable, if it have not sufficient rise, to "run out," or empty, before the heavier pressure can bring itself against it: two folds, one inverted, will obviously be useful here.

Secondly, as regards area, it is manifest that this will, to some extent, depend upon *rise*—the larger the area the less amount will there be of the collapse just mentioned.

p. As a rule, it may, I think, be laid down that the area of the Reservoir should not be less than half a square foot per Stop of Sounding size supplied by that Reservoir (for calculation of Sounding-size, *see* 15, v). Thus, imagine an Organ with Gt., Sw., Ch., and Ped.—and no Coupler Ch. to Gt.—to be furnished

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with Bellows in usual mode, and Reservoir for Manuals, the Bellows will have Trunk to Pedal Organ in ordinary way, and the Reservoir area will be calculated by united Stops of Gt. and Swell: thus, suppose former possess 10 and latter 8 stops, the minimum area of Reservoir will be 9 sq. feet—say, Reservoir 3 × 3 (*see* economy of square plan, 5, o): the addition of Choir to Great or to Swell, or Octave Man. Couplers will, of course, necessitate enlargement of Reservoir accordingly. The large Organ belonging to Mr. T. Spratt, before alluded to (14, g.), has a Manual Sounding-size of 51 Stops, supplied from a Reservoir of 25 square feet; slightly, as will be seen, *under* the rule I have laid down. The wind supply of this Instrument is thoroughly sufficient in every respect for all legitimate playing.

(*To be continued.*)

THE LATHE.—VI.

By Fred. Hoffmann, Engineer.

NO one that has much turning to do uses an oil-can for oiling his centre; a little piece of wood is all that is needed, and a little wooden pot, or stopped-up piece of tubing, that will not always be in the way, and liable to be knocked off, but that can be fastened by a piece of wire round the headstock; or what is, perhaps, better still, is to have a receptacle cast in the movable headstock (Fig. 1). If the work makes a knocking noise in the lathe, it is often from the spindle being loose between the centres, the driving pin in the face-plate continually striking against the carrier. The screw in the movable headstock must not be too quick, as it is frequently used for feeding in boring, and drilling tools, but the fly-wheel should be moderately heavy, and should stand out far enough from the casting to prevent one catching one's fingers between the hand-wheel and casting. Where the movable headstock fits into the lathe-bed, the snugs should be deep, so that they will not wear a slack fit in the bed; they should not be made too tight in the bed, however, or the moveable headstock will come along with a jump when it is pulled. In most lathes a common fault is that the moveable headstock sticks, from the bolt and washer catching against the under flange of the lathe-bed. It is also preferable to tighten the moveable headstock on the bed by means of a handle, as there is nothing so tiring as perpetually stooping down underneath the bed for this purpose. In small lathes an eccentric may be used with advantage, especially in chasing lathes (Fig. 2). A common hand-rest is shown in Fig. 3, which may be turned half round for a boring rest, or a separate rest may be put on as in Fig. 4. Of course, in all rests for hand-finishing and chasing threads the rest must be hard and slippery, and the top be kept oiled. It is often necessary in hand turning to use a long handle of the form of Fig. 5. Fig. 6 shows a common form of chuck for holding studs, and bolts for finishing. In finishing off the ends, a half centre must be used, and the centre mark must not be taken quite out—in fact it is always best to chase the thread to gauge before touching the ends. In following the thread the great thing is not to go too deep at first, and then chase taper so as to try the end of the stud into the gauge or nut, till it fits slack. If the studs are for steam-tight joints, as cylinder lids, they must, of course, be tight, and chased clean up to the collar, or the holes for them must be countersunk a little (see Fig. 7); or else for bolts it is generally found in fitting and erecting shops that bolts and nuts require running down, sometimes two or three times, with the stocks and dies. Fig. 8 is a nut-facing and champfering lathe. It has an overhead reversing motion (as described before in Paper I.) which drives it the reverse way, in order to unscrew the nut, by feeding a piece of iron, fastened in the rest, against it, which also keeps the next nut from turning round when it is being put on. Of course water must be used for this, and in this case, as in all others where water is used, a tin must be placed underneath to collect the water. If the water should upset on a flagged floor a chisel must be driven in the cracks between the flags to let the water find its way out. In this class of lathe only the cross-traversing handle is used, the other one not being used when once the lathe is set, so it is apparent that all nuts will be the same width. The lathe need never be stopped, though it is reversed twice for each nut, but the disengaging worm-wheel (which should be of case-hardened scrap iron) must be taken out of gear, as soon as there is enough champfer on the nut. The reason why a nut is champfered at all is to let the key go on quicker, and to lessen the danger of men getting their fingers or clothes caught by the corners. Lathes are made purposely with hollow mandrels, for turning studs out of long round bars of iron; they call for little remark. If the iron bar sticks out far it must be covered over with a loose tube, or be protected by a railing guard. I recollect once seeing a young man, who was passing one of these lathes, entirely divested of his coat, waistcoat, &c., in about a second, from the end of the iron bar catching him in the small of the back, and finally the strap came off from his scarf catching round his neck. Fig. 9 shows a method of gauging studs to the right diameter, which at first sight appears good, but is really not so quick and accurate as using a gauge of the form of Fig. 10. A tool of the form of Fig. 11 must be used for this work, and the lathe driven at a high speed. In turning some classes of studs, and locomotive copper stays, a little ledge on the lathe bed lifts the rest up, and causes the tool to dig into the work, turning it a smaller diameter until the ledge is passed (see Fig. 12). The object of turning these stays smaller, and generally speaking of turning any spindles smaller, in the middle, is to screw them, or put them in easier, and no shaft for whatever purpose, either a revolving axle or a stay, should be the same diameter all along if it has to be hammered through fixed holes at the end, as when a machine gets clotted with oil, and rust, it is sometimes next to impossible to get the shaft out, from its not having been at first turned down in the middle. In using gauges of the form of Fig. 13, if the gauge is too wide it must be hammered to alter it. It is a mistake to use two different sizes on one gauge, as it only leads to two men wanting the same gauge, and it is a chance if one man wants both sizes at once.

FIG. 1

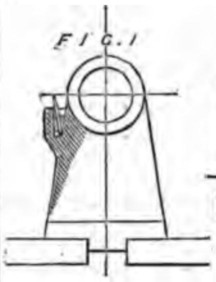


FIG. 2

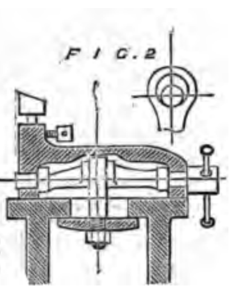


FIG. 3 FIG. 4

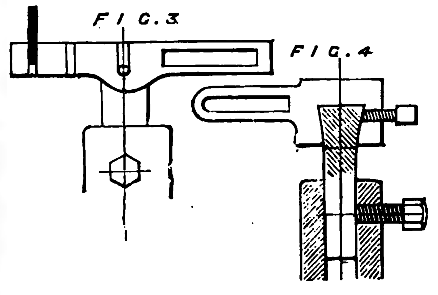


FIG. 5 FIG. 6 FIG. 7

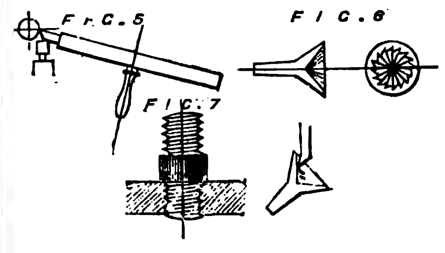


FIG. 8

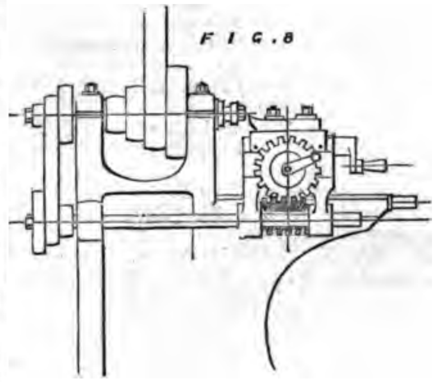


FIG. 9

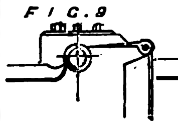


FIG. 11

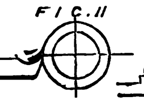


FIG. 12

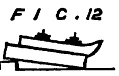


FIG. 10

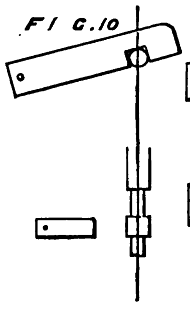
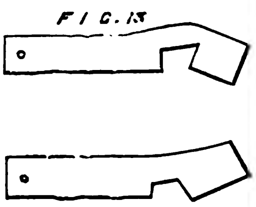


FIG. 13



(*To be continued.*)

THE FLOOR OF THE OCEAN.

AT a recent meeting of the American Academy of Sciences, Prof. Alex. Agassiz read an essay descriptive of the results of the Blake expedition. At last year's meeting of the Academy, Prof. Agassiz said he had prepared the way for his present subject by discussing some of the work done on the Challenger Expedition. He did not then, however, expect to be ready at the meeting this spring with an account of another expedition. But the United States Coast Survey placed at his disposal an opportunity in the cruise of the steamer Blake. This vessel has passed over, for purposes of sounding and survey, a distance of 1,800 miles in and adjoining the Gulf of Mexico. The work of observation was begun at the point where it had been left off by his predecessors in deep-sea dredging for that region—his father, Pro. Louis Agassiz, and Count Pourtales. They had, indeed, run one or two lines of dredging across the Gulf, but it was done with the imperfect appliances of that day, and brought no complete results. In depths exceeding 500 fathoms, for instance, Count Pourtales found little animal life, and at that time there was a general belief that the limit of existence had been nearly reached at such depths. The lines surveyed by the Blake started from Florida across to the Yucatan Peninsula, and afterward crossed and recrossed the Gulf, ending by reaching New Orleans, and passing over a distance of 1,800 miles. The survey would have been longer had it not been interrupted by an accident at the Balize. A Spanish pilot ran the vessel ashore on the coast of Cuba, near Bahia Honda. Marked improvements have been effected in deep-sea dredging and work of like character, so that much more can be done in a given time than formerly, and the results are more satisfactory. In sinking the lead to great depths heavy weights are required. On the Challenger the mode of ascertaining that the lead touched bottom was by noticing when the rope ran out more slowly than before. This operation was performed with a very heavy rope, such strength being necessary to hold the weights employed in sinking it. It was liable to an error of perhaps [illegible] fathoms in giving great depths. It is strange that the English did not use the invention of their own countryman, Sir William Thomson, instead of the antiquated sounding-rope. The improvement principally consists in substituting a piano wire. This, after running out, leaves the shot with which it is weighted on the bottom. Repeated soundings with the piano wire on board the Blake indicated that the accuracy attained was within 1-100 of 1 per cent.; the Challenger soundings were only within 5 per cent. The Thomson sounding-wire was unfavourably reported upon by the British commission that had the outfit of the Challenger in charge. In this country it was favourably received and tried in the sounding expedition of the Tuscarora, and under the skilful management of Commander Belknap, who added to its usefulness by various devices, it met great success. Since its introduction here the piano wire has been altogether used by American aphers. The time gained by using the wire remarkable—for instance, twenty to twenty- ates, as compared with two hours. The iron ight left on the bottom of the ocean is, per- iixth of that lost by the old process.

Agassis showed the dredge as now modified l on the Blake. Hitherto, the dredge has nost unsatisfactory contrivance, because its in and kept burying it so that, no matter g it was dragged, little less than mud was l, requiring hours of sifting to extricate any ns that might be included. On the Blake a was devised which did the sifting at the instead of the top of the ocean. A rope was ied to the dredge that it no longer tended to elf. After this had been successfully tried, r improvement was made by substituting a for the wedge, with net sides; this ran along the bottom without burying at all. were attached behind the dredge, which great service. It is quite astonishing what of animals may be caught by the tangles; bring up fishes.

rawl was another instrument needing nent. Its tendency was to turn over side- d then catch nothing. Sometimes every a week at a time on the Challenger would cessful because of these troubles with the On the Blake no such difficulties were en- l; they used a contrivance somewhat like trawl, that had the merit of doing its work vell whichever side was up. In the whole Blake expedition there were only eight with this apparatus; six of these were at ning before they became accustomed to the d the last two were not the fault of the nce. The clumsy apparatus of the Challenger work costly. The total weight of dredge, d shot, in three miles' depth was three d, of course, the rope wore rapidly under strain, and often parted while out. The xpedition lost 50,000 fathoms of such rope. ke expedition could not afford loss at a ate, even for a season's cruise, and it was ed to do for dredging what had been done ling—to substitute wire for rope. With dredge served sufficiently as a weight. saved by using wire with the dredge was proportionally as with the sounding lead. re made in two hours that would have con- ght hours on the old plan, and five or six e made per day instead of one. In three -sixth as much was done as in the three or s' work of the Challenger.

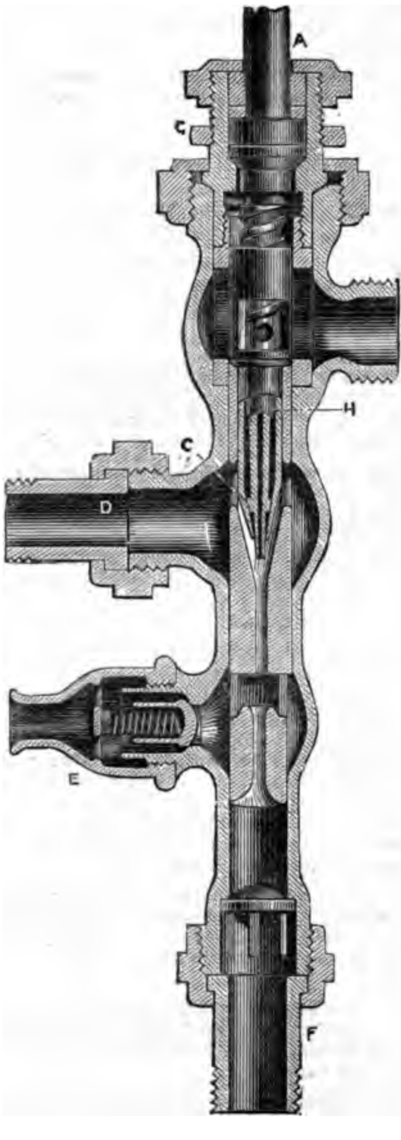
lowing observations are reported by Prof. —Where the depth is 1,800 to 2,000 fathoms Windward Islands, the fauna corresponds the Atlantic outside; the animals having penetrated through the openings between ds. All classes of the animal kingdom he ocean are well represented. Inside the Sea the fauna is more socialised and istic. On the Challenger expedition it had rtained that the red clay ooze of the ocean as largely a result of the decomposition of of surface animals—a disintegrated portion nestone contained in those shells. Every- the Gulf a similar deposit was found. nimals, chiefly mollusks, may be said to fill rom the surface to eight, ten or twenty-five n depth.

edge always brings up a quantity of their nposed shells, and in instances where the oportion was carefully tried, it was found e than half the mud consisted of shell There is no doubt that a stratum is t the bottom of the sea due entirely to ings and hard parts of pelagic animals ist in swarms near the surface. On the as to the existence of many animals in deep ar neither the surface nor the bottom, ssiz is inclined to distrust the Challenger ons. The apparatus there used could not oof as to to the point whether the animals y caught at the depth of 1,000 fathoms or urface. The fruits of the towing-net may gathered anywhere in its course. There me in the brief expedition of the Blake to d employ apparatus by which this question ally determined. In the course of this the temperatures of the Gulf Stream were d throughout, from top to bottom, and he whole area. The fact had been first Dr. Carpenter that an inclosed sea, such diterranean, may have a higher tempera- s depths than corresponding depths of the he difference in that instance is 35°. It is the fact that the ocean water flowing into terranean has to cross a barrier at ; the depth there is about 500 fathoms, mperature at that depth is that of the sea of it, the cold water at the bottom of the ither never rising so as to float over that r if it does, being warmed to the higher re while in transit. The Caribbean Sea is inclosed by barriers, and its waters at their epths are only as cold as that of the lowest on the barriers. Similar observations are on record about the Soloo Sea and other bodies of water thus marked off by submarine or surface elevations surrounding them.

Prof. Agassiz is not yet prepared to throw additional light on the question of sight by pelagic animals at great depths. The fact remains that at these depths there are found creatures of two classes in respect to vision: one eyeless, or nearly so, and with curious changes of structure taking the place, sometimes, that the eyes should occupy; others in a totally opposite condition, having eyes enormously developed, as if to enable them to see with the smallest modicum of light. This is true at depths of 1,500 to 1,900 fathoms or more, both as to crustaceans and fishes. It seems strange that the same conditions should have produced diametrically opposite results. The question is the more interesting because it concerns a very old fauna. The oscillations which have shaped the present continents did not break up the seas below the 1,000-fathom line, nor disturb the existing animals there. This is a fauna that has come down without change of locality since Cretaceous, and, possibly, since Jurassic eras. New forms, those of later epochs, may have been introduced by migrations from the coast and shallow water of the continents, but there can be little question that the dredge at great depths brings up chiefly the direct descendants of the Jurassic, or even an earlier period.

THE ECLIPSE INJECTOR.

It is generally conceded that if an injector is so constructed as to work under a varying pressure of steam and water, it is the most economical mode of feeding a boiler, costing much less than a steam pump, and heating the water by the steam used for its operation. It is claimed that the Eclipse injector, illustrated herewith, meets these requirements. The engraving shows a sectional view. A is the spindle of the regulating handle, B the steam inlet, C the steam plug, D the water entrance, E the overflow, in which is a valve, and F is a feed pipe to boiler, also provided with a check valve. By unscrewing the nut, G, the working parts can be taken out, examined, and replaced without any connections being broken or the injector removed from its position. This is an important desideratum, as the openings in an injector are so small that any particle of dirt or waste getting into it are liable to stop its working. The adjustment to suit different steam and water pressures is effected by the steam plug, C, which gradually regulates both the water and the steam. When the steam pressure is high a large amount of water and a small amount of steam are admitted, and as the steam pressure falls, more steam is allowed to enter, and the water supply is reduced at one operation, by simply turning the handle of the regulating valve, A. The injector is claimed to work equally well with a steam pressure of 1lb. or 200lb., and will lift the water at any pressure. The apparatus is made with an internal jet, H, for lifting.—*Scientific American.*



A TOURIST'S PRESERVATIVE DRY PLATE PROCESS.*

As it may not be inopportune for members to describe the dry plate process, which they find the most practically useful, I venture to direct attention to the following:—My aim has been principally directed to prepare films by the use of a collodion and bath, combining, with long keeping properties, adaptability to the ordinary wet process worked with iron development. The great susceptibility of highly sensitive films to injury from weak luminous radiations during preparation, exposure, and development, render reliable plates of moderate sensibility a perfect desideratum. Such, when worked with others of high sensibility, if easily prepared and developed away from a specially constructed laboratory, constitute, in my view, essential requisites for the amateur landscape photographer.

The method I adopt for the preparation of films of the less sensitive type it is my present purpose to describe. Although any collodion of recognised standard excellence for iron development is perfectly suitable, yet I shouid deem this description incomplete were I to omit a formula equally adapted to this or the wet process. I must confess that, in the manufacture of pyroxyline, I have not found the three-to-one proportion of sulphuric to nitric acid, originally recommended in the patent for explosive cotton, and subsequently ably advocated for the soluble varieties, to be the best. The employment of a larger quantity of nitric acid to the sulphuric, yields in my hands a better result for the soluble kinds. The following formula is based, therefore, on this consideration:—

Sulphuric acid, sp. gr.	1·84 ...	6 fl. oz.
Nitric „ „	1·42 ...	3 fl. „
Water	...	5¼ fl. dr.
Cotton	...	150 grs.

Temperature, 155° Fahr. to 145°. Time of immersion, 10 minutes.

The double temperature given signifies that, at the time of the introduction of the cotton, the acids should be at 155°, and the allowable decline must not exceed ten degrees. Six fluid drachms of a plain collodion, made by dissolving from five to six grains of the above pyroxyline in a mixture of four fluid drachms of methylated ether, sp. gr. ·720, and two fluid drachms of pure alcohol, sp. gr. ·820, is to be mixed with a bromo-iodising solution made as follows:—

Sodium iodide	6 grs.
Cadmium bromide	4 „
Iodine	¼ gr.
Gum Guaicum	¼ „
Alcohol, sp. gr. ·820	2 fl. dr.

Before coating the plate I apply a substratum consisting of an ounce of liquid albumen and 30 minims of "liquor ammoniæ," sp. gr. ·959, dissolved in an imperial pint of water. After the plate is coated, excited in an ordinary argentic nitric bath and removed therefrom, it is to be freely washed in ordinary water kept in motion, and then treated with the following preservative, poured on and off the film twice or thrice from different parts.

Preservative.

Albumen	1 fl. oz.
Glucose solution (raisins 1 part, water 5 parts)	2 „
Water	3 „
"Liquor ammoniæ" sp. gr. ·959	15 mins.
Ammonium chloride	3 grs.
Ammonium bromide	½ gr.

The film is again to be freely washed with ordinary filtered water, and covered with a three grain solution of gallic acid, and evenly dried. The back of the glass, as a matter of precaution against very trying conditions, rather than as an ordinary necessity, should be covered with a non-actinic colour. Burnt sienna ground in water and mixed with a little gum mucilage, constitutes a good medium for the purpose.

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* By T. Sebastian Davis—a paper read before the Photographic Society.

At any convenient interval after exposure the film is washed, and developed with a suitable quantity of solution made in the following proportions :—

Water	4 fl. dr.
Pyrogallic acid (64 grains dissolved in 1 fl. oz. alcohol ·805)	15 mins.
Potassium bromide (16 grs. in 1 oz. water)	15 „
Sodium carbonate (64 grs. in 1 oz. water	15 „

Five minims only of the potassium bromide should be added in the first instance and the remainder upon the earliest indication of an image. As soon as the general details of the picture become faintly visible by reflected light, the alkaline developer should be removed and a three grain solution of citric acid applied. The intensification may then be effected with pyrogallic acid, citric acid, and argentic nitrate, and the unreduced salts dissolved away with sodium hyposulphite as usual.

SCIENTIFIC SOCIETIES.

THE METEOROLOGICAL SOCIETY.

THE usual monthly meeting of this Society was held on the 17th inst. at the Institution of Civil Engineers, Mr. C. Greaves, F.G.S., President, in the chair. A. H. J. Crespi, B.A., M.R.C.S., Rev. David Lamplugh, William Morris, M. Inst. C.E., James Muir, M. Inst. C.E., and Miss E. A. Dymond were balloted for, and duly elected fellows of the society.

The following papers were read :—" On the Daily Inequality of the Barometer," by W. W. Rundell, F.M.S.; " Meteorology of Mozufferpore, Tirhoot, for the year 1877," by C. N. Pearson, F.M.S.; " Note on the Great Rainfall of April 10th—11th, as recorded at the Royal Observatory, Greenwich," by William Ellis, F R.A.S.; " Observations of Sea Temperature at Slight Depths," by Captain W. F. Coborne, F.M.S. The meeting was then adjourned till Wednesday, the 19th of June.

NOTES ON NOVELTIES.

The English Watch Company.—This company, which is established at Birmingham, owns the only factory in England where the manufacture of watches on gauged and interchangeable principles is fully carried out. The necessary arrangements have taken a long time to develop, but we learn that the company can now supply watches in three sizes, of two qualities, in any quantity, and are thus prepared to compete with the Waltham watches. The photographs of the workrooms give an excellent idea of the extent and capacity of the works. The company also forward a tract on the going barrel, &c., from which we shall probably make an extract.

Watch and Clock Makers' Tools.—Mr. Morris Cohen, of Leeds, forwards his list of tools and materials. We noticed his handy little drill on p. 483, Vol. XXV.

How to Make your own Telephones is a full-size drawing of the powder-box arrangement, with brief directions for making two telephones for 5s. 6d. It is published by John Heywood.

The Model Foot Lathe.—Messrs. Blakey Bros. and Emmott, of Halifax, have sent us a photograph of their model foot-lathe—a specialité of theirs which deserves attention from those about to purchase a lathe. Their sets of turning tools are well known to our readers, and these photographs will show any intending purchaser what he is to have for his money.

Corn as Fuel.—The *American Agriculturist* for April says :—" Some journals, whose conductors know very little about corn-growing, and other things in the West, make their annual outcry in regard to the extensive consumption of corn for fuel, which they consider a great and inexcusable waste. Suppose the Nebraska or Minnesota farmers were to sell two tons of corn for six dollars, and buy half a ton of coal for the money, and the corn were at once taken to a distillery and turned into whiskey. Would this be any better? The farmer would probably have to make two journeys of ten or twenty miles each with his loads, and be out of pocket at least six dollars by his trade. The fact is, corn is an excellent fuel, and although it may seem at first sight to be wrong to burn up an article of food, yet it is but a mere sentiment which overlooks the fact that to warm one's self by a fire, and to do the same by the consumption of food, are in the end precisely (?) similar in effect. If more warmth can be procured by consuming, in a stove, a dollar's worth of corn, than a dollar's worth of coal, it is a legitimate use for the corn; but when there is neither coal nor wood at hand, what should these people do when the winter's cold pinches, if the corn from their well-filled cribs could not supply them *with fuel?*"

SCIENTIFIC NEWS.

ANOTHER instance of the fact that great discoveries are frequently made simultaneously by independent observers was announced at the last meeting of the Society of Telegraph Engineers, after Mr. Preece had delivered his lecture on the recent discoveries of Prof. Hughes. It appears that Mr. W. L. Scott has been investigating in the same field as Prof. Hughes, and has devised an instrument which he calls the magnophone. In his first experiments Mr. Scott found that to increase the volume of sound from the telephone it was only necessary to increase the weight of metal in the diaphragm, but instead of increasing the thickness of the plate he discovered that it was better to use several laminæ perforating all but that nearest the magnet. Iron filings formed the next step, with results so promising that other substances in a finely-divided state were tried—precipitated silver, pure iron, mercury, and platinum—the last named being most sensitive to sound. As already pointed out by Prof. Hughes, mercury answers all purposes, but instead of charcoal as the porous holder of the metal, Mr. Scott used pumice or asbestos, from which he cut the phonophoric tablets, spheres, or cylinders. The results are identical with those obtained by Prof. Hughes, and if Mr. Scott discovered the phenomena before the reading of Prof. Hughes's paper, so far as he is personally concerned it is a pity he did not make them public earlier. We shall, probably, publish further particulars of the magnophone next week.

Prof. Spencer F. Baird is to succeed Prof. Joseph Henry as Secretary of the Smithsonian Institution. Prof. Henry's funeral was attended by the President and other members of the United States Executive, and Congress adjourned for the day.

Mr. W. Spottiswoode, F.R.S., will succeed Dr. Hooker as president of the Royal Society.

The Earl of Dufferin has accepted the presidency of the Royal Geographical Society.

For his Rede lecture, delivered on Friday last, Prof. Clerk Maxwell selected the subject of the telephone. There was a very large attendance both of Senate and undergraduates, the telephone harp being on view at the Geological Museum, whence its tones were transmitted to three telephones in the Senate-house.

The conversazione of the Institution of Civil Engineers will be held at the India Museum, South Kensington, on Monday next, June 3, being the fiftieth anniversary of the granting of the Royal Charter. There will be a very large gathering of scientific men in all branches, but, with the concurrence of his colleagues, Mr. Bateman has decided not to invite ladies.

The *Times* is responsible for the following extraordinary announcement :—" Chelmsford, May 20. At Parslow Hall, High Ongar, to-day, the lightning ignited a quantity of unslaked lime. The flames were communicated to an adjoining lodge cottage," &c. One would have thought that a newspaper reporter was sufficiently acquainted with lime to know that if it ever had anything inflammable in it it must have been burnt out in the process of conversion into "unslaked lime."

Mr. J. L. de Montoison has obtained a patent for a substitute for coffee. The stones of dates, well washed and freed from saccharine, are roasted and ground in the same manner as coffee!

An application "not proceeded with" sought protection for a "new" lubricant prepared by adding powdered talc to a mixture of boiled oil and grease.

The "fireless locomotive" has been tried in France on the tramway from Reveil to Marly-le-Roi. The reservoir or "boiler" was charged with water heated to 356° Fahr., giving a pressure on the valve of 130lb. per square inch, and the engine being attached to two carriages ascended a gradient of 1 in 20 at the rate of 16 miles to the hour. The fireless locomotive is a successful machine, but we suspect in this case the gradient should be 1 in 200.

Messrs. Hardy and James, two Scotch engineers, have invented a simple compressed air engine, and experiments have been recently made in New York with a car propelled by its means. The 2nd Avenue Railroad Company are so satisfied with the results that they are fitting up several cars with the machinery.

The Lockport (N.Y.) Heating Company appear to have carried out their scheme of laying on heat in the shape of steam in a successful manner, over 200 houses being supplied from the company's mains. The pipes are clothed with a thin layer of asbestos paper, then a wrapping of Russian felt, and over all a coat of Manilla paper. They are then inserted in timber logs, bored a trifle larger than the clothed pipes, and laid in the streets like gas mains. The pressure is 35lb. in winter.

The following incident has lately been related by Prof Ricard, in *Bohemia* :—A child's drinking glass was bought one day at Saaz, for about 66 kreutzers, and during six months it sustained its character of toughened glass. But one evening in the seventh month, about 9 o'clock, after having been used for drinking sugared water, it was placed, with a silver spoon in it, on a large oak table. Suddenly I heard from my room a violent explosion, like a pistol shot, and a metallic sound. I hastened in and saw, scattered all over the floor, needles and fragments of glass; and not only the floor, but the bed, the table, the curtains, &c., were covered with them. I sought everywhere for the cause of the explosion, and at last I noticed that the child's drinking glass was no longer there. The empty glass had burst without apparent cause, without the approach of a light, and with a force so extraordinary that all the inhabitants of the house were frightened. I mention this incident, not only for information of chemists and natural philosophers, but also to show to families that their articles, stated to be unbreakable, may cause not only fright, but serious injury. Such an explosion is doubtless caused by some change in the extreme tension of the fibres of hardened glass.

All musical instruments worked with the bow, and especially the violin, present a strange phenomenon in the production of certain acu notes, the emission of which is hard and di agreeable. It has been vainly tried to corre the bad quality of these defective notes, whi are avoided as much as possible. In a mem recently published by M. Dien, a remedy i announced. Hitherto the short part of th string above the bridge has not been conside to influence the sonority of the principal pa but really it vibrates simultaneously, thou very weakly, with the latter, and its vibratio cause the interferences to which are due th unpleasant effect in question. M. Dien h accordingly experimented by tuning these pr longations of the strings to the unison o octave of the defective note; and this he do by applying small movable nuts to the p longed parts, which can be adjusted as desir The rectification thus effected is said to b quite complete. M. Dien also describes means of annulling the resonance of the mi seventh in the grave chords of the piano.

The velocity of propagation of waves p ceeding from electric sparks has been fou by M. Moch to amount to 700m. in the fi eight centimetres of the wave's course; bu descends to a value less than that of th ordinary velocity of sound, after a pass through 1 metre.

A new electric lamp, with incandesc acting in free air, has been described to th French Academy by M. Regnier. A thin of carbon, pressed laterally by an electric co tact, and forced, in the direction of its axis, a fixed contact, is traversed between these tw contacts by a pretty powerful current, an becomes incandescent in this part, burning a thinning towards the extremity. As the gets used up, the rod, continually pushed slips in the elastic contact, and is thus kept against the fixed contact. The heat develop by passage of the current in the rod is great increased by the combustion of the carbon. A apparatus made on this principle is said t give a clear white light with four Buns elements. With a more powerful batte several lamps on this system may be lit.

man patent (we learn from *Ding. Pol.*
lately been granted to Dr. Zernikon,
erg, for production of artificial stones
g of mixtures of mortar. The chief
nts of the stone's mass, sand and
ne, are known to show great resistance
pheric influences. By boiling (accord-
atentee) a combination of silica and
es place; and the hardness of the
etrified by aqueous vapour, even in-
y absorption of carbonic acid from the
specimen-pieces show throughout the
of good natural sandstone; they are
it a year old, and must have gained in
, for shortly after casting they could
ut with the knife. Cracks and fissures
ere observed, and are hardly to be ex-
future, as the combination of lime
, under action of hot water, is effected
such small degrees of heat (between
150°), that a reduction of the lime
to free caustic lime cannot have taken
s regards cost of production, the price
w materials—80 to 90 per cent. sand,
20 per cent. slaked lime—will scarcely
r than that of clay for bricks. The
eating is nearly the same in both cases,
heating for bricks requires nearly a
ow, whereas for the mortar-stone it has
e brought to 150° C.; thus there is con-
saving in fuel. The mode of forming
n-shaped stones is similar to that of
made bricks, where they are pressed
a mouthpiece. All expenses of manu-
ncluded, 100k. of the mortar-stones, of
shape, cost about 2 marks.

Coutance, of Brest, has recently called
to the advantages presented to
gists by acephalous mollusca, espe-
cten maximus, for analysing the most
ng and delicate phenomena of muscular
ithout having recourse to the appara-
present employed. Experiments may
on the animals and muscles intact, so
complications connected with vivisec-
avoided. The *Pecten maximus* has an
s adductor muscle (of about 26
weight) placed between two movable
e valves, whose movements manifest
the muscle itself, and may be amplified
s of a long needle attached to one of
es; thus muscular contractions and
ns of fractions of a millimetre may be
d into centimetres on a scale. M.
has made many experiments of this
ying the effect of various stimuli,
ic agents, &c. Among other things,
een able to prove that certain fibres of
ductor muscles are designed to bring
valves, others to retain them. He has
ed the muscular strength of a number
ion acephala, referring it to unit of
the square centimetre.

e spinning mill of Troullier and
r in Epinal (we learn from the *Bulletin*
use), the system of electric lighting
adopted. One-half of a large hall of
n. is thus lit with four electric lamps
of 60 gas flames; the other portion will
the same way shortly. The lamps
d have been in action 3 months, and
lts are highly satisfactory. The light
sed in bells of ground glass, at a
of 3·3m. above the ground. The
n have no complaints to make about
from the bright light, but prefer
it to gas. The shadows cast by
belts, &c., are not troublesome, be-
e light-rays cross each other, and are
eflected by the whitewashed roof and
The light burns quite regularly; inter-
are very rare, and never occur in all
s simultaneously. According to Heil-
d Schneider's experiments, the four
ould correspond to at least 320 gas
The light is produced by means of the
wer only of a hydraulic motor; this
e arrangement very economical. The
ight further does not cause the work-
nvenience through heat, whereas the
gas system sometimes soon rendered
of work a necessity.

Hughes's important discovery in con-
with the telephone was brought before
ch Academy, at its séance of 13th of
M. Du Moncel.

LETTERS TO THE EDITOR.

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[We do not hold ourselves responsible for the opinions of our correspondents. The Editor respectfully requests that all communications should be drawn up as briefly as possible.]

All communications should be addressed to the Editor of the ENGLISH MECHANIC, 31, *Tavistock-street, Covent-garden, W.C.*

All Cheques and Post-office Orders to be made Payable to J. PASSMORE EDWARDS.

*** *In order to facilitate reference, Correspondents, when speaking of any Letter previously inserted, will oblige by mentioning the number of the Letter, as well as the page on which it appears.*

"I would have everyone write what he knows, and as much as he knows, but no more; and that not in this only, but in all other subjects: For such a person may have some particular knowledge and experience of the nature of such a person or such a fountain, that as to other things, knows no more than what everybody does, and yet, to keep a clutter with this little pittance of his, will undertake to write the whole body of physicks: a vice from whence great inconveniences derive their original."
—*Montaigne's Essays.*

◆◆◆

MICROSCOPICAL.

[14381.]—R. H. HERBERT (query 32945) wants to spoil his good ¼in. objective. He cannot have penetration and definition. An objective which focuses well on half a dozen planes at once has no exact focus at all. Apparently he wants an objective which would not require the slow motion while observing. But if he wants to see the whole of a flea at once he must use a lower power. He cannot improve his present objective—he can only spoil it. He must rest satisfied with its "sharp definition" on a little of the object. He cannot do what he wants with any eyepiece.

Some time ago the use of the screw-collar on objectives had considerable attention in your pages. Bearing on this question I think the following remarks of Mr. J. W. Stephenson, printed in the present number of the *Journal* of the Royal Microscopical Society, are worth attention. Mr. Stephenson says:—"In the use of the microscope few things are perhaps more difficult than the effective application of the adjustment collar of a large-angled modern objective. Not only is the best point of correction difficult to obtain, but in many cases it is impossible to do justice to the probably otherwise excellent character of the lens. In fact, so indeterminate is the best point, that an objective thrown out of adjustment would seldom be brought back to the identical number on the scale, if re-adjusted, by any ordinary observer, even on a well-known object. If this be so on an object with which one is familiar, how much more difficult must be the examination of an object the structure of which is perhaps wholly unknown?" I do not wish, Mr. Editor, to re-open an old controversy, but I wished to call attention to these remarkable statements as to the practical value of the adjustment screw by one who is reputed a clever man, and who is somebody, and not a mere nobody like myself. I would further notice that most of us come under the designation of "ordinary observers," and that we do want at times to study objects whose structure is "wholly unknown."

Perhaps it may interest some of my fellow-readers to know that I have now had *Melicerta* in one vessel continuously for over a year. I have read that even three or four months is a long time to do this. At the risk of being deemed unskilful, I must own that during this long period I have never seen a single pellet laid, though I have watched for hours.

"F. A.," query 32929, asks for a good cement for aquariums. If he takes equal parts of red lead, genuine white lead, and dryers, he will have no trouble in making an aquarium water-tight if his framework is metal. If it is wood he can make it hold water for a time, but probably not permanently by any cement he can use.

"Theo Izod," letter 14360, evidently fails with his injections from using too much force. Time and patience are necessary, but long practice is required to produce anything equal to professional work. His remarks on lenses will be interesting no doubt, but he need not condemn beforehand any lens merely on account of its possessing resolving power. Essex.

ON THE MEASUREMENT OF THE APERTURE OF MICROSCOPICAL OBJECTIVES.

[14382.]—IN acknowledging the courteous and kindly-expressed letter of Mr. Wenham in the ENGLISH MECHANIC for May 24, page 266, we regret, in reference to its last paragraph that we omitted to state in our last that all our experiments were conducted as described in our letter in the ENGLISH MECHANIC of Feb. 15th—viz., with a small stop under the field glass. If Mr. Wenham were to repeat his experiments with a stop of, say, ⅛in. in that position, he would probably find the cause of the discrepancy of our respective experiments. Such a stop does not affect the size of the telescopic field. We shall be interested in the results of the new system of measurement suggested by Mr. Wenham. Richd. Nickols.

Jersey, May 24. Martin M. Bull.

MICROSCOPICAL HISTOLOGY.

[14383.]—IN reply to Theo. Izod (letter 14360) I do not quite agree with him that amateurs cannot mount and prepare injections so well as professional ones. I had lent me a few days ago some injections of the rat, which I exhibited at a soirée at the Royal Microscopical Society, and a gentleman told me that he had some German injections which were certainly not better. The ones I showed were done by a friend of mine, an amateur. I don't know whether he has tried the mode of injecting which was illustrated in the MECHANIC a short time since, but I think he will find it superior to the syringe, as the pressure is more equal and steady. The slides I have were done by it. Diatomaniac.

A MICROSCOPICAL GRIEVANCE.

[14384.]—BEING a regular reader of the ENGLISH MECHANIC and a microscopist, I naturally turn directly to things pertaining to the microscope, and am generally disappointed, for, instead of finding something new and interesting, it is nearly always (at least, it has been for the last few months) the same old controversy about angles of aperture and resolving power of objectives on certain difficult tests. Not that I wish entirely to do away with the said controversy, but I do think that, when a microscopist has satisfactorily found out that his 1-8th or 1-10th will dot this diatom and striate that, he might, instead of continually doing nothing else but look at the same diatoms over and over again, examine the lower animal and vegetable pond-life—such as Flagellate protozoa, &c.—so as to find out their mode of existence; he then would be doing some real work for the microscopic world, and his discoveries would be hailed with delight. Jepepy.

PROFESSOR MILLS ON DESTRUCTIVE DISTILLATION.

[14385.]—IT was not my intention to have replied to Prof. Mills' letter (No. 14264), but as he might put a different meaning on my silence, I venture to give a few explanations, which I think are to the point. My letter (No. 14236) contained simple facts, and any man practically acquainted with the distillation of tar will agree with it; therefore the signing of my name to it can really make no difference, and I still adhere to the nom de plume I selected.

Prof. Mills takes very good care not to go into the particulars of the principal statements made by me, but contents himself with the very comforting (to him) remark:—"It is his misfortune that his figures do not agree with mine." No doubt it is a misfortune.

I now take one or two of his assertions in his letter, p. 170, and contrast them with his book and my quotations in letter 14236.

1. In the manualette, p. 23, paragraph 19, "modern tar is as a rule heavier than the liquor; this must necessarily be the case where naphthalin is produced in quantity." In my letter I said: "All coal tar is heavier than water, not because it contains naphthalin, but from the bulk of its component parts being heavier than water. Prof. Mills in letter 14264 says: "I have to remark that I have nowhere suggested, as he seems to imply, that naphthalin is the only cause of coal tar being heavier than water." If Prof. Mills will read my letter carefully he will find that the word "only" does not appear. I will leave this to your practical readers to judge who is in the right.

2. To quote again from the manualette, p. 23, paragraph 19:—"The steam brings over about 10 per cent. at most of light naphtha (sp. gr. 0·78 to 0·83)." In my letter I said, "I should very much like to be let into the secret of obtaining 10 per cent. of naphtha, sp. gr. ·78 to ·83." In Prof. Mills' letter he says: "I have not said that tar yields 10 per cent. of (light) naphtha, but 10 per cent. at most of light naphtha." The only omission on my part was the two words "at most," but this omission is most insignificant, as Prof. Mills carefully gives in the manualette the sp. gr. As I said before, no coal tar yields 10 per cent. (I choose to take the maximum quantity stated in the manualette) of naphtha, sp. gr. ·78 to ·83, it is the gravity I object to in conjunction with the quantity that I ridicule. Had Prof. Mills experimented with crude coal-tar naphtha he ought to have known that the sp. gr. varies from ·850 to ·900, the bulk being nearer to the latter than the former gravity, and his theoretical knowledge should have told him that coal-tar naphtha is chiefly composed of benzole, toluole, cumole, &c. Pure benzole has a gravity of ·88, pure toluole ·87, and none of the series fall below ·85. It seems inexplicable to me how he can produce a coal-tar naphtha, sp. gr. ·78 to ·83.

3. On p. 14 of the manualette,
—"Olive oil and charcoal have

purifiers of the gaseous ammonia; but the former absorbs ammonia to little purpose; the latter oxidises it to nitrate. The proper purifier is lime placed in still." In my letter I say, "using lime to disengage the gas is a very old process, but it requires something else to deprive the gas of its impurities." Prof. Mills writes in his letter, "I have expressly warned my readers that rigorously pure ammonia cannot be prepared by any direct process from the watery liquor in the paraffin industry, and have pointed out that there is still less chance with ordinary gas liquor. I have not said that pure ammonia can be obtained thence, either by the lime process or any other. The lime process is not mine. It has been worked for years with excellent results." It seems to me that my reading of Prof. Mills' manualette is the only one. If "the proper purifier is lime placed in the still," it surely means that lime placed in the still is a purifier. I say that it is no purifier at all used thus, and I am astonished that any man professing to understand the manufacture of ammonia could make such an erroneous statement. If the many hundreds (?) of manufacturers (tar-distillers and ammonia-makers, I presume) are working according to Prof. Mills' manualette, they must be groping in the dark. Had my assertions in letter 14236 been wrong, then I should have stood convicted of four misrepresentations; but as such is not the case, I tax him with having made statements likely to lead the novice astray, and I must say that I cannot reconcile his letter and manualette, the statements in each being at variance. **Destructive Distillation.**

ARSENICATED VIOLET POWDER.

[14386.]—It appears that a large quantity of violet powder, intended for application to the skins of ladies and infants, has been introduced to public use which contains arsenic in considerable quantity; it is therefore very desirable that every one who has any of this substance in use should make sure of the absence of this poison. It would seem almost incredible that any one could be so monstrously wicked as to substitute arsenic for starch in a substance expected to be perfectly innocent, and left about without suspicion of danger, but the fact appears to be established. The effect of the poison upon the skin is to produce great irritation and a troublesome rash, but considering the readiness with which children put everything within reach into their mouths, much more serious dangers may be apprehended. It appears to me that should any one be so killed "accidentally," the seller or manufacturer of the substance would find themselves open to the penalties of "wilful murder," because a person who recklessly does acts likely to result in injury or death is supposed to contemplate the probable effects of his action, and it is difficult to conceive of any action which could be more justly brought within this legal principle. **Sigma.**

EVIDENCE BLIND.

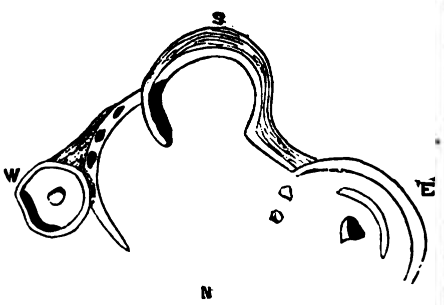
[14387.]—It has been clearly proved that a great many people are colour-blind. From an intimate acquaintance for forty years with courts-martial, inquest, inquiry, judicial, and, lastly, with ecclesiastical courts, I am satisfied a majority of people are evidence-blind—that is to say, they are incapable of weighing evidence, and that no instruction or training will remedy this defect; it is hereditary. When the "bell-wether" is not present they go all astray, and hence the queer verdicts we are constantly treated to. Has any one else observed this?

Adowlut.

LUNAR CRATERS THEBIT, VITELLO, AND DOPPELMAYER.

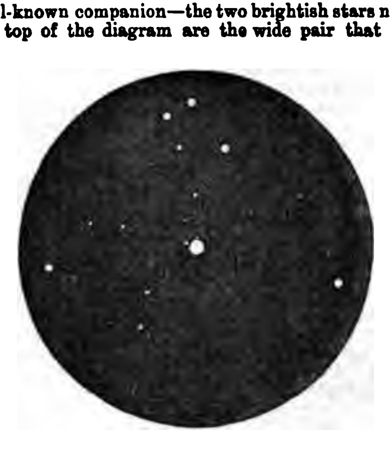
[14388.]—I beg to thank "F. R. A. S." for his kind promise (letter 14296, p. 215), to look up the lunar crater Thebit. When he has had an opportunity of doing so perhaps he will oblige us with observations of his respecting its features. I should be glad to know whether he thinks the minute point of light noticed by me in the smallest of the three craters proceeded from its central cone. I have referred to his sketch (Vol. XXV., p. 632), and it evidently confirms much that I saw.

May, 13d. 9h., I had a good view of the craters Vitello and Doppelmayer, and the region between them. On referring to the lunar map accompanying Mr. Webb's "Celestial Objects," I found both these craters shown as being entirely surrounded by a wall or rampart, but on examining the craters I saw this was not the case. Vitello had its rampart continuous and perfect, but Doppelmayer presented only a semi-circular rampart on the east side—the other part appeared to have been broken away; at least, I saw no trace of it. The central mountains, both in Vitello and Doppelmayer, were very distinct, and east of the one in Doppelmayer was a ridge, and a little southward were two prominences. The formation (Lee) which Mr. Webb shows as connecting Vitello and Doppelmayer, appeared to me to be the remains of two large broken rings that had at some time apparently intersected each other. I took a sketch at the time, and am induced to send it to you with these remarks, through having read Mr. Dennett's letter (14332, p. 242) by which I perceive he has been directing his attention to these craters. Comparing the time and date of his observation with mine, it is clear I must have observed the craters under about the same illumination as he did. **E. Mawe-Smith.**



POLARIS.

[14389.]—I inclose a diagram of the stars near Polaris, as seen with my $5\frac{3}{4}$in. Newtonian on May 18, 1875, and subsequently. I shall be glad to hear whether other observers can see more than thirteen stars in the same region. The bright star in the centre is Polaris—the small one close to it is the well-known companion—the two brightish stars near the top of the diagram are the wide pair that are sometimes mentioned as helping inexperienced observers to find the close companion by showing the direction in which to look for it. I shall also be glad to see a diagram of the two new companions which are said to have been lately discovered.

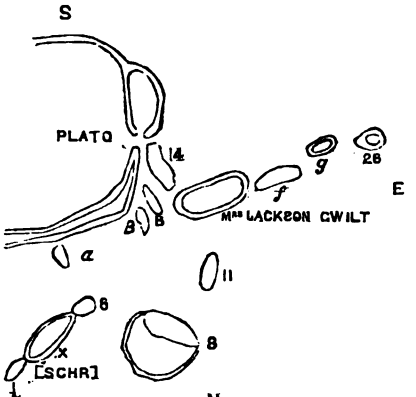


A. Woolsey Blacklock, M.D.

Gateshead, May 20.

NOTES ON OUR SATELLITE.

[14390.]—Neighbourhood of Plato.—On 1878, May 11d. 10h., I managed to outline the appended diagram before the moon was enveloped in clouds. It will be seen that Schröter's χ is very differently placed to where Gaudibert (English Mechanic, Feb. 1, 1878) shows it. The terminator lying along Longomontanus E. wall, through Rephœan Mts., and a diameter E. of Condamine. Definition very fair. Schröter's χ very easy in position shown. I took the object north of δ for a ring, but Gaudibert describes it as "a large mound, whose surface is very rough." 1 and 6, at either end of χ (and which I took for hills), were very lucid close to χ. β appears to be omitted by Gaudibert, who gives two hillocks in place of a, but leaves them unnumbered. On the following evenin visible pretty easily. I was using my 2 power.



Thebit.—If Mr. Mawe Smith carefully the walls of this crater he will find, unde able circumstances, a craterlet in the posi he shows the white patch. I have seen it my $2\frac{1}{4}$in., but that was after a knowled existence, having first seen it 1877, Sept. using 8in. aperture of one of With's $9\frac{1}{4}$in. and a power of 132 or 215, I forget which.

Now I am going to say a few words of c young observers. In the English Mech Sept. 28, 1877, Thebit is figured by me. sketch there are two depressions marke position of hillocks shown on the fi "F.R.A.S." and Mr. Smith. I have si them as hillocks. Compare this with my ob of Schröter's χ, given above, when the two and 6 were seen as hills. In both cases I wa eyepiece to which I had not become acc This looks very much as if great caution exhibited in the use of instruments observer has become perfectly used to them

I note what Mr. J. T. Stevenson (14355) with respect to the light spot W. of P have it under constant observation, and w vour to say something about it before long mention now that there are variations sometimes which somewhat baffle the obser

Frank C. De

10, Terminus-terrace, Southampton, Ma

SIRIUS.

[14391.]—With reference to the blue Sirius (letter 14334) my attention was likew to it last winter by an inexperienced observ answer I then gave I believe to be the true tion—viz., that as the brightest object the it was mentally compared with the rudd Mars, which had lately been the most co object in the midnight sky, and consequ seemed more blue than usual. Careful ob with my $6\frac{1}{4}$in. Calver failed to convince m real change of colour. **A.**

THE DOUBLE STAR CASTO

[14392.]—I have to thank "F. R. A. S." and "Arcanum" for their very full repli query (32612) respecting the distance of ponents of Castor. In reply to the lette "Kelby," No. 14333, page 242, I think highly of "Slugg's Observational Astron wilfully misrepresent the work, and I ma that no one could have been more astonishe was to see 4in. given in my query as the di the comites. It appears to have been a sl compositor, as I distinctly marked the figu two signs, thus, 4″, meaning of course 4 as stated by "Slugg." I thought the mi palpable that no one could have been misle I would have corrected it sooner.

I think "Poor Student" (query 3295 find "Slugg's" book just what he wants, tains excellent diagrams of the leading cons showing the various double stars and nebula price is only 4s.

The "People's Atlas of the Stars," pub Gall and Inglis, price 1s., is also a very ha for identifying stars down to about the fift tude. I should not recommend "Poor Stu get a higher power than 180, as the loss in be so great with a higher power as to n neutralise any increase in the size of the ob

MIDLAND ENGINES.—To "R. I

[14393.]—In my letter, p. 190, I gave t of the cylinders, wheels, and the tractive fo four classes of Midland engines, which upon a somewhat similar design—namely, 96, 1282, and 1353 classes. "R. N. H.," will at once see that I purposely omitted t details of the bogie engines, as they are o different class to the one illustrated in n There are two classes of express bogie engi first, Kitson's 1312 class has cylinders 17 coupled wheels, 6ft. 6in. diameter; tracti 102·083lb. The second or 1322 class, built and Co., has cylinders 18 × 26; coupled wh diameter; and a tractive force of 100·285lb

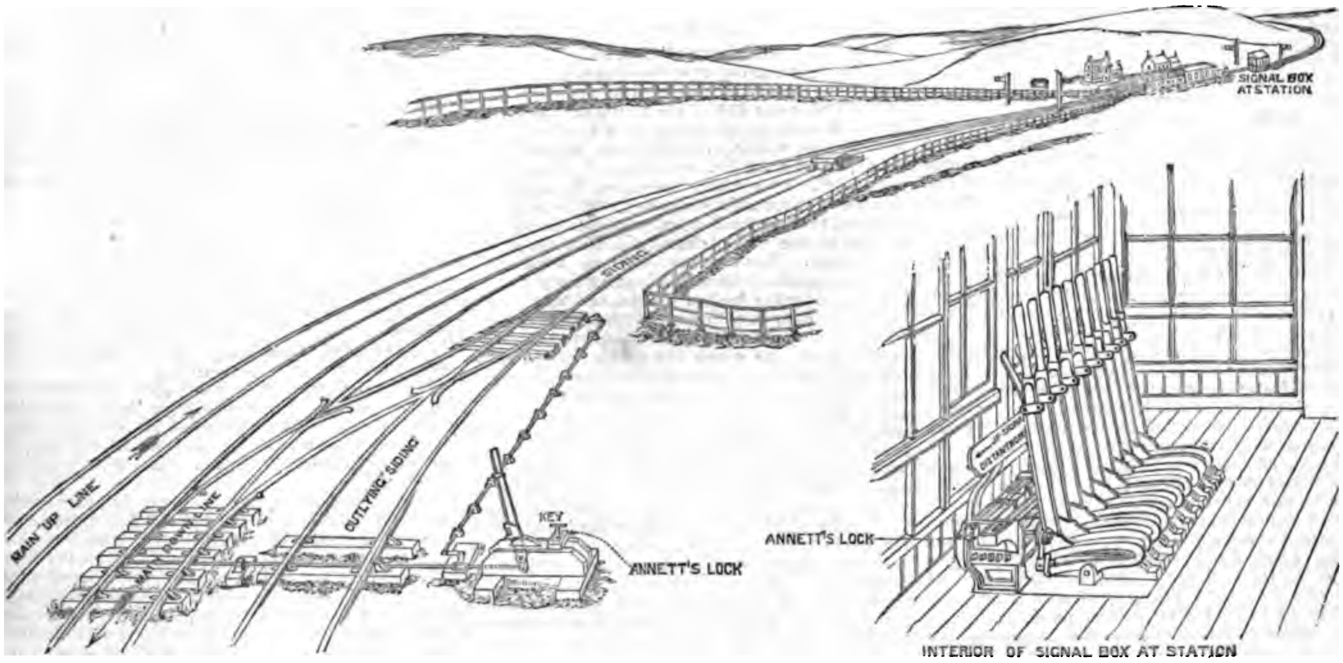
The engine, No. 899, about which "R. asks, is one of the 890 to 909 class, built b and Co. in 1871, from the late Mr. Kirtley' Several of these engines have lately had bell chimneys replaced by Mr. Johnson's c This is a great improvement to their ap The reason that the new engines are witho is, that a series of experiments has for a been made with two classes of express en 1290 and the 1312)—the former run on si the latter have a leading bogie. After months' careful trial the result was that bo did their work splendidly; one ran as other, and the coal burnt was the same. A trial is now being made with some of the 1322 class of 7ft. bogie engines and some of the 1353 class. These are also both working most satisfactorily. The 1353 class are great favourites, and have the advantage of four leading axle boxes and a horizontal line of motion.

May 22nd. C. E. S.

RAILWAY SIDINGS—ANNETT'S SAFETY LOCK.

[14394.]—It frequently happens that outlying sidings are made which have not enough traffic to require a signalman to be stationed at them, and yet are situated at too great a distance from the station signal-box to be worked and interlocked with the signals in the ordinary manner. To extend the security of the interlocking system to outlying siding points, Annett's safety lock has been invented. The drawing shows a siding in communication with the down main line.

Both the "main line" and the "safety" or "leading" points are connected by rods to a single lever fixed in a frame by the side of the line, and fitted with an Annett's safety lock. A duplicate lock is also fitted to the "down main line" signal levers in the station signal-box.



INTERIOR OF SIGNAL BOX AT STATION

One key only of a special pattern fits both locks and it is so designed that after being used in either lock it cannot be removed without securely locking the points or signals in the proper position, or, in other words, the signalman at the station signal-box cannot part with the key for use at the siding without having his distant and semaphore signals locked at danger. As soon as the key is removed the signals remain locked beyond the control of the signalman until the key is brought back again. In the same way, when the key is used at the siding it cannot be taken out of the lock until the points have been locked in the proper position for the main line.

When the "shunting" is finished at the siding the train proceeds, and the porter or other person appointed for the duty locks the points and carries the key back to the station, when it unlocks the signals and the ordinary working is resumed. When a siding is made upon a "single line," it is usual to make Annett's key a part of the "train staff." This insures safety, as the siding points cannot be used by a train unless the driver is in possession of the "train staff" and the "staff" and key, after being used cannot be taken away from the siding until the points are securely locked.

Annett's safety lock is being largely introduced by Messrs. Saxby and Farmer, and the practical working of the system, especially upon single lines, is most satisfactory.

May 22nd. C. E. S.

THE GAS ENGINE.

(Continued from page 64.)

[14295.]—No. 252 (1877) Dugald Clerk, analytical chemist, Glasgow, "Improvements in motive-power engines working with hydrocarbon gas or vapour." This invention relates to motive-power engines in which the power is obtained by igniting hydrocarbon gas mixed with a suitable proportion of air, and the object of the improvements is to render such engines more economical and otherwise better than existing gas-motor engines. In carrying out this somewhat ambitious programme any convenient motive-power engine, such as is worked by steam, is worked by a gaseous mixture, which is under pressure, and is supplied from a reservoir, whilst the exhaust passage communicates with an intermediate vessel placed between the reservoir and an explosion chamber. The explosion chamber is fitted with one or more lift valves opening into the intermediate chamber, and this intermediate chamber is similarly fitted with one or more lift valves opening into the reservoir. The explosion chamber is fitted with suitable valve details, and by preference of the kind hereinafter described, for admitting the necessary quantities of combustible gas and air, and for igniting and exploding the mixture at suitable intervals. When an explosion takes place the expanded gases open the valves into the intermediate chamber and into the reservoir; an increase of pressure is thus produced in the reservoir, and is retained by the immediate closing of the valve between the reservoir and the intermediate chamber. The valve or valves between the intermediate chamber and the explosion chamber also close immediately after the explosion, and then those chambers become in a more or less vacuous condition, and in consequence a check valve in the exhaust passage from the engine to the intermediate chamber opens and allows the exhaust gas from the engine to pass into the intermediate chamber. The pressure in the engine thus works against a pressure which is at intervals below that of the atmosphere. The partial vacuum in the explosion chamber causes atmospheric air and gas to enter for the next explosion on simply opening the inlet valve, or the supply of air and gas may be obtained otherwise, as hereinafter described. The admission of air and gas is controlled by one sliding valve plate worked from the engine, and there are by preference two air inlet ports with a single gas inlet put between them. The ignition is effected by means of two gas jets, one of which burns continually at a little distance in front of the air ports, whilst the other is placed so as to direct a rat-tail jet of gas across the continually-burning gas jet into the air port. The tap of the rat-tail jet is opened by the slide valve just as the ports are being closed, and the gas getting ignited by the permanent jet carries the flame sufficiently inwards to ignite the mixture in the explosion chamber. The gearing for working the admission slide of the explosion chamber is arranged so as, on the pressure in the explosion chamber exceeding a certain amount, to become disengaged, and so the explosions are interrupted until, from the working of the engine, the pressure becomes lower again. Instead of the supplies of air and gas entering the explosion chamber, in consequence of a partial vacuum in that chamber, they may be made to enter by moving a piston therein towards the intermediate chamber. The piston, which need not fit very tightly, is in place of the first partition between the explosion chamber and the intermediate chamber, and it is fitted with the left valve referred to as between those chambers. The piston is moved slowly by the engine, and after an explosion is moved back to the bottom of the explosion chamber. By this arrangement the force due to the vacuum and, which is more than necessary for taking in the supplies of air and gas, is rendered to a great extent available in the intermediate chamber in connection with the exhaust of the engine. It is a special feature of this invention that the expanded gases due to the explosion act directly through the lift valves on air or gases, a portion of which they force into the reservoir instead of acting on a piston as in other explosion motor engines. The patentee claims—first, the system or mode of working motive power engines with hydro-carbon gas, wherein there operates a gaseous mixture stored or accumulated under pressure through the action of exploded mixtures of the gas and air without the intervention of an air-tight piston. Second, the system or mode of working motive-power engines with hydrocarbon gas or vapour, wherein the partial vacuum succeeding each explosion is made to directly assist the exhaust of engines driven by stored pressure caused by successive explosions. Third, the combination of the explosion chamber, the intermediate chamber, and the pressure reservoirs. The design which this patent embodies is precisely similar in principle, and very nearly so in detail, to inventions previously patented by Cohade, 1585 (1860); F. W. Turner, 4088 (1873); Mills and Haley, 265 (1875); Hallewell, 2826 (1875); and is certainly no advance upon the last-named patentee's subsequent patent—4988 (1876).

No. 491 (1877), N. A. Otto and F. W. Crossley, relates exclusively to improvements on the Otto Silent Gas Engine previously described, 2081 (1876), and consists of the following details:—First. Establishing an equilibrium of pressure between the compressed charge in the cylinder and the igniting charge in the slide chamber before such chamber communicates directly with the cylinder port. Second. Arranging the passage in the slide, through which the combustible gas for the igniting charge is introduced into the slide chamber to communicate with a passage leading into the cylinder before the slide chamber communicates directly with the latter, in order to effect an equilibrium of pressure between the compressed charge and the igniting charge. Third. The arrangement for the cam and governor for working the gas supply valve or slide whereby the cam is moved entirely to one side of the valve or slide lever when the engine runs too fast, so as not to effect the opening of the valve or slide until the speed is reduced. Fourth. Arranging the cam and governor for working the gas supply valve or slide, whereby the cam is moved entirely to one side of the valve or slide lever by the governor when the engine stops, so that the cam cannot then hold the gas valve or slide open. Fifth. In combination with the arrangement of cam and governor for the gas supply valve described above, the provision of a supplemental load on the governor so arranged that it only acts on the governor when the engine is working at or above the normal speed. Sixth. In combination with the arrangement of cam and governor to the gas supply valve, the arrangement of means whereby the cam is temporarily held in position for acting on the gas valve on first starting the engine. Seventh. The provision of means for allowing a portion of the gaseous charge to escape from the cylinder when compressing by hand on first starting the engine. Eighth. Providing on the sleeve of the cam that operates the gas valve, a second cam or disc so arranged relatively to the escape valve lever, that on the engine running above the normal speed, the said cam or disc holds the escape valve open when the piston is performing its outstroke. Ninth. Expanding the packing ring of the piston by means of an inner coned ring so arranged in combination with inclines formed either on the trunk of the piston or on a rotatable junk ring, so that on rotating the junk ring the said inner ring is caused to move longitudinally. Tenth. In combination with the split packing ring of the piston, the use of a second split ring, fitting in a groove in the first-named ring, and springing inwards so as to press tight at the bottom of the groove. Eleventh. The use in combination with the air supply pipe to a gas engine of a closed receptacle or chamber connected to the supply pipe leading from the locality from which the air supply is taken, and to a separate pipe leading to the air inlet of the gas engine.

Nos. 775 and 776 (1877), Mr. P. W. Boulton. It is necessary before describing the particular features of these inventions, as also of No. 3620 (1876), the description of which was omitted in its chronological order, to consider for a moment the remarkable series of inventions by the same patentee, of which the patents now before us are the latest developments. The first of the series of patents was taken on April 30th, 1864, the latest being the 28th of the series on Feb. 28th, 1877. The leading object of the inventor has been to combine in one engine the essential features of both the steam and gas engine by utilising the heat contained in the exhausted products of combustion formed by the explosion of a gaseous compound in a piston. Another object has been utilising products of combustion when formed in a closed surface, having acted on a piston by causing them to pass through a boiler to raise steam and pass together through a steam engine constructed and worked in. Taking the series altogether they are worthy of attentive study, and form one of the most remarkable instances of persistent ingenuity to be found in inventive and industrial history.

Leicester. **Jno. F. Dickson.**

(*To be continued.*)

CONTRACTION OF GASES.

[14396.]—THE law that gases contract 1·273 of their volume at zero centigrade for each degree decrease of temperature, so that 273 volumes at zero become $273 - n$ at $-n^\circ$ is undoubtedly true; but the deduction that "Lator" (letter 14335, p. 242) makes therefrom—namely, that a given bulk of gas would utterly vanish at −273°—implies the assumption that the gas will continue to exist as a gas down to absolute zero; an assumption which is not only entirely unwarranted by experiment, but is manifestly inconsistent with common sense. There can be no doubt that long before arriving at −273° all gases would condense to liquids, and then, being released, from the law of Charles, which controls gases, would escape total destruction. Moreover, it is a mistake to imagine that the above law has any essential connection with the centigrade zero (which is, of course, arbitrary): it could be expressed just as well were the boiling point of ether taken as starting place; but, of course, the co-efficient of contraction would differ. With respect to my friend's extraordinary suggestion as to the service which the law we are discussing might render to materialists, it may be remarked that they do not need it. The body of man is certainly annihilated as such after death; its elements quit their complex combinations, and return to the world of non-living matter for a time, only again to pass through the marvellous cycle of life: and as to the Ego, either one of two things—either it is something apart from and beyond that "mysterious thing" we call matter, and then it is independent of material laws, or else it is an attribute of some wonderful combination of matter (just as the red colour of magenta is an attribute of its combination), in which case it must share the general ruin.

Wm. John Grey.

Newcastle-on-Tyne, 23rd May.

TECHNICAL EDUCATION IN DUBLIN.

[14397.]—Now that the attendance at the Royal College of Science has been called in question, and that the average cost of technical education per head is stated at such a high figure, it would be well to examine the matter and find out, if possible the cause of the low state of attendance in Irish science schools. I am a native of the vicinity of Dublin, and have attended at a class in connection with a public institution, taking 1st class certificate in magnetism and electricity, and 2nd class in chemistry. I am anxious to continue my studies, particularly in chemistry, but cannot find a class where the second course is taught. Being engaged at business all day I can't afford to enter at the Royal College of Science, as the classes are held in the middle of the day. I have inquired for evening classes and can't find any except those held in connection with medical schools, where you must go in for the whole course if you want to learn chemistry.

Now, sir, if technical education is paid for by the State it ought to be given to those for whom the State intend it—viz., for the business people and not civil service students. I think that if the mass of the students given at the College of Science were analysed, it would be found that the number is almost entirely, if not altogether made up of imported science students, Civil Service candidates, and the sons of the aristocracy, none of whom are entitled in any degree to aid from the State for their technical education. It is absurd for the State to vote any sum for education of any kind without seeing that it is laid out for the purpose for which it is voted. Now, who are the classes for whom technical education is voted? Most undoubtedly for business people and those who engage in trade and manufactures. How many of these classes attend the Royal College of Science? Few, very few, if any. But you will ask, are there no popular lectures? Well, yes, there are, at 4 o'clock in the evening. But do you think it is likely business people can attend at that hour? In another scientific institution each course of lectures is accompanied by a special tea meeting; but admission is only given to a narrow circle and practically it is not open to the public.

Now, it cannot be said that business people will not attend science lectures, for I was present 7 or 8 years since at several courses when the theatre of the college was quite full—often so full that you could not get a seat. If the Royal College of Science wishes to increase their number and hold the grant, they will open evening classes in the next winter session and give technical education to those for whom it was intended, and to whom only it can be imparted with benefit to the country. If they do so they will strengthen their claims to the grant and technical education may possibly fulfil the mission for which it was intended—viz., to assist in promoting the trade and manufactures of the country.

Alexis R.

THE COMPOUND PULLEY BLOCK.

[14398.]—"ALIQUANDO" (let. 14323, page 241), is quite correct in depicting by diagram the chain, &c., of the compound pulley block, described in my letter 14281, page 194, of the ENGLISH MECHANIC. Before describing the action of this block, let us first suppose that the circumference of each small pulley, *a* and *b*, be 1ft., and of each large pulley, A and B, 4ft. By rotating the pulley, B, a sufficient number of times, till the pulley, A, has made one rotation, the small pulley, *a*, would evidently take up 1ft. of the single chain, and raise the weight accordingly. Now let us see what has taken place. The letting out of 4ft. of chain from the pulley, A, passing under the bottom sheave, and taken up by the small pulley *b*, with an additional 2ft. of chain taken from the shortening of the loop (1ft. double chain, mark), on which the weight hangs; thus, taking 6ft. of chain for every foot rise of the weight, and B being four times larger, and taking 24ft. of chain, will give a power of 24 to 1. On raising a weight, whatever length of single chain the small pulley, *a*, may take up, the small pulley, *b*, will take up twice that length, added to the length of chain which is payed out by the large pulley A, whatever may be the ratio; therefore, the rule is (2 + ratio of A) × ratio of B = the power. With regard to lowering, it not being strictly a self-sustaining block, a little resistance would be required, and not power exerted. I have a simple contrivance for holding the hand or power chain from running down, at the will of the operator, which will make this almost frictionless block self-sustaining. This I shall describe, with another new pulley block, in a future number.

Joseph Jewsbury.

Brookfields, Birmingham, May 20.

THE PIERI RIFLE.

[14399.]—THE Pieri rifle belongs to that class of arm known as "bolt action," in which the breech mechanism works in a line with the axis of the barrel, and in contradistinction to that type known as "block action," in which the breech mechanism works at an angle to the axis of the barrel, caused either by the elevating or depressing of one end or of the side of the breech, as in the Snider, the Martini-Henry, and others.

The Pieri rifle is of the same type as the French Chassepôt, the Russian Berdan, and the Italian Wetterli, but is much simpler in its construction than either of these arms, or of the present English weapon—the Martini-Henry; for, whilst the breech mechanism of those weapons consists respectively of 26, 25, 28, and 26 separate pieces or parts, that of the Pieri is composed of seven pieces only, which may be enumerated as follows:—1. Head-piece; 2. Extractor; 3. Striker or central fire pin; 4 and 5. Cylinder and trigger (these two in effect form but one piece); 6. Spiral spring; 7. Connecting thumb-screw.

The cylinder, which has on its upper surface a rectangular piece of metal projecting slightly beyond its forward edge, and pierced to take the thumb-screw, and carrying the lever or handle, by which the bolt is rotated and moved backward and forward, is bored almost throughout its entire length so as to receive within it the striker, spiral spring, the rear end of the head-piece, and trigger spring, sufficient metal being left at its rear end to allow of a small hole being bored to permit the back end of the striker to pass out when the arm is at full cock, of which fact the projection of this part furnishes an indication.

The striker is greater in diameter in the centre than at either end, and upon this surface the spiral spring works. The forward end is tapered off so as to form the central fire pin, whilst the rear end is simply turned for about $\frac{3}{4}$in. to a small pin, sufficient in diameter to pass through the hole in the back of the cylinder. Upon the fore end of the enlarged diameter in the centre of the striker is a raised rim, against which the spiral spring bears, and this raised rim again carries on its forward end a tooth or projection, the extremity of which forms an inclined plane, which in its turn works into a slot (one side of which forms an opposing inclined plane) cut in the rear end of the headpiece. The rear end of the striker has a notch in its side to take the tooth of the trigger.

The headpiece is bored taper throughout to admit of the passage of the striker, and has the form of two connected cylinders of different diameters. Both diameters have a longitudinal groove cut in their surface, in which the extractor is placed. The lower side of the extractor is provided with a small right-angled projection, forming a shoulder when fitted to the headpiece, the object being to prevent the rotation of the headpiece when in the shoe of the breech, as hereafter described. The lesser diameter of the headpiece has cut in it, besides the slot already mentioned to receive the projection on the striker, a small transverse groove, of such length as to allow the point of the thumbscrew sufficient traverse to admit of the cylinder being turned half round on its axis when it and the headpiece are connected; whilst on its rear face a slight indentation is made in which the point of the striker rests when the rifle is at full cock.

The trigger spring, which is placed in a groove in the lower side of the cylinder, and is furnished with two teeth—one to prevent the trigger spring withdrawing from the cylinder, the other to take the notch in the rear of the striker—projects to the rear of the cylinder, and terminates in a thumbpiece or trigger, the use of which will appear.

The thumbscrew is simply a left-handed screw with a large head, milled to allow of its being freely turned with the fingers, which retains the cylinder and headpiece in their proper positions, and prevents the bolt going entirely clear of the breach, as will hereafter be seen, the object of making the screw left handed being to prevent its accidental loosening in the event of being gripped in the act of pulling back the bolt.

The spiral spring is not easily susceptible of damage, and being rectangular in section, working closely on the central part of the striker, and being confined, tolerably closely, inside the cylinder, is nearly as effective, if broken into several pieces, as if intact.

The entire bolt works in a shoe or, in other words, a casing attached to the end of the barrel, sufficiently cut away on the right-hand side, in such a manner as to form two eccentrics, to allow the block of metal on top of the cylinder, and carrying the lever to fall easily into a horizontal position without fore and aft play, and having in its upper side a piece cut out of its entire length of sufficient width to allow the block to pass backward out of it, when the lever is vertical. The end of this shoe is finished off so as to form two wings, which protect the trigger and render it almost an impossibility to touch it off accidentally. Just where those wings commence a slight rib or bead is placed on the outer surface of the breech shoe, the object of which is to prevent the bolt being involuntarily extracted from the breech, which can, however, be done at will by simply raising the thumbscrew until its head passes clear of the bead. On the lower interior surface of the shoe, and extending its whole length, a longitudinal groove is cut which receives the projection on the lower side of the extractor, already mentioned as preventing the headpiece rotating. The stability of the headpiece is necessary in order that when the cylinder is rotated the inclined plane on the striker may be forced up to that in the slot in the headpiece until its point rests in the indentation before mentioned, the effect of which is to compress the spiral spring, and thus to "full cock" the weapon.

In loading it is only necessary to raise the lever to the perpendicular, draw back the bolt (which action withdraws the old cartridge case) until the thumbscrew rests against the bead, place the cartridge in the breech (it need not be pressed home with the thumb, as in the Martini-Henry, Snider, and others), push forward the bolt, and turn down the lever to the horizontal. The arm is then ready for firing. To do all this only requires three motions.

The Pieri rifle supplies a want which with firearms has long been felt—a position of absolute security—which is better than any "half cock," and this is attained as follows:—When the arm is loaded, place the lever at the perpendicular, press the trigger, which at this time is on its edge, at same time allowing the lever to fall gently into the horizontal. By this means, owing to the gliding action of the [illegible] inclined planes already alluded to, the striker s gently forward until its points rests on the head of the cartridge.

Owing to the position of the trigger being on top of the stock, that which to all rifle shots is known as the "pull off," and which is so detrimental to good shooting, is entirely avoided, as the instant the sight is taken the simple depression of the end of the thumb releases the trigger, whilst at the same time the rifle is steadied by the tightening of the grip upon the stock in the act of firing.

Owing to the absence of cutting away, the stock is much stronger than in any gun having an independent lock.

For the purpose of cleaning, it must be self-evident that the Pieri possesses great advantages over any rifle of the day, as upon the removal of the bolt, not only does the barrel represent a mere tube, but the lock mechanism is removed from all chance of getting injured by wet or dirt. The same remark applies in part to troops being compelled to throw away their arms. They need only leave the stocks and barrels, which would be useless to an enemy unless provided with the breech mechanisms of the same pattern.

Lastly, but not least, the Pieri rifle fulfils all the requisites of a military weapon — namely, great simplicity so as to be easily taken to pieces, cleaned, and put together again without the intervention of the armoury sergeant or the use of any tool whatever, capability of withstanding rough usage, simplicity of action, lightness without disturbing the range, increased rapidity and accuracy of firing, simplicity and certainty in the extraction of the cartridge case, facility of manufacture and consequent cheapness, whilst for sporting purposes it supplies a want long felt, a gun that will stand rough usage, which can at the same time be easily repaired in the event of injury without skilled labour, combined with immunity from those fearful accidents so frequently happening from the want of a position of absolute security.

As a guarantee of this arm standing rough usage, the Italian Ministry of Marine have most severely tested some of the rifles, and, having formed a most favourable opinion of their merits, ordered their frigate Adelaide to be fully armed with them some two years ago, with a view further to test its powers, and have expressed themselves highly satisfied with the results. W. P.

PURIFICATION OF SEWAGE.—IV.

[14400.]—THERE are three systems at present adopted by which sewage is dealt with for the purpose of getting rid of it:—1. By discharging it into the nearest river in its crude state, or into the sea without any attempt at purifying. 2. By treatment with chemicals for the purpose of extracting some of the valuable constituents previous to discharging the liquid into the rivers, and utilising the solids as manure, cement, &c. 3. By applying the sewage to land by irrigation and filtration. I will now shortly discuss each of these systems, but I will not attempt to enter into the merits of all the different processes that have been proposed in the different systems. I must confine myself to a few remarks on the processes with which I have had some practical experience.

1. *By discharging into the nearest river.*—Town Councils and Local Boards of Health have a penchant for getting rid of their sewage by discharging it in its crude state into the nearest river without the slightest regard to any nuisance it might cause in the immediate neighbourhood of the outfall, or any annoyance it might cause to their neighbours farther down the river. They do not appear to care if the sewage should contain sufficient poisonous matter to kill all the fish in the river. All that corporations appear to care about, when dealing with sewage, is how they are to get rid of it from their own doors at the least possible expense, without giving heed to the intolerable nuisance it is certain to create. The sewage of some towns, where there are no manufactories, will not injure fish if run into a river that has a strong current of water, and large in proportion to the sewage. In such cases the fish are seen to collect round the mouth of the sewer, and feed on the solid matter discharged; but the sewage from most manufacturing towns contains sufficient poison to kill all the fish even in very large rivers. Whether sewage kills fish or not—if discharged into any rivers in its crude state it must create a nuisance in certain states of the weather, and ought not to be allowed if it can possibly be avoided. It ought not to be allowed even to be discharged into the open sea in its crude state, because it creates a nuisance even there in the neighbourhood of the outfall, no matter how far that outfall is carried out into the sea. Sewage ought, in all cases, to be deodorised, disinfected, and the crude matter extracted, before being discharged into the open air anywhere, because sewage in its crude state, when discharged into a river or the sea in large quantities, in certain states of the weather, evolves large quantities of poisonous gases and vapours at the point of discharge, and no one can tell where these poisonous vapours may be blown to, or what injury such poisoned air may do; therefore the least that can be said about discharging crude sewage direct into a river or the sea is, that it is a slovenly method of getting rid of it, and altogether inexcusable.

2. *By treatment with chemicals.*—Mr. Bazalgette, in opening this part of the question, says:—"No chemical process can, unaided, effectually deal with sewage, but that its application must be auxiliary to some other process—as, for instance, the disposal of the sewage on land." If that is so, then I ask why not follow up the chemical process by some subsequent process, if that will purify the sewage? If we eat dry stale bread it will not, unaided, nourish the body, but to sustain life it must be followed by some sort of liquid; but surely that is no reason we should reject the bread. Neither, I apprehend, should a chemical process for defecating sewage be condemned because it requires to be followed up by some other process to complete the purification.

1. *The lime process.*—The earliest tried and most extensively applied method of defecating sewage was what is called the lime process, but it is found that sewage treated with lime after a few days begins to smell very offensively, and it has been abandoned in nearly every place where it has been tried. The Rivers' Pollution Commission report:—"The lime process has been a conspicuous failure whether as regards the manufacture of a valuable manure or the purification of the offensive liquid." I quite agree with that report when applied to the lime process as hitherto carried out; but the lime process has not yet been exhausted. There are several methods of using lime in conjunction with other substances that have not yet been tried on a large scale, although they have been tried on a laboratory scale and proved very successful.

2. *The A. B. C. process.*—I tried that process 10 years ago (I think that was before it was patented) with the sewage of a water-closet town of 5,000 inhabitants, and found the process to be worthless as a purifying agent, although it possessed considerable power as a precipitating agent, but the process neither deodorised nor purified. I tried the alum, blood, and clay, in various proportions, both by mixing them and using them separately; but I failed in every instance to purify the sewage by that process, and I abandoned it for a better one.

3. *Sulphate of alumina and milk of lime.*—I tried this process at the same works on which I tried the A. B. C. process, and abandoned it for the same reasons. I mixed the clay, sulphuric acid, and milk of lime in various proportions. I also applied the ingredients separately, and mixed them in the tanks with the sewage, but all to little purpose, for the process did not purify the sewage. Several years afterwards I examined the same process at Stroud, called "Bird's Patent Process," and I found that there it partially deodorised and clarified the sewage, but did not purify it. Although on testing the crude sewage taken from the main sewer, I found it remarkably easy to purify by another process, it was three times easier to purify than London sewage.

4. *Hille's coal tar process.*—I do not quite understand what this process consists of, not having examined any works where it is applied, but I may state that in 1859 I used, to a considerable extent, a mixture of coal tar, lime, clay, charcoal dust, and plaster of Paris, for precipitating, deodorising, and clarifying sewage. I found that the mixture answered the purpose better than anything else I had previously tried, with the exception of hydrochloric acid; but although the above mixture acted as a good precipitator and clarifier it did not purify it, nor did it thoroughly deodorise it, but it disguised the sewage smell in a very remarkable manner—in fact, it converted the sickening stench of the sewage into a rather pleasant scent.

"*Scott's Cement Process.*"—In 1872 General Scott adopted a process at Ealing for defecating and getting rid of the sludge nuisance, by mixing the sewage with lime and clay in the proportion of 1⅓ ton of lime, and ⅔ ton of clay, to 1,000,000 gallons of sewage, then precipitating the solids in tanks, collecting the precipitate, drying, burning, and grinding it to make cement. I very carefully examined that process at Ealing, but I found it did not purify the water. The effluent water, after standing three days, had a disagreeable offensive smell; neither was the water thoroughly clarified—it had a very perceptible yellow tinge; it also held a large quantity of caustic lime in solution—in fact, it was lime water—and as it flowed along the outfall course towards the Thames, by absorbing carbonic acid from the air it continued to precipitate carbonate of lime. Whenever sewage or water is mixed with lime in such large quantities, the water dissolves a portion of the caustic lime, which is poison to fish, especially trout. Trout cannot live in water impregnated with even a very small quantity of caustic lime—therefore the supernatant water from such a process as Scott's cement process ought not to be allowed to run direct into a trout stream. If the supernatant water from the above process were passed through an aërating filter, or used for irrigating land, the process would completely purify the effluent water, providing the filter was of sufficient area. I have tried extensively filtration through charcoal, mixing with chloride of lime, chloride of zinc, perchloride of iron, and many other chemicals, but none of them thoroughly purified the effluent water, with the exception of the process I have already mentioned—namely, *hydrochloric acid, followed by lime, carbonic acid, and filtration.* **Wm. Burns.**

(*To be continued.*)

PROFESSOR W. F. BARRETT ON MUSICAL SCALE FORM.

[14401.]—I AM reading with much interest Professor Barrett's instructive lecture on "The Analogy between Light and Sound," now being published in the ENGLISH MECHANIC, but I find some statements relating to scale structure in the fourth portion, given in No. 685, which appear to me to require explanation, for, as I understand these statements, they are contrary to fact.

The first to which I wish to direct attention is, that "the so-called chromatic scale in music is arranged in equal steps." This I allow is correct as applied to that deformity—serviceable drudge though it be—fashioned out of the true relationship of notes by the procrustean process of tuning, called temperament; but not as applied to any scale whatever that is true to the principles of just intonation, or, in other words, to natural law. This is obvious when it is considered that the intervals of the diatonic scale, called tones, are of two measures, one of which is greater than the other by a comma (81 : 80). The semitones so-called—*i.e.*, the steps—which form the chromatic scale, therefore, whatever be their true measures, cannot be equal in the two cases—that is, the cases of forming both great and small tones.

The next is this very emphatically expressed declaration:—"A series of notes arranged with their vibration numbers in arithmetical progression would form simply intolerable musical intervals, and therefore no such series is to be found in any musical scale. But if, instead of arranging the vibration number of our notes in an arithmetical series, as 1, 2, 3, 4, &c., we arrange them in a geometrical series, 1, 2, 4, 8, &c., then we have the well-known chromatic scale, or scale of equal temperament as it is sometimes called." As it has happened, we have had in the ENGLISH MECHANIC lately a good deal of discussion respecting numerical series in relation to the two chords and the diatonic scale, which these two chords together mutually and equally go to build up; and I think it must appear to all who have taken interest in the subject that the above statements differ from the views which have been presented in this discussion.

With regard to the statement that notes, the vibration numbers of which are in the geometrical series, 1, 2, 4, 8, &c., supply the chromatic scale, it is evident to us that instead of this they supply simply a series of the octaves of any single note—*e.g.*, C, C′, C″, C‴, &c., because the ratio or vibration number of an octave is 2 to 1 of its fundamental. Then, as to a series of notes, the vibration numbers of which are in the arithmetical progression, 1, 2, 3, 4, 5, 6, which the professor affirms would form intolerable musical intervals, and that, therefore, no such series is to be found in any musical scale, we have had, on the contrary, the fact before us, and so constantly of late, that nothing can be more familiar to us, that this series supplies nothing less than one of the two essential elements of all scale structure—namely, the major or harmonic concord in its most original and perfect form—*e.g.*, C, C′, G′, C″, E″, G″, the vibration numbers of which notes are respectively C1, C′2, G′3, C″4, E″5, G″6.

Besides this we have seen that the reciprocals of this arithmetical series, extending as far as the number 6—namely, the ratios 1, ½, ⅓, ¼, ⅕, ⅙—give the minor or hypharmonic concord in its original and perfect form—*e.g.*, E″, E′, A, E, C, A_1—the vibration number of E″ being as 1 to 1 (signifying unison); E′ as 1 to 2 of E″; A as 1 to 3 of E″; E as 1 to 4 of E″; C as 1 to 5 of E″; A_1 as 1 to 6 of E″. For it must be granted that in the minor or hypharmonic concord the mathematical relations of the notes originate in the uppermost note, contrarily to the mode of the major or harmonic concord, the relations of the notes of which originate in the lowermost note. Now, as the simplest union of two of each of those descriptions of concords produces in its perfect form the diatonic scale, the parent stem of the musical system, which is moreover all of the same kind of structure as this parent stem, I am at a loss to conceive what the learned professor's meaning is in saying that "a series of notes, arranged with their vibration numbers in arithmetical progression, would form simply intolerable intervals."

May 20. **Fred. J. Jackson.**

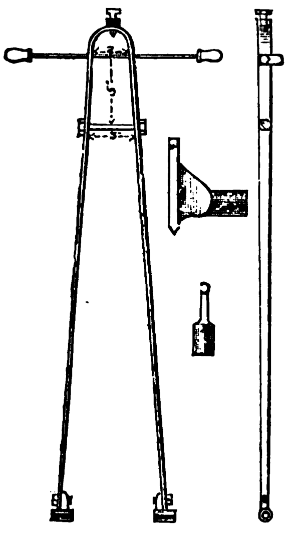
MUSICAL TONES.

[14402.]—IT is sometimes stated that the vibrations of C sharp are to those of C natural as 25 to 24, and those of D flat to those of D natural as 24 to 25. This would seem consistent with Weber's remark that C sharp is somewhat lower than D flat. But other high authorities assert that D flat is really lower than C sharp. Will some of your correspondents kindly tell me how the mathematical values of C sharp and D flat are determined?

Another question I should be glad to have answered is, what is the relation between the accents in the Hebrew Bible, according to which it is intoned in the synagogue, and our ordinary musical notation? Is there any book for teaching this intonation, or can it only be learnt from oral tradition? **G. P.**

CHEAP BICYCLES.

[14403.]—No doubt "Pound a Week" is wondering where "F. L. S." has put himself, and by this time has probably constructed his wheels, and is ready for the framework. The steering will be "dome-shape," not down shape, as was printed. It is made by bending a piece of flat bar iron, 1¼in. wide, 1¼in. thick, into the form of a long-legged U, as in the sketch. About 5in. from the inside of the bend, bolt or rivet a cross-bar, to hold the bottom centre of the staff; let the cross-bar be of good strength, in order that the countersunk hole for the centre point will not make it too weak. The handle bars will be best fitted to the front of the fork-head, as shown; this way gives more firmness when ascending hills, and allows a good clearance for the thighs. Let the legs of the fork be reduced in width from 1¼ to ¾, the taper commencing at 1ft. from the cross-bar. The bearings will be of plain steel, and must be will fitted and hardened, and the interior got up smoothly; to do this bore the bearings out till they fit stiffly on the axle, then harden and fix on the fork ends (having previously put them on the axle), put on a crank, get some very fine emery and oil and apply to both, and turn until the wheel begins to run fairly easy. Take off crank and bearings, thoroughly remove all trace of emery, and repeat the process with crocus and oil; this will polish the surfaces. Great care must be taken to get the bearings perfectly parallel, and in line with each other, so that they take a bearing all over the axle, and not on one end, or you can never run well. The bearings will be 1¼in. long, ⅝in. bore; outside diameter, 1⅜in.; material, double shear or best cast steel; will fit on fork end, as shown in sketch. Get your smith to forge a piece to fit in backbone, as in sketch; this is the staff. The length of the staff is 5in. Sink a centre in the top, and make the bottom come to a point, to fit in the cup centre in the cross-bar. Drill a ⅜in. hole through the top of the fork-head, and tap it, and put a pointed screw through to meet the top of staff, then secure with a lock nut. This will complete the steering apparatus.



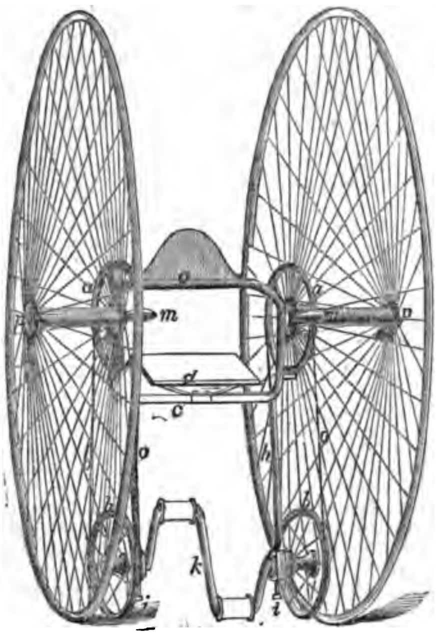
The butt end of the staff must be turned to fit in the end of backbone, a rivet put through and brazed. Now make a back fork and fit the butt end nicely in the small end of backbone; drill a hole through and make a step for mounting, &c., with a piece to go through the hole, and braze all in together.

The spring can be fitted on to the staff and clip on the backbone. For this purpose let the staff be taper, and have the spring with a hole forged in the end to fit the staff about 2in. down. Let the spring be about 2in. from the backbone, where the saddle will come, and give the spring such a shape that the play is directed to a point a few inches in advance of the machine when at rest. This will make it run easy over rough ground. On referring to the sketch of hub, in No. 682 (Fig. 2), you will see it is recessed in at the front side near the axle; this recess is to receive the end of bearing, and protect it from dust. To protect the back-wheel bearings from dust there are projections on the hub; round these wrap a piece of soft leather, and secure with a wire twisted round; this will keep the dust out and the oil in. Drill a hole in the middle of the back nave to meet the transverse hole, and fit a thumbscrew; this is for oiling purposes.

Middleton, Manchester. **F. L. Striffler.**

THE OTTO BICYCLE.

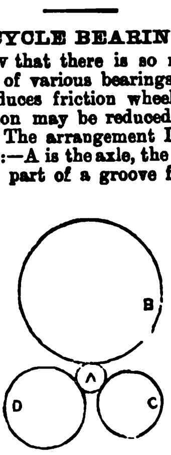
[14404.]—ALLOW me to send you a sketch of a totally new style of bicycle, called the "Otto Bicycle," a patent, which has just been introduced to the public. Its lightness and simplicity of construction makes it one of the safest and easiest-going bicycles. The steering is effected by a very simple contrivance, which does not cause any effort to the rider.



C is a bent-steel axle, on which rests the rider's seat; on the end of this axle are two large wheels, which can move independently of each other. To these wheels are attached pulleys, *a a*, which correspond in size with the two pulleys, *b b*, on the treadle crank axle, K. This latter turns in two sliding axle boxes contained in the ends of the steel rods, *h h*, which are attached to the axle, *e*, and the back of the rider's seat, *g*; *o o* are the gut bands that connect the pulleys; *m m* are the handles of the steering gear, which regulate the revolution of the wheels, or stop them entirely by loosening the gut bands and putting on the brakes. **F. Baker.**

BICYCLE BEARINGS.

[14405.]—Now that there is so much discussion as to the merits of various bearings, I wonder that no maker introduces friction wheels, by means of which the friction may be reduced to almost any degree desired. The arrangement I would suggest is the following:—A is the axle, the circle representing the deepest part of a groove for the edges of the friction wheels to work on. B, C, and D are friction wheels, B having four times the diameter of the axle, and running on adjustable coned bearings. Almost all the pressure would fall on B, especially if it were placed a little in front instead of vertically over the axle. Thus, allowing for the slight friction of C and D, the entire friction would be about ⅓rd of ordinary coned bearings. If the whole were contained in a sheet-iron box to exclude dust, the rolling friction would be inappreciable. The cranks of the treadles would have to be placed, perhaps, an inch further out. **F. R.**



IMPROVEMENTS IN BICYCLES.

[14406.]—HAVING lately had a run over to Nottingham on my bicycle and visited Mr. Calver's works, I saw there just the thing which "B. N." (No. 686, let. 14344, p. 244), desires, and, no doubt, if he communicated with him, could be well suited. Apropos of the heading of this letter may be mentioned some improvement in the bicycle proper (not the twin back wheel machine, for the benefit of a good understanding) introduced into the hollow-spoke bicycle. The safety pedal is an arrangement whereby the pedal cannot slip even should the nut get loose. This is an advantage, in a race especially. The next improvement is a safety saddle and spring, and a new way of fixing the saddle on the spring. A number of projections across the spring fit into corresponding indentations in the saddle-block, and by means of a simple spring-clip the saddle is instantaneously adjusted, thereby doing away with the clumsy nuts and length of time necessary to tighten them. The saddle can neither slip nor twist. This is another immense advantage to make sure of in racing.

Another good improvement is the elongated staff or back-bone head. This is an arrangement whereby a long steering centre is obtained, without lengthening the forkhead or raising the handles. The steering centre is as long as the forkhead, and the rather dangerous (in case of a fall) adjusting screw is dispensed with, only a smooth-rounded head of a large size hollow screw is in its place. The great advantage of the long centre is the immense firmness which it gives the machine, and much less wear in the centres. For those who desire it, an adjustable and detachable handle is provided. By loosening a nut and slackening a taper key the handle can be made as low or as high as the rider requires; or, should he wish to make sure that no one could ride it in the event of its being left anywhere, the handle can easily be taken completely off the machine. This will commend itself to some who have had the horses quietly walked off while their riders have been refreshing themselves. In the bearings, too, Mr. Calver is not behind. I noticed double-ball bearings being made to back as well as front wheels. Also new roller bearings, which run quite close together without touching. His plain bearings are capitally fitted. **F. L. Striffler.**

TELEPHONE.

[14407.]—I SEND you herewith a description of a telephone which I made about the end of April for use with battery currents, and with which I have been able to transmit speech.

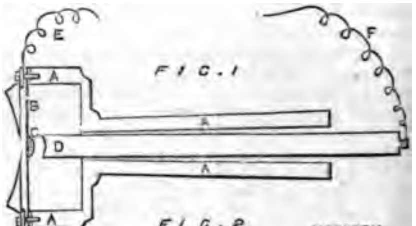
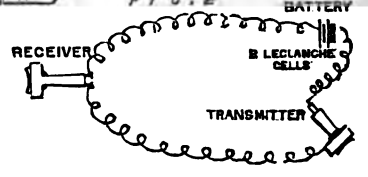


FIG. 1

FIG. 2



Since making it I have read with much interest the account of Professor Hughes's investigations. Fig. 1 shows the transmitting instrument, which is made as follows: *a*, ordinary telephone case; *b*, diaphragm; *c*, hemispherical piece of brass soldered to *b*; *d*, ordinary graphite pencil hollowed out so as to allow *c* to fit into it; *e* and *f*, wires leading from instrument. To adjust the instrument, place *d* (which must fit the case rather tightly) so that it touches *c*. To ascertain whether it does or not, place an electric bell in the circuit, and if it rings feebly it is all right. All that is then necessary is to join it up, as shown in Fig. 2, using an ordinary Bell telephone as a receiver.

I would, in conclusion, say that the arrangement above described was only used for experiment, and it might be improved upon; but as a proof of the possibility of transmitting speech by the aid of battery currents it is all that is needed.

Nota Bene.

WALKER'S IMPROVED TELEPHONE.

[14408.]—NOTICING your editorial note on p. 268 respecting my improvements on Professor Bell's telephone, I think it is right to M. Trouvé, as well as to myself, to state at once that, so far as I am aware, my plan is entirely different from his; but being as yet in ignorance of any details of his method of increasing the sound, I cannot, of course, be sure as to this; but I can be, and am, clear on one point, and that is, that the plan I have adopted, whatever may be its merits, was not suggested to me by that of M. Trouvé. Indeed, I do not know that there was any publication of his method, even indefinitely, until after steps had been taken to test my own method. It is difficult to describe the latter without the aid of drawings, but the ideas upon

I have acted are simple and easily stated. It generally acknowledged that a small dia- 1—say, about 2" diameter—gave more satis- results, in clearness of articulation and the uction of the natural tones of the voice, than ones, I adopted what seemed to me a atural course of procedure, and endeavoured tiply that sound by putting a second coil and agm, then three others, and afterwards seven into the same circuit, and by a special (and tented) mouthpiece united them into one, so e combined effect of all acting together with synchronousness, might be received in one , and as one sound, by the ear. The mouth- so formed that the sound waves, on issuing ne lips of the speaker, are divided up equally, riking the 2, 4, 8, or more diaphragms cause vibrate in precise unison, and thus the cur- roduced in the coils are unitedly transmitted receiving telephone, and the effect is the same s added an equal number of voltaic cells in o a circuit for ordinary telegraphic purposes. le diaphragm telephone exhibits this effect reat distinctness.

l also an idea that if one could magnetise the agm and maintain it in a state of magnetism e to that of the core, a better effect might be ated; and, therefore, in making and connect- my telephones I bent the usual bar magnet horse-shoe form, with a coil upon each end, stead of actually dividing the one sheet of pe, forming the two diaphragms, I had them very tightly between and around the opening containing the coils, so as practically to divide though allowing, at the same time, the ve action of the S. pole to pass over to the agm of the N. pole, and vice versâ. This l in my getting more than double the sound r out of a duplex (or two-diaphragm) instru- nan I did out of a single one of ordinary con- on. And further I believe that I also gain ing by having the diaphragms at an angle axis of the mouthpiece, as in the human ear.

octoplex instrument was exhibited on the 1st y the Telephone Company, at the Royal 's soirée; and, on the 3rd, by myself at yal Institution (by special request). On the g of the same day I had the pleasure of panying Willoughby Smith, Esq., Mr. Alder- nd Sheriff Staples, James L. Shuter, &c., to rks of the Telegraph Maintenance and Con- on Company, at Greenwich, for the purpose ing the penetrative powers of the octoplex nent. The tests were entirely made under nith's own supervision, and a memo. of the nd results was made by him at the time. We listinctly through the whole of the cable then in tanks (42 knots), and afterwards through resistances, representing from 200 to 2,000 of land line, with satisfactory results. At 000 miles Mr. Smith notes, "Singing, good; , doubtful." With 200,000ohms. resistance uit, "Singing and talking very indistinct; ' good." With one meg. ohm (1,000,000ohms.) nce, representing probably 40,000 to 50,000 f ordinary telegraph land lines, "Singing and very difficult; 'cuckoo' still heard dis- ." (I copy Mr. Smith's notes, made at the nd vouched for by the other gentlemen pre- The results were most surprising to all, and ond anything anticipated.

E. Cox Walker.

awrence Cottage, York.

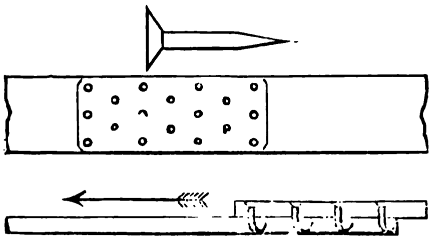
E MICROPHONE—CROSS HAIRS.

9.]—I HAVE made some twelve forms of the hone and have constructed one which for ity leaves nothing to be desired. It is as :—A piece of zinc about 4in. × 2in. is mated and forms the base of the instrument. his a pad of blotting-paper, same size, and in a weak solution of sulphuric acid, is laid— ove this a plate of carbon, same size. The is secured with two pieces of cord, or, pre- , a screw, at each end, not touching the zinc. end a piece of wood, 2in. × 2in. × ½in. is l or glued, and on the top of this a piece of 2in. × 1½in. × ½in. is securely fastened. A ip of carbon, like an ordinary French nail, d in a depression in bottom carbon plate, and osely into a small abrasion in top plate, a pace being filed out to a knife edge instead of A nail, pieces of copper, brass, iron, steel, latinum, and gold wires may be used, the sing the same. With such an apparatus as versation can be carried on with ease, and a ing over the carbon plate or the noise made camel hair brush is overwhelming. The my modification of the microphone is that of one and battery being in one small appa- Many thanks to "F. R. A. S." for calling my n to an error (of haste) respecting cross For the purpose the student required them irs would be much the better to use.

W. J. Lancaster.

SOMETHING WORTH KNOWING FOR PIECING BELTS.

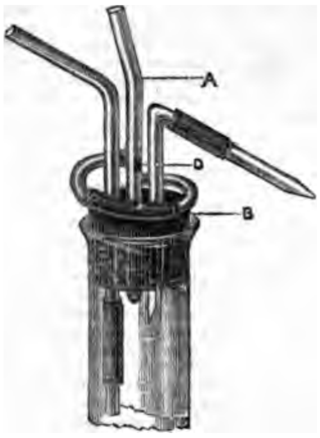
[14410.]—I HAVE received great practical benefit from reading your excellent paper, and can only wish it had more of practical mechanics and less of star-gazing in it. Our musical friends appear to have had a good benefit. Let us hope that it will be the cotton-spinners and general mechanic's turn some day. The science of cotton-spinning has yet to be written, and it would be a capital thing if some of your many readers in that large industry would state the difficulties they have met with in the working of material, in machinery, and what may appear trifling manipulations, and how they overcame them.



As a very little thing, I send my quota about piecing belts. Belts breaking are a daily nuisance, and I have tried all sorts of things from Helvetia laces to patent fasteners, but find nothing so good or so cheap as nails. If you want a belt to last whilst there is a bit of good leather in it, for spinning looms or bleaching, nail it. The best kind of nail is one with a countersink head, about ¾in. long. Nail it diagonally. Of course narrow belts want lighter nails. **B.**

AN IMPROVED FORM OF WASH BOTTLE.

[14411.]—IN washing precipitates with sulphureted hydrogen water, solution of ammonia, or boiling water, the chemist is often annoyed by the reflux of the gas or steam into his mouth. To prevent this annoyance, a Bunsen valve is sometimes placed upon the mouthpiece of the bottle. This prevents the gases from returning, but there are two defects in this plan. In the first place the valve prevents the operator from pouring water through the mouth-tube in the usual manner; and secondly, as the air that has been forced into the bottle cannot escape, it continues to impel water through the jet for some time. To remedy these defects I have added a third tube. This tube (A) is shown in the accompanying sketch. It has two tubes fused into it at right angles, which are bent round upon the top of the cork, and connected by a piece of good caoutchouc tubing. The tube (A) is stopped between the two junctions of the side tubes by a piece of cork (D), or by being fused up.



When the operator wishes to use the bottle he holds it as usual, placing his forefinger upon the caoutchouc (B), so as to prevent air passing through it, and blows through the mouthpiece into the bottle. After this the jet of water continues to issue with almost undiminished force for about three-quarters of a minute, while it may be stopped at any time by releasing the pressure upon the caoutchouc tube (B). Water may be poured out through the new tube (A) as usual. It is convenient to bend the lower end of the tube dipping into the water. This enables the operator to blow out the last portions of water.

The advantages of the bottle are as follows:—

The jet will issue for some time after the operator has blown into the bottle, and it can be directed upwards into a beaker by inclining the bottle. The jet can be stopped at pleasure. The water passing through the new tube when the bottle is inverted can be regulated to a drop by pressing upon the rubber. The mouthpiece never gets hot, nor does gas or steam pass through it into the mouth. Lastly, the bottle can be used as an ordinary one by blowing into the new tube without pressing the caoutchouc. After the tube (A) is made or purchased, there is no extra trouble in making the bottle. A caoutchouc stopper is the best to use, but a good cork answers perfectly well.

In constructing the tube (A) care must be taken that water runs down easily through it without remaining anywhere in the passage.

Several of these bottles have been in constant use for two or three years in the chemical laboratory of the Royal College of Science, Dublin, and have given great satisfaction.

Thomas Bailey, Assoc. R.C.Sc.I.

A METHOD OF FINDING THE DENSITY OF THE EARTH AS COMPARED WITH THAT OF WATER.

[14412.]—WOULD some of our astronomical correspondents kindly give their opinions on the following attempt to find the density of the earth?—

The weights of equal bulks of different forms of matter are as the densities of such bulks. The energies of different moving bodies of equal bulks, and having equal velocities, are as the weights, and therefore as the densities of the bodies. The attractive power of the earth is as its density. Applying the formula $\frac{v^2}{2g} = s$, and taking 32·255ft. as the value of g, and 64·510ft. as the value of v, we have one volume of air moving with energy sufficient to do work equal to raising its own weight 64·510ft. in height. Then, $64{\cdot}51^2$, or 4161·5401 times, one volume of air moving with velocity of one foot in one second, would do the same or equal work. Water weighs 815 times heavier than air, therefore $\frac{4161{\cdot}5401}{815}$, or 5·10618 volumes of water, moving with velocity of one foot in one second, would likewise do the same work. One volume of matter of a density 5·10618 times that of water might be substituted for the 5·10618 volumes of water. If the earth were of a density 5·10618 times greater than at present, then one volume of water would equal in weight the present weight of a volume of matter—that is, 5·10618 times as dense as water. But as, with the earth's present density, water is $\frac{1}{5{\cdot}10618}$th the weight of matter that it would equal in weight, providing the earth's density were increased 5·10618 times, then the present density of the earth must equal the density of matter that now has a density 5·10618 times greater than that of water.

The value of g used in the foregoing argument is that usually assigned as its polar value. It is employed because the writer has reasons for believing that the earth is not a spheroid of revolution, or not so, as is usually implied by that term; that it has not behaved as a homogeneous mobile rotating body; that consequently no contraction of the length of its polar diameter has occurred; and that although a bulging has taken place at and about equatorial regions, yet, as this bulging is accompanied by a decrease in density of the matter there (as is shown by results of pendulum experiments, after allowing for effects of rotation, at different latitudes), the polar diameter is more likely therefore to be the diameter of a sphere whose attraction is equal to the earth's attraction than the mean diameter is. The moon's mean distance and periodic time, after taking into account the effect of proximity of earth's matter—on pendulums, and therefore on value of g—(which effect is similar to the effect that is the cause of cohesion in matter, and is exhibited in the rapidly increasing density of the atmosphere as it approaches the earth's surface), and also, after allowing the true velocity to the moon (which is the cause of her maintenance in circular motion) in contradistinction to the velocity she has in her path (which is the resultant of original velocity and gravitation towards the earth), corroborates the writer's views.

The idea involved in using a value numerically equal to $2g$, as the value of v, is that, supposing a body were moving in, say, a horizontal direction, at the rate of 64·51ft. per second, and this body be connected to a weight equal to its own, and on the earth's surface, in such a manner that its energy would cause the weight to rise against the effect of gravity, then the said body, having a velocity of 64·51ft., would move in two seconds through 64·51ft., and for two seconds would overcome the power of the force of gravity on the weight to which it is connected, and cause the weight to move through 64·51ft. also; but it is the velocity of 64·51ft. that has enabled the moving body to perform this, and for purposes of comparison of the moving forces of different bodies we thus obtain in a measure of v the measure of g.

Air is used as one of the bases of the argument as, other things being equal, the test of the densities of different spheres would [illegible] envelopments each [illegible] from space.

The different densities of air and water, their mutual dependence, the one upon the other, and both upon the density of the earth, may be shown to be so delicately adjusted as to make them perfectly reliable bases for the line of reasoning advanced. For instance, the present adjustment that pertains allows of a portion of the water of our sphere to assume the vaporous state, and it is only our alternating nights, the inclination of the earth's axis, and the indirect action of the sun's rays on northern and southern parts that prevent the greater part, if not the whole, of the water on earth's surface from assuming the same state. Any increase of temperature or decrease of density of the earth would correspondingly alter the present proportion of vapour and water about and upon her surface, and cause a difference in density of atmosphere as compared with that of water.

We may, therefore, take the densities of air and water at our average temperature and height of the barometer as being in accord with the density of the earth, and reason as shown with confidence.

G. Pinnington.

Hough Green-road, Chester, April 22.

A METHOD OF SOLVING PROBLEMS IN MAXIMA AND MINIMA.

[14413.]—A FEW years ago, whilst pondering on the subject of maxima and minima, an idea—which resulted in the subject of this letter—occurred to me, and a few weeks since I submitted it to Mr. Mitcheson, for the purpose of gaining his opinion as to its originality and merits; to which he replied—in your last impression—suggesting that I propose it as a question for discussion. This, with the Editor's permission, I proceed to do, as I am desirous of knowing if it is original, and that if it is so, and has any merits, that others should know it also.

Rule—Represent an unknown function by x, and form an expression for the subject under consideration. Form two other expressions by substituting y and z for x, which equate, and reduce as far as possible. Substitute $(x+d)$ and $(x-d)$ for y and z, and again reduce as far as possible. Assume $d=o$, and find the value of x from the residue.

NOTE.—The intermediate process of substituting y and z, instead of $(x+d)$ and $(x-d)$ for x is introduced solely for the purpose of facilitating the reduction.

EXAMPLES.—To divide a given line into two parts, so that the rectangle contained by the segments shall be a maximum. Let A be the given line, and x one of the parts; then $(A-x)$ is the other, and $(Ax-x^2)$ the rectangle.

Substituting y and z, and equating $A y-y^2=A z-z^2$
Transposing $A(y-z)=y^2-z^2$
Dividing $A=y+z$
Substituting $(x+d)$ & $(x-d)$. $A=(x+d)+(x-d)=2x$
Consequently $x=\frac{A}{2}$, or the given line must be bisected.

To cut the greatest parabola from a given cone. Let A be the diameter of the base, B the slant side to which the section is parallel, and x the distance of the point of division of the diameter of the base from the extremity opposite B.

Then $\frac{Bx}{A}$ is the abscissa, $2\sqrt{(Ax-x^2)}$ the ordinate, and $\frac{4Bx\sqrt{(Ax-x^2)}}{3A}$ the area of the parabola.

Substituting y and z and equating $\frac{4By\sqrt{(Ay-y^2)}}{3A}=\frac{4Bz\sqrt{(Az-z^2}}{3A}$
Dividing and squaring $Ay^3-y^4=Az^3-z^4$
Transposing $A(y^3-z^3)=y^4-z^4$
Dividing $A(y^2+yz+z^2)=y^3+y^2z+yz^2+z^3$
Substituting $(x+d)$ and $(x-d)$, expanding and collating $A(3x^2+d^2)=4x(x^2+d^2)$
Assuming $d=o$ $3Ax^2=4x^3$
Dividing $3A=4x$
Consequently $x=\frac{3A}{4}$.

I have refrained from giving more examples or making comments, as I am afraid I have already trespassed largely upon your space—so will leave it for a future occasion, should it be required.

S. Stokes.

New Ship Canal.—The Maryland and Delaware Ship Canal Company propose to build a canal seventeen miles long, having 25ft. depth of water, and 100ft. width, between Chesapeake Bay and Delaware Bay. By this means Baltimore will be brought as near to Cape May, at the mouth of the Delaware, as Philadelphia is, and the distance for ocean vessels between Baltimore and New York and Europe will be shortened by 225 miles, while the saving of freight between Baltimore and New York will be about 50 cents. a ton. The estimated cost of the enterprise is 8,000,000 dols., and the company is authorised to levy a toll charge of 20 cents. per ton upon all traffic *passing* through the canal.

REPLIES TO QUERIES.

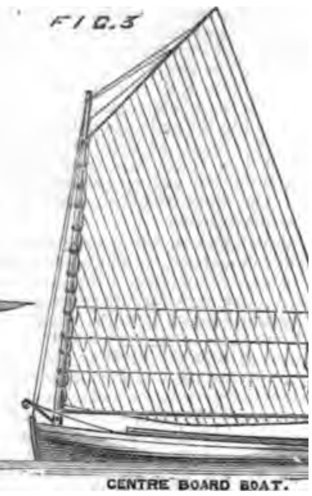
**** In their answers, Correspondents are respectfully requested to mention, in each instance, the title and number of the query asked.*

[31976.]—**Compound v. Single-Cylinder Engines.**—There are a few engineers besides Mr. Sunderland who yet prefer to swear by their old friend, the single-cylinder engine. Unfortunately for that old friend, the new acquaintance—the compound engine—is fast gaining ground, and will ere long, by the law of "survival of the fittest," bustle its antiquated competitor out of the way. Every one will regret to miss his well-tried and symmetrical companion; but the laws of economy are inflexible and unconquerable, and we are now compelled to employ a less gainly servant, because we find him to possess more useful qualities. In spite of the protestations of Mr. Sunderland and others, it is an undeniable truth that the compound engine has made its position secure. Notwithstanding theory it has attained to practical fact. But does theory support the simple engine? No, it does not. Your correspondents generally support the compound theory, but none that I remember have assigned the true cause of its superiority. There may be a little, one way or the other, in what the latest disputants say in regard to the loss of heat in the two systems; but, were it only a matter of difference of heat, I should incline to belief in the simple engine. The steam in a single-cylinder engine only makes a journey of the length of the cylinder; in the compound it goes the length of two cylinders, and breaks its journey half-way. It is this journey-breaking that constitutes almost the whole advantage over the other plan, thus:—Say the second cylinder is four times the capacity of the first, then, when the first exhausts, the second is widely open to receive the steam. The back pressure on the first piston is thereby greatly reduced, without lessening the force of the steam on the second; for, though the pressure is much less, the area of piston is correspondingly greater. The practical effect of this transference of steam from one cylinder to the other is to give us what is tantamount to a vacuum at the end of first cylinder, about equal in amount to that which we get by condensation at the end of the second—that is, for one charge of steam we get two vacuums. In the single cylinder we can only get one vacuum; hence the disadvantage. It is wholly by having the second cylinder much larger than the first that we gain by compounding. Were the two to be alike we had better have two single engines, and cut off at half the distance.—ROBERT LANGTON.

[32367.]—**Flock or Wool-cutting Machine (U.Q.).**—I have never seen or heard of a machine that will cut or grind flock so fine as you wish, but the nearest approach to it is a machine called a devil. It consists of a large hollow cylinder, with long sharp steel points all over the outside. The wool is carried on a revolving linen tray, where it is drawn in between two grooved rollers, and as it comes out of the other side of the rollers it is acted upon by the cylinder with the steel points. The wool comes out as light as a feather. It is driven by a large fly-wheel with teeth on the outside, which gears into a pinion fixed on the cylinder axle. When these machines are used have plenty of ventilati
it will very soon affect your health.—T
TELE.

[32386.]—**Centre Board Boat (U.Q.)**—
a plan which shows a new way of fitting
board," which, I think, would be safer th
plan. The centre board, H, works upon rol
which is a much safer plan than the ordinar
fitting. There is a mast-joint at M, by
sail can be lowered, as in Fig. 2. This arr
will be very handy for centre-board boats,
lieves the yacht of the mast weight. In a
mast is so light that it can be lowered by
FERNIE.

FIG. 3



CENTRE BOARD BOAT.

FIG. 2

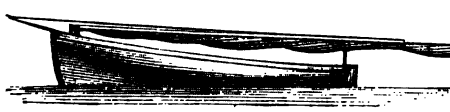
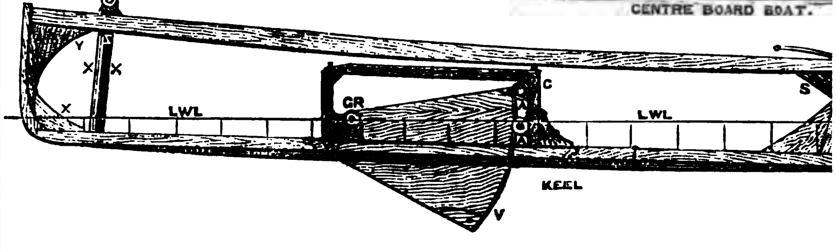


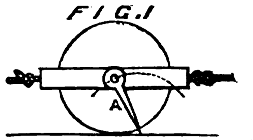
FIG. 1



[32418.]—**Royal Engineers.**—Do
ticulars apply to telegraphists who may joi
you kindly recite any advantages to one
doing ordinary testing, erecting, and regul
instrument in use in the postal system, an
maintenance of batteries?—P. O. TELEGR

[32447.]—**Electrical Indicator.**—It is
that my arrangement of electrical indica
not work if the tide did not rise to the sa
every day. I much admire the clever w
"Dudley" has attained his end, and I
obliged to him for pointing out the fa
device. I now send an amendment to
which will, I think, get over the difficulty
satisfactorily with a varying height of tide
have the plank arranged with little strips
projecting from each long strip towards o
and one overlapping the other, but just not
as I have shown in Figs. 1 and 2 in the
MECHANIC of May 17th. Each of thes
brass strips would make a connection w
over by the "current connector," and
placed as close together in succession as t
is required. The "current connector"
made with only one roller instead of four,

FIG. 1



FIG

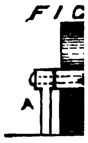


FIG. 3

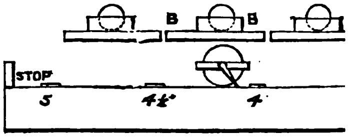
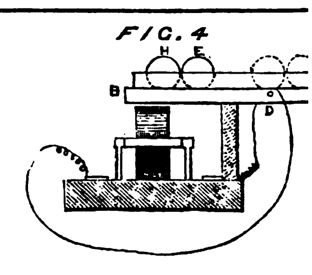


FIG. 4



ave a "drag leg" (A A in figures) on each side, so at when it changes direction, which it would do hen the tide turns, it would have to lift up and fall own again. This, I think, will be clearly understood when examining the figures. Now, supposing e tide turns soon after the index hand has passed o. 4 on the tide-rising side of the dial, it ought then, the next connection of the current, to point to 4 n the tide-falling side of the dial; but before it can o this it is clear, as "Dudley" explains, that it will ave to make and break the current three times. ig. 3 represents a side view of the plank, with the current connector" in the position I have imagined. ust over the roller, but not touching it, is balanced small board, the end view of which is B B. It has groove on the top, with two large marbles in it. The side view of this board is B C in Fig. 4. It noves on a hinge at D, just over which is a pair of mall brass strips, similar to those on the main oard, which only want pressing down to connect he current. K is a rest to prevent the board, B C, alling too far. Now it is evident that if the tide urns when the current connector is under this oard it will tip up the end, B, and so cause the first arble, E, to to run to the other end, C. On its way t will pass over the brass strips at D, and so connect and break the current. The marble, H, will lso run down the board, but will not be able to pass he strip at D, as the first marble, E, will stop it, nd so it will make the current but not break it. Now, as soon as the "current connector" has dropped again on its way back, the end, B, of the board will be able to fall to its old position, and so the marble, H, will run to its former place, and in doing so will break the current which it has just made. The marble, E, will now run back, and on s way make and break the current again. The ader who has followed me thus far will see that the ide turning when the current connector is between and 4½, will thus make and break the current hree times, and so would move the hand from the ide-rising side of the dial to its right position on he tide-falling side. Between 4½ and 5 there would ly be one marble in the groove of its board—as, if he tide turned when the current connector was there, ly one make and break of the current would be ecessary to move the hand to its right place on the ial. In the same way three marbles would be placed n the board between 3½ and 4, so that if the tide urned there, the current would be made and broken ive times. I shall be glad to know, and I have no oubt "Dudley" too, what "An Old Reader" ntends to do. Will he please kindly say?—A. A. WATKINS.

[32536.]—**Moulding.**—The best material for oulding is good fine sand. There are several kinds: one is very fine, and of a bright yellow olour; it is principally used in the Falkirk district. There is also the Belfast sand, which is very fine, of reddish colour, and is what they use in the Glasgow istrict for mixing their facing sand in the proportion of 1 of coal dust to about 7 of sand. Let the al dust be very fine—as fine as flour. Mix them ree times over, and then tramp on it with your et to bruise it or mill it; then riddle through a in. riddle and then through a ¼in. riddle; then put into your tub or box and keep it moist and fit for orking at any time, and when using it sieve hrough ⅛in. sieve on to top of pattern.—W. GRAY.

[32631.]—**Amateur Printing Press.**—In reply to "Galvano" the letters in a copper-plate are sunk elow the surface, and the material to be printed upon has to be forced into the design or letters—requiring immense pressure. Litho work is on the urface of the stone, and requires an edge pressure scraper of wood or edge of cylinder), which takes ut a small part of the surface at once, and thus ives the necessary pressure over the whole surface he stone being drawn through or under) with a ithe of the power that would otherwise be required, nd with scarcely any risk of breaking the stone. If "Galvano" wants a really useful book he cannot do etter than get "Printing at Home," by J. Francis, Rochford, Essex. This is far superior to those he as mentioned. I am acquainted with all the presses y this maker, and can assure "Galvano" they are irst-rate, will do work equal to the most costly, and re cheaper than any person could make one.—PRACTICAL PRINTER.

[32670.]—**Whitening Bells.**—If this query were little more definite it would probably receive an swer. Does "Wisemore" mean whitening brass ells by electro-plating with nickel or silver, or imply with tin.—UNCERTAIN.

[32677.]—**Limited Liability.**—Obviously a question to be decided by the courts. If there had not een a doubt the meeting would not have been alled.—X.

[32679.]—**American Organ.**—I think I shall be le to supply the information about the tremolo next eek, as I have just received the sample promised by Elevo." The manual can be altered by drawing d re-arranging some of the pins in the front rail. at is, the front pins of keys F to B represent 4 turals and 3 sharps, while C to E represent 3 turals 2 sharps. F, F sharp, G, G sharp, A will obably do for C, C sharp, D, D sharp, and E; but w, instead of the pin being where it is for A sharp, u want it suitably placed for F, and then the pin at did for B will not do for F sharp, though the C may possibly do for G. The back pins may probly do, but I should think it better to sell the ard and get a new one, for the pins must be inserted with great accuracy, which takes up a long time. If, however, there is space you might cut the board between B and C, and at the top between E and F (perhaps shifting the broad key will do), and then fasten it together with dowel pins, transposing the seven lower keys to the other end of the board. I am afraid dowelling would not be strong enough by itself, so if you can afford the space screw the old rails down to a new frame. You are more likely to make a good job this way than by shifting pins. I do not understand the last sentence in your query. If you want sub-bass on pedals only, what do you mean by "some kind of coupler to break communication with the manual?" The sub-bass can easily be arranged so that it speaks only when pedals are worked.—ORGANON.

[32687.]—**Dissolving Partnership.**—"One in a Fix" should have consulted a solicitor.—X.

[32680.]—**Cordial Making.**—What cordials does "J. M" require? I think Mr. Cooley compiled a book of receipts (I don't mean his "Cyclopædia") some years ago, and it is probably published by Hardwicke and Bogue.—S. M.

[32694.]—**Brass Tools.**—I don't think that grooves are required in the brass tools, for they are intended to work the speculum roughly, and the emery sticks into the brass, but if you want to work specula see the papers by Mr. Lassell in Vol. XXII. of this paper.—PARABOLIC.

[32700.]—**Malleable Castings.**—I know of no "solution" to retain the brightness except lacquer. —J. P.

[32710.]—**Organ.**—If convenient to "C. C. C." to call at undermentioned address I shall be happy to show him some very effective decoration on the pipes of a new organ now standing in my workshop. —H. D., 10, Nelson-street, Greenwich, Kent.

[32710.]—**Organ.**—"C. C. C." can see a variety of patterns and designs for front pipes by applying personally or by letter to Mr. Courcelle, 65, Barclay-street, Clarendon-sq., St. Pancras.—TONOMETER.

[32721.]—**Socket Joints.**—Tow and red lead well rammed in, and a final caulking of strips of sheet lead driven in with hammer, will be about the best thing.—JOHN.

[32742.]—**£5 Telescope.**—In my reply to this query, p. 217, second line from the bottom, B should, of course, have been printed 13.—F. C. DENNETT.

[32768.]—**Stopwork.**—In this query we are spoken of as "a watch company just started," and "Seconds' Practical Watchmaker," is asked his opinion as to the value of our "patent sliding click." The inquirer, who signs himself "A Lover of the Art," gives a fair descriptive abstract of the click itself as we have published it. So far, however, from being "a company just started," perhaps the gentleman is not aware that we have been in manufacturing and commercial existence for more than six years. During that period we have not only built up a special connection of our own, but we have invented and set in producing operation the most costly and expensive machinery known in this country for the manufacture of watches. In your journal for May 17 we find the reply from "Seconds' Practical Watchmaker," upon which we crave your indulgence to say a word or two. We have often read the contributions of that gentleman with great pleasure, and, therefore, we hope that he will not take it amiss if we say that he is hardly in possession of the materials for giving a decided opinion against our latest invention. The gist of this opinion is, that there is as much danger in breaking the mainspring with the sliding-click as with the ordinary stopwork, and that "the value of the patent click is more ideal than real." Upon this we beg leave to join issue. If the gentleman will, kindly, again take the trouble to read over what we have said about the click he may be induced to reverse his belief. We claim—speaking from experiment, mind you—that, whilst the sliding-click is fully equal to the old stopwork in the point of safe-guarding, "in simplicity, certainty of action, and impossibility of failure or breakdown, it is immeasurably superior." We, therefore, maintain, that the "give" of the click renders it impossible to leave the mainspring on the strain, or to block it; and, consequently, the disadvantages of overwinding on the one hand, and excessive action of the escapement on the other, vanish together; and, in point of fact, this is exactly what does happen. To sum up, we claim, by the combination of the pivoted brace and the sliding-click, "to prevent the tearing away of the barrel-hooking, to prevent blocking, over-winding, or over-straining of the mainspring, and to prevent the undue acceleration of the escapement whilst the mainspring is fully wound up and on the strain." We further say, that, after most exhaustively testing the invention on several thousands of our watches, under all possible circumstances, and with unqualified success, we have adopted it as a radical cure for all the ills and shortcomings to which the going-barrel, either with or without stopwork, has hitherto been subject. That, we ventre to submit, Mr. Editor, is a very different affair from an "ideal" one, and we trust that our experience upon the subject will be taken to be of more value than that of any gentleman speaking only from a few descriptive sentences in our very brief "Notes on Stopwork." It is quite clear that "Seconds' Practical Watchmaker" knows who we are, and, if he will forward his address to us, we will, if practicable, call upon him, and show the patent click itself, which will enable him to form a far better judgment than he can possibly do in any other way.—THE COMPANY IN QUESTION.

[32776.]—**Vienna Flute Organ Stop.**—A good Lieblich, Suabe, or small-scale harmonic flute, in my opinion, quite equals the Vienna, if properly voiced. The Suabe flute should have the inverted mouth, also a well three-fourths the diameter of the pipe in depth. Cut up only a fourth, and keep the cap down a little (not as described by "Adept"). N.B.—If this stop be cut up higher than one-fourth, clearness and brilliancy will be lost to some extent.—S. TAYLOR.

[32805.]—**Underground Telegraph Lines.**—Allow me to correct "Union Jack's" reply to this query, and to inform him that pipes are first laid down, and covered wire, or wires, drawn through them afterwards. "Union Jack's" idea that pipe and wire are manufactured together is, to me, a novelty.—JNO. LITTLE.

[32806.]—**Testing Leakage in Gas Mains.**—The best method you can adopt will be to bore the line of mains suspected, by means of an inch steel bar and sledge hammer, during the hours of your maximum pressure, testing the bore holes so produced with your nose or a light. The bar I generally use is made square on the head, with a collar welded on, to take an iron bar punched in the middle with a square hole, to fit the head of the steel bar—the iron bar acts as a wrench to turn the steel bar round as it is being driven into the ground; it likewise enables the bar to be withdrawn much easier. You will be able, by the above method to localise an escape to within a yard or so; then excavate a trench, and you will probably be rewarded with a broken pipe, decayed service, or a drawn joint, which you can repair in the usual manner. Your labour will be shortened, in looking for escapes, by boring in the neighbourhood of recent sewerage operations, as bad shoring and careless filling in are disastrous to gas mains, and escapes are sure to follow. Next month will be the best time to test your mains for percentage of leakage, as the consumption of gas is then very small between the hours of three and five a.m., and by fixing a meter on the outlet main from your works during those hours, according to the following directions, you can get the loss of gas near enough for all practical purposes. Drill two 1½in. holes on the outlet main from governor, one each side of the outlet valve; connect the inlet of a meter to the hole in main on the governor side of valve, and connect outlet of meter to the hole on the town side of valve. Fix a pressure gauge on the outlet of meter. Close outlet valve on main, and open tap on inlet of meter, noting time and index of meter at the same instant. Take great care that the pressure at outlet of meter remains the same throughout the experiment. Then, at the end of an hour, close meter tap, open valve, and note index of meter. You will now have the gas lost in one hour at a given pressure. The loss by one pressure being known you can calculate the loss during twenty-four hours, by taking account of the pressures employed during that time and their duration. The leakage of gas will be as the square roots of the pressures employed, the specific gravity of the gas being the same. Suppose, for example, you test your mains as above, at a pressure of twelve-tenths, and at at the end of an hour your meter indicates a loss of 60 cubic feet, and assuming your pressures to vary during the twenty-four hours as follows: Maximum pressure 20-tenths for four hours; minimum pressure 6-tenths for twelve hours; for cooking, &c., during the day, 8-tenths for eight hours. The calculation is then made for each pressure and their duration as under—

Maximum pres. as $\sqrt{1{\cdot}2} : \sqrt{2{\cdot}0} :: 60 : 77{\cdot}47 \times 4 = 309{\cdot}8$

Minimum pres. as $\sqrt{1{\cdot}2} : \sqrt{{\cdot}6} :: 60 : 42{\cdot}35 \times 12 = 508{\cdot}2$

Cooking pres. as $\sqrt{1{\cdot}2} : \sqrt{{\cdot}8} :: 60 : 40{\cdot}0 \times 8 = 392{\cdot}0$

1210·0

which gives 1,210 cubic feet of gas lost during the twenty-four hours. Supposing, then, your yearly make to be 8,000,000 cubic feet, you will distribute something like 20,000 cubic feet per day during the month of June, and you can easily get the percentage of loss during the twenty-four hours from the data obtained above, as follows: 1210 × 100 ÷ 20,000 = 6·05 per cent. of leakage. A twenty-light meter will be large enough to test your mains with, if they do not exceed seven or eight miles in length. By using the small testing dial of the meter for your experiment you can get the loss of gas per hour to a greater nicety than by using the hundreds dial for the same purpose. You should watch the meter during the whole time of the experiment, to keep the pressure at the outlet the same throughout as you started with, and it will be no more trouble to watch and note the number of revolutions the finger of the small dial of meter makes at the same time. You can by this means get the quantity of gas passed to a cubic foot. If the above calculations are too complicated for you, test your mains, and send particulars as above in another query, and I will work them out for you.—J. R. WARREN.

[32806.]—**Testing Leakage in Gas Mains.**—"Hydraulican" must drill three holes in the mains he wishes to test, 1 foot apart. In the centre hole insert a bladder, with a ¾in. gas tap to the neck. Blow the bladder up well, so as to stop the pressure of gas; then fix two ¾in. stand pipes, with a tap to each, and fix a dry meter between the two w will very soon register the quantity escaping one is consuming gas at the time). Bear i you cannot, under any circumstances, tell the loss of gas by a governor—the governor is merely to regulate the pressure of the gas.—F. R. WAITE.

[32807.]—**Gas Testing Meter.**—All that is required in fixing a test meter is a strong and perfectly level bench, fixed near to a supply of gas and water. The inlet to be fixed to the nearest gas supply, and the outlet connected to the inlet of the meter to be tested. A test meter should never be used to test a meter smaller than itself, as a wet meter becomes fast when worked under its normal speed, and slow to a certain extent when worked over. But you can get over this difficulty by fitting your test meter with outside water gauges similar to a station meter, connecting their tops to the inlet of meter, so that the pressure acting inside the drum is caused to act upon the gauges, therefore indicating the line of the water inside the drum. You can then have the capacity of your meter determined when working at its normal speed, and mark the water-line on the gauges whilst so working. The meter can then be made to measure correctly at any speed, by simply adjusting the water-line to the marks on gauges whilst the meter is working at the speed required. More water will require to be added when working over normal speed, in order to compensate for the difference in the levels within and without the drum. The Sales of Gas Act allows a meter to be stamped as correct if under three per cent. slow, and two per cent. fast.—J. R. WARREN.

[32807.]—**Gas Testing Meter.**—In reply to "Hydraulican," I presume he means a photometer to test the illuminating power of the gas against candles, &c. Or is it a meter to test the consumption of gas by the various gas burners, that by the observation of one minute it will register the number of cubic feet of gas consumed per hour? or is it a meter to test other meters of various make, either new or those that have had their drums repaired? I should be glad to have a better explanation, as I can give you any information required upon this subject.—F. R. WAITE.

[32808.]—**Invisible Ink.**—If "Union Jack's" cobalt chloride is bluish-green, and changes to bright green when heated, it is impure, for the pure salt is red in solution (or pink, if very dilute), and changes to blue on heating. The impurity is probably nickel. It is not completely invisible when dry.—DAGHBERT.

[32815.]—**Telescope.**—The object lens must be of good quality, if you are to use it to see bullet-marks at 1,000 feet; and you will require a terrestrial eyepiece with a power of at least 45. This would use up so much light that I should recommend you to keep the telescope as it is, and in time either sell it or exchange it for a larger telescope.—W. J. LANCASTER.

[32817.]—**Magnetising Steel Wire.**—The only method of doing this is with the aid of a magnet, beginning at one end of the wire, and continuing with same pole to the other end. You will find it rather a tedious process to magnetise such a length of wire.—W. J. LANCASTER.

[32826.]—**Midland Drivers and Firemen.**—Men who rise to the rank of driver and fireman on the Midland line have to go cleaning first. They have to be 5ft. 6in. in height and from 18 years of age up to 25. Each one takes his turn to be passed for fireman or driver. When appointed, drivers' wages, first six months, 6s. 6d.; end of twelve months, 7s.; after four years, 7s. 6d. No trip system. Time paid from the time they sign on duty till signing off; therefore all overtime is paid for at the rate of 8 hours a day, and also 8 hours for Sunday duty. This system is very satisfactory to the men. Firemen, first year, 3s. 6d.; end of the first year, 4s.; next rise when passed for driving. They have always a lot of men passed for drivers firing on the main line and also two drivers on the shunting engines (one in case of emergency), and put a spare fireman out of the shed along with the other driver. —YOUNG FIREMAN.

[32838.]—**Cooking Stove.**—Why waste heat, as you evidently do by allowing the flame to go out at the top without doing much work? If you want to make the most of your heat, make a stove in the following manner:—Have a cubical iron box made, size according to your wants, and run inside all round a piece of ¼in. iron gas-pipe, with small holes (pin's-point holes) all round, and facing centre of stove. These, when lit, will give a sufficient amount of heat to roast a good joint. Then have a hole directly in centre of the top, and about 3in. in diameter. The heat coming through this must do work; and here arrange a small oven, about 6in. deep, for baking pies, &c., allowing the heat to go round it, and finally enter into a flue. If you cannot work from these instructions I will give you a sketch.—W. J. LANCASTER.

[32839.]—**The Analogy between Light and Sound.**—Prof. Barrett was not far wrong in his calculation, for the length of a wave of the green portion of the spectrum near the dark line, E, is 0·0000207in. This roundly is 1·50000th of an inch, and as light travels 186,000 miles per second, it is, I think, a simple matter of calculation to find how many undulations of green light enter the eye in one second of time. An undulation in the violet is still shorter, being near the H line, 0·0000155in., or roundly, 1·65000th of an inch. You must not consider that these waves enter the eye, for they do not—they merely give up their period of vibration to the luminiferous ether contained in the cornea and so on to the retina.—W. J. LANCASTER.

[32842.] — **Electro-plating Bath.** — You had better look through a few of the back numbers. You will find an endless supply of information on the question you ask. If you have not the back numbers I shall be pleased to tell you how to make the solution.—W. J. LANCASTER.

[32852.]—**Air-Pump Valves.**—I should recommend the butterfly valve as about the most useful and safe for your purpose. The valve is made out of a circular piece of casting, bored and planed on the top surface. The valves are formed of brass about 16 gauge, hinged in the centre, so that they will flap like a butterfly's wings. The under surface is covered with leather and well oiled. The holes below each valve can be about a quarter of an inch diameter, or less would be better.—W. J. LANCASTER.

[32854.]—**Induction.**—The armature being of soft iron has induced in it a greater amount of magnetism than would be induced in a piece of steel, or in the secondary helix alone—hence this develops a greater amount of current; it, in fact, follows the law of squares in the case of iron. But, if you use steel, the strength is only proportional to distance—hence difference in effects.—W. J. LANCASTER.

[32855.]—**Electric Light.**—You can get an electric light with one Bunsen's cell—such a light as would render darkness just visible. 6 cells would give a little more light, but not sufficiently bright to be called an electric light. At least 40 Bunsens will be required for the purpose you wish to use the light for.—W. J. LANCASTER.

[32861.]—**Removing Cement from Iron Pipes.** —In reply to "Wallasey," the only way is to chip out the cement with narrow fine-pointed chisels. If too thick would be apt to split to spigot end. If hammering the spigot at end is resorted to with a holder underneath you will be sure to break the spigot.—F. R. WAITE.

[32863.]—**Electro Magnet.**—Use about No. 24 silk-covered wire, and have 15 to 20 layers upon the bobbin at least—more if you can.—W. J. LANCASTER.

[32864.]—**Gold.**—How would Theo. Pitt "reduce the metal to powder?"—DAGHBERT.

[32869.]—**Sensitive Flames.**—The best method for you to adopt in obtaining a good sensitive flame is the following: Procure or construct a small gasometer, capable of holding about 2 c. ft. of hydrogen; from the top of this have a piece of ⅜ compo tube, with a tap at the end on top of gasometer; then, at the other end, have a gradually tapering piece of brass tubing, with a steatite nipple; or you may be successful in making a glass nipple. Having all in readiness turn on the tap to the full, light the jet of gas, and weight the top of gasometer until the flame is on the point of roaring. This is the only point that requires care. The flame should be just ready to vibrate or shorten the moment you speak to it. If you are careful you will be able to make a good sensitive flame. If you have not a gasometer you may obtain good effects with a gas-bag, the essential points being that the tube from gas-bag must be as smooth as possible. No roughness or stoppages must be permitted. On this one point rests the sensitiveness of the flame.—W. J. LANCASTER.

[32870.] — **Chemical.** — This question appeared among "Queries" in a slightly different form some time since, and I looked carefully but in vain for an answer. It is an algebraic and not a chemical question; but from the title chosen perhaps some mathematical correspondents who can easily solve it have overlooked it, not thinking it was in their line. I feel myself too rusty in algebra to undertake it, but hope some competent correspondent will give us the solution. It may be approximated by arithmetic thus:—Find the percentage of chlorine in the mixture, according to data; then, as sodium chloride contains 60·68 per cent. of chlorine, and potassium chloride contains 47·65 per cent. of chlorine, the respective proportions of these in the mixture may be found by comparing these percentages with that of the mixture. Thus, for example, if the mixture contains 52·13 per cent. of chlorine, it is evident that there is more potassium chloride than sodium chloride present, for a mixture of equal parts of these would contain 54·17 per cent. of chlorine, and will be found a mixture of 2 parts of sodium chloride and 3 parts potassium chloride contain rather more than 52 per cent. of chlorine, showing the salts to be present in that proportion in the mixture.—H. B. F.

[32876.]—**Cutting Gauge Glasses.**—The simplest method of cutting these glasses is to file a nick in the glass all round. File it about half through, then tap it on some hard metal, or over the edge of the file, and the piece will fall off quite clean. You may afterwards smooth the end with emery on an iron plate, with a small quantity of water.—W. J. LANCASTER.

[32876.]—**Cutting Gauge-Glasses.**—This is best done by taking a half-round file, and rubbing the place briskly till the glass is hot. Then wet instantly with your tongue, and take the glass in your two hands, with the thumbs together, end to end, on the opposite side of the glass, to where it has been nicked; wrench the glass, and it will break straight. I have broken a gauge-glass in six pieces in less than two minutes. This operation must be done quickly.—J. BARLOW, Southport.

[32876.]—**Cutting Gauge-Glasses.**—They can be readily cut by wrapping a piece of stout paper round, and tying it on tight, to prevent vibration, and form a guide for a hand-saw file. Place edge of paper where you require the separation to be, and carefully file a nick all round, holding the glass on the bench or a board. In the act of filing the odd piece will drop off clean. It always has done with me; and I have just cut an old one now for my own satisfaction before answering this.—H. P.

[32880.]—**Leclanche Cell.**—The simplest way to make a Léclanché cell is to get a piece of carbon long enough to go to the bottom of the porous cell, then pack in around it an equal quantity of manganese dioxide and coke as small as you can get it. The outer cell is, of course, zinc. The cell should be about half full of a solution of ammonic chloride, and then covered up. Cells made as I have roughly directed cannot fail to work well.—W. J. LANCASTER.

[32881.]—**Gas-Holder.**—The cheapest gas-holder you can obtain is a two or four-gallon stone bottle, having a cork in the top with two tubes, one going to the bottom of the bottle, the other just below cork. By having a reservoir of water, and allowing the water to flow in, you can have a regular supply of gas; and, at any rate, this will be the cheapest form of apparatus you can have, and much less troublesome than a small gasometer.—W. J. LANCASTER.

[32881.]—**Gas-Holder.**—In reply to "F. A. B. J." a tinsmith would be able to make him one for a few shillings. It must be made of sheet-tin, with three pillars at equal distances with pulleys on top, for carrying cord of balance weight, and more for keeping the gas-holder perpendicular. He must also have two separate pipes through bottom of tank to top of same, for inlet and outlet pipe, also a ½in. gas tap fixed on the under side of each bend under the tank, to let off the condensed ammoniacal liquor, &c. The pipes must be of lead or iron, as the reply given by "Os" would not answer at all. He states only one pipe in the tank. Also that the gas-holder and pipe must be made of zinc. He, "Os," must bear in mind that all gases produce acids in their manufacture, especially muriatic acid gas, which, if well purified, would destroy the zinc pipe and gas-holder in two hours.—F. R. WAITE.

[32883.] — **Railway Grease.**—The principal ingredient in most railway greases is palm oil. This is mixed with other greases, such as tallow and lard, or with solids, like plumbago or sulphur, in a state of fine division.—H. B. F.

[32893.]—**Weakness.**—Good walking exercise, not too much at once, and a rest after each exercise, will do more than gallons of physic. A tonic in the shape of some salt of iron, with quinine, might be of use; but I would rather recommend the use of a constant current battery, with 20 to 30 cells, about a quarter of an hour every morning, and well rubbing the skin after a bath every morning with a rough towel. The use of a pair of light dumb-bells would be of service to her, not too much at first.—W. J. LANCASTER.

[32908.]—**Refractive Power of Water.**—It is quite true that water is not by any means unique in its property of expanding upon solidification. Bismuth and antimony do the same, as do also many alloys, notably type metal. The expansion seems to arise from the fact that these substances assume a crystalline structure on becoming solid, or, in other words, their molecules arrange themselves in a definite way, and thereby occupy more room than when they are packed together in confusion as a liquid. The *refractive index* of water is said to diminish from zero to its point of greatest density, but the decrease must be excessively small for the index at zero is 1·3330, and at 10° it is 1·3327, showing a diminution of only ·0003 for a range of 10°. "H. B. F." writes of the "power of refraction" in his query, and I have therefore italicised the words "refractive index" because it is possible that something different is meant. Much depends upon the character of the book from which he quotes, and I would be glad to learn its name. Ice has a refractive index = 1·308. Surely my friend knows that the refractive index is independent of the angle of incidence.—WM. JOHN GREY.

[32908.]—**Refractive Power of Water.**—The index of refraction for water is 1·336, for ice it is 1·310. The index of refraction will vary with the density of water, but you of course must be exceedingly particular in measuring the differences between the index of water at 0° C. and 4° C., and I doubt whether you have apparatus sufficiently delicate to find a decimal point in the third figure.—W. J. LANCASTER.

[32921.] — **Noiseless Gear for Lathes.** — "Anxious," or any other reader of the ENGLISH MECHANIC, can see the above gear in motion at my residence, Crabtree-road, Birmingham.—J. JEWSBURY.

[32924.]—**Telescope.**—The object-glasses of these telescopes are usually bad, and will not bear more than 40 to the inch. This is about the highest power sent out with them. They are, however, doubled before the would-be observer gets them, and besides, most of those eyepieces I have had have been wrongly mounted. These are points which need correction, and certainly when any one gives an amount such as £12 18s. 6d., which would more than

› one of Wray's best 3in. clear aperture, it
n a pity that the "seller" cannot be brought
Now, if you have been a reader of this
u ought to have been forewarned—as the
le say, forearmed—but I suppose there are
ı the world still who will be sold.—W. J.
TER.

.] — **Telescope.** — "Totham" appears to
in. instrument, costing £12 18s. 6d., instead
s the early portion of his query would seem
ate. For this sum many of Wray's beauti-
objectives are mounted. Why don't you try
eyepiece? Look at the moon with your
ent when the terrestrial eyepiece is on it, and
note the tint of the fringe of colour border-
disc. If it is violet or blue, the objective is
tic; if red or yellow, it is imperfect. I will
test his eyepieces if he likes.—F. C.
T.

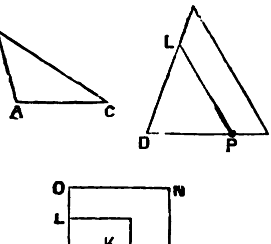
.]—**Telescope.**—I hope ere this "Totham"
overed what is the matter with his telescope.
ust be something wrong somewhere. Is it
tham" himself? Some time since I was
by a friend to examine a telescope he had
ed but could not manage. I found that he
ing to use a part of the day eyepiece with
onomical ones, by only removing the two
ses and then inserting the astronomical ones
appened to fit the day eyepiece tube), thereby
g a four-lens eyepiece. He thought that as
onomical eyepieces consisted of only two
was sufficient to remove two of the day eye-
instead of the whole four. He likewise
it very queer to be obliged to shorten it up
called it. Now, "Totham's" description of
rance of a star answers exactly to the above-
onditions: so before condemning the instru-
hich, by the bye, is not a bonâ fide 5-pounder,
ost more than double that amount), show
e one who is conversant with the telescope,
likely all will be right. I have a £5 one,
s afforded me a deal of pleasure. It will
Lyræ, but I am getting dissatisfied with
e I want something of larger aperture, so I
avouring to make a reflector.—A. N. H.

.]—**Mensuration.**—"John's" error may
explained:—The area of the circle referred
cular feet equals the square of the diameter,
Templeton's constant, ·02909, is used for
ng (circular) cylindrical feet contents into
rds, the formula, $4·75^2 \times 35 \times ·02909 =$
yards, is correct, whereas, in "John's"
$4·75 \times 4·75 \times ·7854 \times 35 \times ·02909$, the area
rcle, instead of being taken in circular feet,
ed to square feet, which, multiplied by the
nd then by ·02909, gives an incorrect result,
the number of square feet in the area of the
less than the number of circular feet, as
and therefore the multiplier or constant,
ecomes too small and inapplicable to bring
eet or cubical contents into cubic yards.
nula in this case should be:—

$$\frac{\times 4·75 \times ·7854 \times 35}{27} = 22 \text{ cubic yards.}$$

le consideration the above will also explain
ing of "John's" second query—"to dia-
"—EDWARD W. FURRELL.

]—**Mensuration.**—The way to find the
ntents of a cylinder is to multiply the area
se by the height, and the way to find the
he base is to multiply the square of the
by ·7854. Thus, if the diameter be 4·75 and



ı of a well 35ft., then $4·75^2 \times 35 \times ·7854 =$
the number of cubic feet, and the number of
ds will be this divided by 27, or 22·97. "To
1," &c., means that if the square of the
be 1, the area of the circle will be repre-
the same scale by ·7854.—W. G. P.

]—**American Dried Apples.**—Here in
especially in the country, most families
store of dried apple slices (apfelschnitte)
inter. Any apples, those that fall or are
wn, are peeled, any bruised or grubby spots
then cut into slices and strung on a thread
a thick needle. This festoon is hung in
or in wet weather on the kitchen ceiling
Mushrooms are done in the same way, and
hashes, stews, &c., impart a most ex-
vour. Pears may be treated in the same
apples. Bilberries and plums are also
se require daily turning.—N. SIRCH.

[32932.]—**Birdlime.**—Boil linseed oil in an earthen vessel, when it has come to a boil keep it on a slow fire, just simmering. This is a work of some hours. Have ready a clean piece of pipe-stem, dip it in now and then, and let drop upon a cold flag-stone. As it cools put it between your finger and thumb, and go on until you find it sticky enough. When cold add about one-eighth of Stockholm tar, and you will have a birdlime that will draw the hair off your head.—JACK THORP.

[32933.]—**Legal Question—Tithes.**—By the statute 24th Vic., cap. 93, sec. 29, a penalty of 2s. 6d. is imposed in all cases where the amount of rent-charge due is not paid at the time and place appointed for the same. It is further enacted that the above penalty shall be deemed and be taken to be a part of the rent-charge which is in arrear and unpaid, and shall be recoverable by distress in like manner as the said arrears of rent-charge are recoverable.—HUGO DONELLUS.

[32934.]—**B. Sc. London.**—I am sorry you are not so near the B. Sc. as you seem to think, and as I imagine the correspondent has not yet left school I will not blame him. I must tell him, however, that he must be well grounded in the following subjects:—Latin, Greek, French or German, English language and history, modern geography, mathematics, natural philosophy and chemistry. After he has passed his matriculation in these subjects he will have to pass the 1st and 2nd B. Sc. examination, which consist of pure mathematics, such as arithmetic, algebra, geometry, and trigonometry, mixed mathematics, inorganic chemistry, experimental physics, biology, with the addition, for the 2nd B. Sc., of the differential calculus, integral calculus, astronomy, organic chemistry, botany, zoology, animal physiology, physical geography, geology, logic, and psychology, the examination for the 2nd B. Sc. lasting through three weeks. I am afraid W. H. Escott has not a sufficient amount of knowledge derived from "Pinnock's Catechism" to cover all these subjects. I have written so much so that other aspirants may know what they will have to learn before presenting themselves, but as other men have passed before them, there is hope that any one with energy and determination may obtain the B. Sc. so coveted by some.—W. J. LANCASTER.

[32934.]—**London B. Sc.**—While thanking "Owen's College" and "R. S." for their kind answers to my query, I beg to say that the idea of "cram" never entered my head. I might state that I have always been fond of science, and have read such works as Joyce's "Scientific Dialogues," "Evenings at Home," Bakewell's "Geology"—a fine old work on chemistry published by Hodgson (1812), with no name of author, &c.; and the knowledge thus acquired I have supplemented and tested by learning up so as to be able to answer—even dodging—the questions in the catechisms referred to in my query, which catechisms perhaps neither "Owen's College" nor "R. S." have ever seen, for I am assured that they have been out of print for many years, and the copies I have have been in the possession of my family full forty years. Such being my case, I considered I might without presumption try to obtain the honour of putting the letters B. Sc. after my name, and that it would be enough that I possessed the knowledge—no matter how I acquired it—and that the certainty of my being possessed of the knowledge could be settled at one examination. "Owen's College's" suggestion that I should go out to Australia to graduate, so as to be able to escape the previous examinations, would be not only troublesome, but, to me, expensive and impossible. Surely some of your numerous readers can see the position in which I am placed, and direct me how to proceed. What can make the knowledge of three languages besides English necessary? The only language I know besides my own is a little Welsh; but I am afraid that is not one of the languages required.—W. H. ESCOTT.

[32934.]—**B. Sc. London.**—Mr. Escott seems to have a very dim idea of the examination for the degree of B. Sc. London. Three examinations are necessary—viz.: 1st, the matriculation; 2nd, the 1st B. Sc.; and, 3rd, the 2nd B. Sc. If he really wishes to obtain this degree, he should begin to study at once for matriculation, and in about three years he may, if uniformly successful, obtain it. Mr. Escott must be joking when he says he has been through "Pinnock's Science Catechisms," as, from my knowledge of them, they might fitly be studied in an infants' school.—B. SC. LONDON.

[32936.]—**Bicycle Construction.**—To reply fully to "Phœnix" (No. 686, p. 251) would be a rather long matter. I will do so as well as I can without occupying too much space. No. 1. Charcoal iron spokes are preferable to steel ones as a general rule, because they are tougher—unless the steel is specially prepared it soon snaps off at the thread. No. 2 is partly answered by No. 1; ordinary steel can be headed cold, but it would be advisable to soften it. No. 3. These would be received of the necessary shape, and would not require tempering because the steel of which backbones, &c., are made is of a low quality and will not readily harden. No. 4. Thickness of bush, $\frac{1}{16}$th of an inch. Why not case-harden the spindle? as vide my letter on p. 144 (let. 14239, No. 682). No. 5. 1in. rims can be procured easily. No. 6. This would depend on the pocket of the amateur. A good lathe would cost £20 and upwards, would require to be 6in. centre to take the cranks. Also a forge would be required. Altogether not less than £100 would fit up anything worthy to be called a workshop for bicycle-making, and then as trade developed other machines would be required. If "Phœnix" is anything of a practical man and has a knowledge of tools he can easily estimate his outlay. If he wants to make a machine for himself and has not all appliances he will never satisfy himself. I know from personal experience. The only case in which I should advise an amateur to put a machine together for himself would be something after the fashion of "Pound a Week," whom I am answering in this issue. A bicycle can now be bought for £5 or £6 up to £25, and no amateur can make one for less than £6 to £7. They can be made in quantities for a much cheaper rate, because quantities pay.—F. L. STRIFFLER.

[32945.]—**Reducing Aperture of Quarter-inch O.G.**—You cannot satisfactorily reduce the angle of the ¼in. Better leave it alone, and purchase a ¼ of, say, 60 to 70. You will not, however, be able to see the whole of a water flea in absolute focus at the same time. About the best thing you can have is an ordinary ¼in. French triplet. With this you will obtain good penetration, and at a low price—about 17s. 6d.—have a set of lenses making seven different powers.—W. J. LANCASTER.

[32946.]—**Telescope.**—Your query is vague. You say you have made an eyepiece out of two lenses, and then ask what "lenses to get." Now, the two lenses you have should be ½in. apart, with a small diaphragm in the focus of eye-lens, and 3-16in. diameter. The object-glass should be one of Wray's 2¼in., costing you £2. You can make the black by mixing best vegetable black with French polish, then brushing it on to the telescope or inside, and allowing to dry.—W. J. LANCASTER.

[32948.]—**Preserving Caterpillars.**—At the late Exhibition of Entomological Specimens at the Westminster Aquarium a certain lord exhibited a collection—"a life history"—of butterflies. The caterpillars were prepared by the nobleman on a system of his own. An application for advice would meet with a courteous answer. The address is obtainable at the Westminster Aquarium. The specimens were absolutely life-like.—N. SIRCH.

[32952.]—**Photographic.**—The varnish is too poor in gum. If you have a lot of it, put about 1oz. of bleached lac to each pint, and a small piece of camphor: shake well for a week, and decant clear liquid. Heat well after varnishing.—W. J. LANCASTER.

[32955.]—**Moths.**—Various queries will be best answered by studying a little book which has been a great help to me: "On the Collection and Preservation of Objects of Natural History."—N. SIRCH.

[32955.]—**Moths.**—There are so many varieties of moths—and the methods of capture necessarily vary—that I should recommend "X. Y. Z.," if he wishes to make a collection, to obtain either Knagg's "Lepidopterist's Guide" or Greene's "Insect-Hunter's Companion"—both inexpensive books, published by Van Voorst, Paternoster-row, and replete with every information and instruction as to the collection of butterflies and moths. There is also a shilling book, entitled, "Common British Moths," published, I believe, by Routledge and Co., which has illustrations and descriptions of the most common sorts likely to be obtained by a collector during his first year; but the most perfect work on the subject is Newman's "British Moths," price £1, published by Tweedie, 337, Strand, which has splendid engravings and descriptions of over 700 species.—CHARLES WHALEY.

[32955.]—**Moths.**—The best, and, indeed, only way of catching night-flying moths (Noctuæ) is by "sugaring"—that is, making a paste of sugar and beer, with the addition of a little rum, and painting it on trees, fences, &c. The "sugar" should be laid on at dusk on still evenings, and visited at frequent intervals. But "X. Y. Z." must not despair if unsuccessful at his first attempt, as he may one evening return home with an "empty bag," while on another he will find his sweets have literally attracted swarms of moths. As there are above 300 species of British Noctuæ, and, probably, nearly half are more or less common, a list of these would be rather long; but, perhaps, specimens of the most abundant might be mentioned: X. Polyodon (Dark Arches), M. Brassicæ (The Cabbage), T. Pronuba (Yellow Underwing), N. Xanthographa (The Rustic), &c. The best way of naming captures is by comparing them with the specimens in a museum collection, should there be one in the neighbourhood. If not, doubtless some more experienced entomologist would give the requisite information, or grant the use of his cabinet. But, should neither of the above be accessible, one of the more recently published works on "British Butterflies and Moths" would be found sufficient for naming all captures.—INQUISITIVE.

[32956.]—**Highest Power for Object-Glass.**—If "A Poor Student's" O.-G. is a good one, it will, under favourable circumstances, carry powers up to 275—that is to say, 100 to the inch, 100 × 2¾ = 275. For general lunar work 120 or 130 would be the most serviceable. Higher powers are sometimes useful for more closely examining some objects when definition is fine. The cost of the eyepiece would be from 10s. 6d. to 15s. With regard to the star maps, I am rather afraid our Editor would scarcely care to spare the space. I find the "People's Atlas of the Stars," published at 1s., by Gall and Inglis, an invaluable assistance when looking for comets.

nebulæ, Uranus, &c., by marking down their places on the map, and then comparing it with the heavens. If "our" querist will glance at Regulus, and carry his eye a little (about a quarter of the distance between Regulus and γ Leonis) way to the west of it, he will find find two nearly equal stars, small, of 5th mag. The southern one is ν Leonis, but the other, situated at present a little N.W. of ν, is Uranus, which in a 2¼in. telescope scarcely presents a definable disc.—F. C. DENNETT.

[32956.]—**Highest Power for Object-Glass.**—For the moon, 150 will be the highest power you should use, unless the night is perfectly clear and calm. 250 would be useful on such a night for splitting doubles, &c., but will require clever manipulation to be of service. Of course I assume that your O.G. is a good one.—W. J. LANCASTER.

[32956.]—**Highest Power for Object-Glass.**—In reply to "A Poor Student," I may say that a 2¾in. object-glass must be of the very best quality to bear a power of 200 to 250 with good results. The maximum is generally considered to be 100 to the inch of diameter, and this only in very favourable states of the atmosphere. Much will depend on the steadiness of his stand, and whether it is equatorial or not. The cost of an eyepiece will vary according to the maker, but a good one will generally be from 15s. to 21s. If "A Poor Student" had looked at your front page he might have avoided occupying useful space with this question. Maps of the constellations were published in the ENGLISH MECHANIC some years ago by "F. R. A. S." "A Poor Student" should get Proctor's smaller or school atlas, price 5s.—A. WOOLSEY BLACKLOCK, M.D.

[32957.]—**Loco Notch.**—Notching a locomotive back is the most economical way of working an engine, as it does not require as much steam as it would if not worked expansively; and as steam is made by the means of fuel and water, consequently there is a great saving effected in both these items. It also enables drivers to attain a high speed and keep it at one uniform rate. Without this it would be impossible for them to do so, as their engines would not make steam fast enough for the consumption. A locomotive should never be notched back at the start, but the regulator should be gradually opened until it is full open, and the train has attained a fair rate of speed, when the reversing lever should be pulled back gently a notch or two at a time until it reaches the notch next the centre of the sector.—C. J. BONSER.

[32957.]—**Loco. Notch.**—You ask if there is any good done by notching up a locomotive. Certainly there is: it works the steam expansively, and also reduces the blast on the fire that would soon knock it all out of the box if she was not notched up. Give her a fair start, then pull her up two or three at a time till you have the lever in No. 1, 2, or 3, according to the gradient and the train you have on.—M.R. FIREMAN.

[32958.]—**Weak Part of Cylinder.**—If the steam passages, &c., permit, a thin iron or steel band might be placed round the cylinder so as to cover the weak part, and tightened thereto by a bolt passed through lugs on the divided ends of the band at the opposite side of the cylinder; or the ends of the band might be formed with bolts or studs passing through a cross-bar tightened by nuts against any available flat surface at the opposite side of the cylinder. A patch would be of no use.—EDWARD W. FURRELL.

[32982.]—**Sleeping on the Back.**—If "Bachelor" will procure an old cotton thread spool (the penny size will do) and through the central hole pass a piece of tape about a yard long, and tie the same firmly but not too tightly round his body, placing the spool exactly over his spine, he will find it somewhat difficult to *sleep* on his back. He might attach the spool to the middle of some soft kind of belt. The bed he sleeps on should be a hard one.—J. FRASER, Doncaster.

[32985.]—**Canoes and Canoeing.**—All cruising paddles are made to divide at about 6in. from the middle. The ends are then fitted with ferrules similar to those used on fishing-rods. A well-made brass ferrule is better than a screw, as the blades may be turned at any angle. They are very often used at right angles to each other; but care is required in light canoes, as a false stroke may be made at any time. By fitting a stump into the longer half it may be used in a crutch on the right hand to steer with when under sail.—E. H. JONES.

[32985.]—**Canoes and Canoeing.**—I had a paddle which was jointed in the middle with a ferrule, like a fishing-rod. The blades must be put at right angles to each other. Of course the paddle will be slightly heavier owing to the brass joint having to be made very strong.—JEPEPY.

32992.]—**Gold Leaf.**—Lay a sheet of writing paper on glass and rub it all over with beeswax. It will then, if pressed on the gold, sufficiently adhere to allow its being cut into strips; but for white paper I should imagine bronze powder would answer equally well, and would be much cheaper and easier of manipulation. The best way to letter paper for gilding, either with leaf or powder, is from type, and the best ink is prepared from linseed oil boiled down to a consistency of treacle, with perhaps a suspicion of resin in it to give it body and "tack." If powder is used it should be dusted on with cotton wool; if leaf, it should be allowed a few hours to set before being rubbed off with a wool pad, otherwise the edges are not nice and sharp.—W. H. DAVIES.

[32993.]—**Musical Box.**—The cause of this jarring, which is the bête noir of musical boxes, is the re-action of the tongue against the barrel pin. The evil is partially and sometimes successfully avoided by fixing springs under the tongues. "Discord" will probably notice that the jar is worse in slow tunes and in the lower notes. Supposing the contact springs are properly adjusted, the only possible remedy would be to increase the distance slightly between the comb and barrel; for this purpose the screw holes in the former are generally made a little oval, or if not, can easily be filed without injury.—W. H. DAVIES.

[32994.]—**£5 Telescope.**—Let "Telescope Tele" just look at the lenses of his day eyepiece; I rather fancy they want a good cleaning. The places for the diaphragms depend on the size of the hole in them. They should be placed so that an eye placed at the focus of the O.-G. can see the whole of that lens, but none of its surroundings.—F. C. DENNETT.

[32998.]—**Phonograph.**—There can be no doubt that the tinfoil used by Mr. S. Newton is too thin. This will account both for his failure to produce any sound, and also for the difficulty in mounting the tinfoil on the cylinder. A square foot ought to weigh about an ounce. If a single diaphragm is used the point should not be fixed directly upon it, but to a steel spring, one end of which is fixed below the diaphragm and the other, that which carries the point, made to press against the centre of the diaphragm. Between the spring and the diaphragm there should be a small pad of indiarubber. But I strongly recommend Mr. Newton to add a second diaphragm for the reproduction of sounds. Full directions will be found on page 157 of this Vol.—SHELFORD BIDWELL.

[32999.]—**Curious Apparatus or Chemical Toy.**—The reason why the red liquid moves in jerks up the tube is that the liquid is in a partial vacuum. Therefore, when the hand is applied to the bulb, the warmth of it, heating the air outside the bulb, forces the red liquid up the tube, where it remains as long as the hand is kept there. The red liquid is alcohol, coloured with cochineal.—HOSNIKOS.

[32999.]—**Curious Apparatus or Chemical Toy.**—This is what is known as a pulse-glass; the tube contains the liquid, but no air. It is boiling by the heat imparted by the hand holding it when it bubbles up. Very little heat is required to boil a liquid in vacuo.—F. C. D.

[33006.]—**French Polishing Violin.**—I have seen dozens of violins French-polished in my time, and their beautiful appearance and improved tone have been much admired. The violin should be well scraped and polished by a practical man. The only objection I can see is that it gives an appearance of newness to the instrument, which some old players dislike to see.—JNO. LITTLE.

[33006.]—**French Polishing Violins.**—I like polish, and think it best, and more durable and clean. A lot has been written about the resonant virtues of varnish. I only acknowledge its capacity for keeping the wood dry, and thus rendering it more vibratory. If your violin has been varnished already I should clean it and polish over the varnish, not removing any of the old.—FIDDLER.

[33007.]—**Violins.**—I am not competent to inform you which is the best maker of those you have mentioned; and, really, there are so many makers and old fiddles that I doubt if any one is acquainted with all. I think it bootless to inquire, because there are so many good copies. As far as tone is concerned, by simply removing the sound-post, a "Strad" becomes worthless—a toy fiddle would beat it. I have never read a treatise on the varying effects of different positions of the sound-post in a violin. But, depend upon it, it's most important to get the right place for this "Here Stands a Post."—FIDDLER.

[33016.]—**Nickel.**—Will "Fritz" please to say in what back number Mr. Sprague says that platinum decomposes the solution of ammonio-sulphate of nickel? The simplest mode of preparing the solution is to dissolve the crude metal in sulphuric acid, then add a little nitric acid, and heat to peroxidise any iron present. On addition of a sufficient quantity of sulphate of ammonia the double salt will crystallise out.—SIGMA.

[33017.]—**Tuning the Violin.**—Get an "A" tuning fork, not the Philharmonic, but old or lower pitch; tune your second string to this tone. You are aware that by stopping the string with the first finger a tone higher is produced; and so again with the second and the third stopping two more higher tones are got. Now, when the fourth finger stops the "A" string "E" is found, which is a fifth tone higher than the open string, and is the sound for the first string. But, as you cannot place the fourth finger properly, just lay the finger lightly on the string, then bow, and the harmonic E will guide you. The third finger stops D, and this is the tone for the third string (the thickest of the uncovered gut strings), only an octave lower; now place the fourth finger harmonically, as above directed, only on the third, "D," string, and compare with the second "A." You have now three strings tuned. Proceed with the fourth, or silver string, as recommended for the third, and you will do. After this place the third finger on the E string, and find upper "A" to agree with open "A" string; then place third finger on "A," and find "D" to agree with open "D" string, then do the same for the last string "G." Understand that the fourth finger placed lightly on a string produces an harmonic fifth, which should agree with the open string next above it. All this, however, is nothing like a good taught ear, which comes in time.—FIDDLER.

[23017.]—**Tuning the Violin.**—For a beginner it would be better first to tune the strings by any instrument with a fixed scale, otherwise he might find himself tuning 4ths instead of 5ths, the resemblance being sufficiently near to mislead him. The strings being thus brought to pitch, the discord pulsations can be distinctly heard; these will gradually decrease as the perfect interval is approached. A very little practice will ensure proficiency; but as to any mathematical rule being given to hasten this result I am afraid the reverse would be the case. If "Tyro," however, thinks differently he has only to run his eye down a few of the columns of the late admirable letters on "Mathematics of Music," &c., to convince him of a few of the simplicities of the theory, and even if it does not make him wish he never had been born it will probably make him content, at least for the present, with the practical part alone. With regard to cultivating the power of "appreciating nice distinctions in musical sound," this must be a work of time and application alone, even supposing the "organ of tune" exists. If it does not, the time spent in learning to play the violin, if not exactly wasted, will not produce any valuable results, as many would-be fiddlers, including the present writer, have found to their cost.—W. H. DAVIES.

UNANSWERED QUERIES.

The numbers and titles of queries which remain unanswered for five weeks are inserted in this list, and if still unanswered are repeated four weeks afterwards. We trust our readers will look over the list, and send what information they can for the benefit of their fellow-contributors.

Since our last "Telescope Tele" has answered 3336 D. Fernie, 32386.

32406. Twist, p. 48.
32409. Yacht Boiler, 48.
32411. Telephone.—To "Cob," 48.
32412. Windmills, 48.
32425. Balance Wheels, 48.
32430. Dog Skins, 48.
32434. Large Telescopes, 48.
32436. Angularity of Connecting Rod, 48.
32440. Blacking Cane, 48.
32445. Induction Coil.—To "Sirius," 48.
32450. The Organ, 48.
32452. Electric Bell, 48.
32458. Lunar Photographs.—To "A. A. C.," 48.

32672. Cornish Double Beat Valves, p. 150.
32684. Reversion, 150.
33688. Cattle Spice, 150.
32692. Polishing Machine, 150.
32693. Chemical Reaction, 150.
32697. Camera Obscura, 150.
32698. Refrigerator, 150.
32699. Plain Turning, 150.
33700. Powerful Telephone, 150.
32701. Pony Bicycle, 150.
32702. Bicycle Improvements, 150.
32709. L.N.W.R. Engines, 150.
32712. Secondary Batteries, 151.
32713. Stables, 151.
32726. Scholarship, 151.
32727. Ochre, 151.
32730. Rolling Photos, 151.
32733. Railway Coaches (Metropolitan), 151.
32735. Petroleum for Attacking Ships, 151.

Brighton Aquarium.—A fine lot of octopods has just been added to the collection at the Brighton Aquarium. They were caught off Guernsey.

A Snail and Slug Guard.—Those who grow choice hardy plants in beds and on rockwork are often troubled with the depredations of slugs and snails, and especially in the case of deciduous plants, as these are liable to attack just when the young leaves are thrusting themselves through the soil. A cultivator of this class of plants has adopted the old plan of forming guards out of sheets of perforated zinc. These guards are cut of a size sufficient to surround a plant to the depth of 4in., and before placing the guard in position some fine cinder-ashes are spread on the surface of the soil round about the plant. Since this plan has been adopted not a single plant has been harmed; the slugs will not attempt to scale the zinc ramparts, and they do not appear to care to thrust themselves through the soil under its walls, the gritty particles of the ashes not being at all to their liking. As plates of perforated zinc are by no means expensive it follows that a number of guards can be had at a comparatively small cost. They should be used without any paint or colour being placed on the [illegible].—*Gardeners Chronicle.*

QUERIES.

l.]—**Bleaching Glue.**—How can the ordinary ommerce be made perfectly, or nearly, colourless, he same time perfectly insoluble and waterproof? ICTS.

2.]—**Hominy.**—Can any reader oblige me with wo simple receipts for the preparation of hominy? T.

3.]—**Barometer.**—Will some reader kindly in- e how to make the corrections for altitude and ture in the barometer—viz., correct to sea-level ace to 32° F.? I presume the altitude of the place known where the correction is to be made.—).

4.]—**Oil.**—I wish to separate the "palmitin" rom ty of animal oil so as to obtain the pure olein. I it may be done by cooling the oil to 32° F. and out the congealed fat. Can any of your readers the most suitable apparatus for preparing from ive to ten gallons at a time, or suggest a better than the above, and oblige—Colloid?

.]—**Electrical Induction.**—Answers to the g would be most thankfully received by the —1. Why is a thicker wire used for a magneto- machine than for the secondary of an induction . About what length of spark would a coil give of producing the electric light, and what size wire secondary would be necessary? 3. Why is the y coil wound in an elliptical form—i.e., thicker in dle and thinner at the ends? I should have just the opposite, the magnet, which induces the being strongest at its extremities. 4. What size uld be best for a coil to give a 1½ or 2in. spark, ld cotton-covered suffice?—W. B.

.]—**Heat Question.**—The following question i in the elementary paper on heat, Science and partment Examination: "I breathe through a ich dips to the bottom of a glass jar, taking care my breath before it enters the jar. When the jar with breath a lighted taper plunged into it is y extinguished. Explain the whole experiment." swer required is evident, but did the examiner erform the experiment? Expired air has added s that 4½ per cent. in volume of CO_2, and ordinary tains only four or five volumes CO_2 in 10,000. he addition of 4½ per cent. be sufficient to extin- lighted taper?—E. J. S.

7.]—**To "Incog."**—I have suffered with pain ar regions for 2½ years, aggravated by fatigue, but endent on it; bowels inclined to be constipated, nerally worse after stool. When first felt came on vere walking upon an empty stomach. Digestive much affected during the first six months. Pain come chronic, producing intense morbid mental on, depression, and hypochondriasis. Tried a of homœopathic treatment, medical electricity, a urse of valerian, hypophospate soda, and quinine, o other astringents and tonics under different ms. Results nil. Have never tried valerian and te of ammonia, but would like to, having known vo a near relative affected somewhat similarly. a prescription of gelseminum and lupulin be of ? General health and muscular strength good, n relieved generally while digestion is going on. course of cold hip baths, but pain came back as the circulation was restored. If "Incog" could I should be extremely grateful. Aged 30 years.—

3.]—**Siphon.**—Is it possible to siphon water out 1 40yds. deep? What is the longest depth a siphon rk at? What is the simplest and best way to get er out, as I want to get water out of a well 40yds. here I have a fall of 60yds. from top of well?—

.]—**Electrotyping in 15 and 18 Carat** —Can any reader give me a few particulars on the how the solutions are prepared, what battery and other arrangements are required, and oblige— .?

.]—**Nitrate of Copper.**—In our manufactory occasion to dissolve large quantities of copper in cid for the purpose of separating it from more metals, after which this nitrate of copper (which ry clean) is thrown away. Can any one tell me n purify and crystallise it, and to what use I can ?—R. N. C.

.]—**Piano.**—Will any correspondent kindly tell to begin to make a plain serviceable piano, or icate with me through the pages of this paper for fit of myself and others?—A. T. C.

.]—**Horse-shoe Stall.**—Will any of your ndents give me directions for erecting a stall for nmanageable horses, and an illustration of same, ge—Aamdal?

]—**Clockwork Mice.**—Will any reader tell o make the fur-like coat seen on clockwork mice?

]—**Staining Wood Sections.**—Can any tell me the modus operandi for the above? I ght in Hogg and Davies without avail.—A. T. J.

]—**Logarithms.**—Will any correspondent of ISH Mechanic kindly inform me how to find the opposite the following logarithms, which I find it's Mensuration?"

The log. of 30 = 1·4771213
" 5 = 0·6989700
" 27·18 is 1·4342495

e greatly obliged if any one will inform me how are found.—Arithmetical Ignoramus.

]—**Mensuration.**—A piece of board 24ft. long, e at one end and 24in. wide at the other end, of "ours" kindly inform me at what part of l must I take a transverse cut so as to divide it equal parts? Please give rule so that I may be ccceed with similar problems in future.—Omi-

]—**Clarionet.**—Would some reader kindly in- if the tone of the clarionet has been changed by is so as to alter the nasal sound produced by it, rendered more pleasing? Is the clarionet played piano like the flute?—Diatonic.

[33038.]—**Legal.**—Will "Sperans, Lincoln's-inn," or "B. H., Solr.," kindly reply to the following? 1. A widow has £1,200 in money. If she marry can she retain the money to her own separate use under the married women's property, or any other Act, without going to the expense of a deed of settlement? 2. If my stepfather (my mother's husband) leaves me by will £500 in houses and land, what legacy duty shall I have to pay?—Bod.

[33039.]—**Exaggeration of Power of Eye-pieces.**—If four inches be a "funny distance" for the components of Castor, what are we to say to the case where "an eyepiece engraved 70, magnified B" (page 247, reply to 32742)? Surely Browning's achromatic eyepiece B magnifying 144 cannot be meant?—G.

[33040.]—**Condensers.**—I have a lantern with 3½ condensers, a ½ plate lens. My transparencies are Hughes, of London, 3in. dia. The pictures are dim round the edge when I have a picture on the disc 6ft. dia. Would 4in. condensers be of any more service with a ½ plate lens?—Helme.

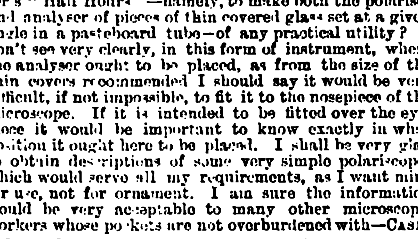
[33041.]—**Boiler.**—Would any of "ours" kindly inform me what would be the best style of boiler for slide-valve engine 1in × 2in. stroke, of what metal to make it, what would be the best means of heating same? Kindly give dimensions of boiler, thickness of plate, size of supply and waste pipes. I require it to drive a small lathe or watchmaker's turnbench.—Horizontal Slide.

[33042.]—**Polariscope.**—Would Mr. Lancaster, or other practical contributor, kindly give me detailed instructions for making a polariscope in the easiest and very cheapest manner? Is the method given in Lankester's "Half Hours"—namely, to make both the polariser and analyser of pieces of thin covered glass set at a given angle in a pasteboard tube—of any practical utility? I don't see very clearly, in this form of instrument, where the analyser ought to be placed, as from the size of the thin covers recommended I should say it would be very difficult, if not impossible, to fit it to the nosepiece of the microscope. If it is intended to be fitted over the eyepiece it would be important to know exactly in what position it ought here to be placed. I shall be very glad to obtain descriptions of some very simple polariscopes which would serve all my requirements, as I want mine for use, not for ornament. I am sure the information would be very acceptable to many other microscopic workers whose pockets are not overburdened with—Cash.

[33043.]—**L. C. and D. R. Engines.**—In the *Engineer* of May 17, under the head of "Locomotives at the Paris Exhibition," reference was made to two Chatham and Dover engines which were put on the line by the late Mr. Martley, "Flirt" and "Coquette," which have four coupled 7ft. driving wheels and 17in. × 24in. cylinders, and a four-wheel leading bogie. I have always been under the impression that the engines in question had driving wheels about 6ft. 6in. diameter, and cylinders 16in. × 22in. I should very much like to know which is correct. Will "H. L." give the height of centre line of boiler from rails of the new bogie express engines?—E. L. P.

[33044.]—**Parrots.**—I have a valuable grey parrot which of late has taken to pull out its down and young feathers, more particularly from its breast, neck, and thighs, and this to the extent of leaving these parts almost bare. The bird never touches meat nor bones, its food being canary seed, Indian corn, nuts, and dry toast. Formerly it was fed almost wholly with hemp seed, but has had none for the last two months. I have closely examined the cage for parasites using petroleum and turpentine. I found three or four rather large-sized lice, but not more. If any of your readers can help me in this matter I shall be greatly obliged.—C. O.

[33045.]—**Hydraulic for Blowing.**—Will some correspondent kindly oblige by telling me what two metals will work best together in water for valve of engine? I have a small one, of 1¼in. bore and 6in. stroke, but the valve (which is lignum-vitæ, working on brass) will only work when oiled, and then only for about ten minutes at a time, until, it seems, the oil is all gone—then it begins to stop, and will not go without being oiled again; in other respects it is satisfactory, having plenty of power and speed for what I want it for, and I feel confident it cannot be far wrong, as it worked well for a week when first tried. I send sketch of valve-box which is iron, hoping some one will help me. I have also tried a brass valve, but with the same result.—Try Again.



[33046.]—**Brown Head to Stout.**—Will Mr. Harris or any one who knows tell me how to produce a brown head to my stout? Mine always comes a white head like ale. I am told it requires soft water to produce it; if so, how can I soften my brewing water which is of 18 degrees permanent hardness by the soap test?—X. X. X.

[33047.]—**Chromatic O.G.**—I have an object-glass, astronomical, 2½in., which I bought for an achromatic, price 27s. 6d., in brass cell and cap. Its definition is bad—a bright star appears winged and "flashy" in it. Stopped down to 1in. it is much better though still imperfect. I am told it is French. There are two glasses. Would it pay to get it reground? What would be the cost? Who would do it? Any reply from "F.R.A.S.," or other competent correspondent, thankfully received.—Chromo.

[33048.]—**Microscopical.**—Not long since I purchased an expensive object-glass of high powers. I have nothing to complain of except that in a short time I found that numerous particles of the black composition which is applied to the interior of the brass-work of the object-glass had got on or between the lenses. I cannot remove these particles. The opticians here decline to clean the glass; I must send it to London, they say, to the makers, who will charge half a guinea for cleaning it. Now I should like to know (since the tube must, I suppose, be blackened) whether some composition cannot be devised for that purpose that shall not chip off in little opaque black particles, greatly obscuring and sometimes utterly spoiling the definition of a really first-rate object-glass?—Kaph.

[33049.]—**Boring Sticks.**—Can any of "ours" tell me how to bore sticks nine or ten inches long for pipe stems, and oblige—Cherry Stick?

[33050.]—**Centres of Circular Tracery Windows.**—Will any reader inform me how to obtain the centres for a circular face tracery window? Supposing we have the lines on the long face (or the one farthest from centre, from which the plan was struck), how are they to be obtained on the short one? Are they the same distance from each other, or do they converge to centre of plan also? Will some reader acquainted with the works of various men please recommend the best that will give information respecting circle upon circle, and circle upon rakes, handrailing, &c.?—G. Pillinger, Corsham.

[33051.]—**Carriage Mileage Indicators.**—Will any of your readers give me a description of the different ways in which carriage or bicycle mileage indicators are made?—Percy Leake.

[33052.]—**Flexible Composition.**—Can any reader inform me what are the ingredients of the composition of those flexible grotesque faces, dolls &c., which are sold by toy-dealers and sometimes fixed on bon-bons, and what is the proportion and mode of mixing same?—A New Subscriber.

[33053.]—**Colouring Water.**—Will some of "ours" kindly tell me how to colour water (chemically, or mechanically) a brigut red, that will not precipitate?—Kappa.

[33054.]—**Sulphuretted Hydrogen.**—Would any one be kind enough to tell me how sulphuretted hydrogen is prepared.—Kappa.

[33055.]—**Sticking Paper Labels to Cloth.**—I want to stick paper labels to cloth, alpaca, &c. Can any brother experimentalist inform me as to what preparation or adhesive matter will answer my purpose? I want first to spread it with brush, or in any convenient way on the paper, so that when cold and dry it is non-adhesive, but when the prepared paper is laid on the cloth and heat applied, it should cause them to adhere to each other, and as the cloth cools, the preparation should dry. What I really require is something that is rendered soluble by heat instead of liquid. I have tried several solutions of guttapercha and indiarubber without success. —Peardon.

[33056.]—**Telescope.**—I have come into possession of a 5in. diameter lens. It is 70in. focus, non-achromatic. I wish to show some young friends some celestial objects, and want to know the best I can get from it. What power can I use with the whole aperture—also with it stopped down to 3in. and 1½in. respectively? I would rather have low powers and decent definition than high ones. Using a meniscus lens of six-inch focus I can see a number of stars, and definition very good. Can I expect to separate any double stars?—Instructor.

[33057.]—**Henry Andrews, Almanack Maker, &c.**—I have in my possession an engraved portrait dated 17 8, of Henry Andrews, with a globe at his side. Underneath is printed the following:—"Henry Andrews, Astronomer—the celebrated author of Moore's Almanac." Will some reader kindly answer the following queries relating to the above? Where was Andrews born? Was there ever published a memoir of his life? Was Francis Moore a real personage, or only a pseudonym adopted by Andrews, the compiler of the "Almanac" (published by the Stationers' Company), from 1769 to 1818? Any information will oblige.—E. O. H.

[33058.]—**Boilers.**—Will some one inform me how the Galloway boilers are set up, and the different sizes of boilers, and number of horse-power, actual and nominal, and the size of the conical tubes they put in? I think they would be a very useful boiler for this country, as coal is very dear. Any other information respecting the Galloway boiler will be thankfully received.—Henry Gildart, 262, Colborn-street, London, Ontario, Canada.

[33059.]—**Phosphate of Alumina.**—Can any fellow-reader afford me information as to this mineral, where found, analysis, fusibility; and also its value and where obtainable if there are any English deposits?—F. W. S.

[33060.]—**Differential and Integral Calculus.**—As I am proposing to begin the study of those as soon as I am qualified for the task, I shall feel obliged to "Leibhold" or any of your mathematical correspondents, by helping me with the following queries: What branches of mathematics are indispensable before entering on those studies? Is "The Theory of Equations" by Todhunter necessary? What books are the best and most suitable for a self-taught student to begin with?—Anxious Enquirer.

[33061.]—**Legal Question.**—A Hard Case.—A paternal uncle, A, died nine years ago in Scotland, leaving a large manufacturing concern. He had a brother, B, with him as a partner. A left a settlement by which the real and personal estate was to go, by law, the same as if he had died intestate. I was in America at the time. About four months after A's death the solicitor for B, my surviving uncle (my father is dead many years, and I was estranged from the family for 21 years), wrote to me in America, saying that by law my deceased uncle A's property would be divided into four parts, B to get one part, I to get second part, the third and fourth part to be divided among the families of the deceased uncle's married sister's children. The letter also informed me that my surviving uncle, B, had the privilege by the settlement to purchase the interest of the legatees if he so pleased, the purchase money to be paid in five yearly instalments—the first in 12 months after the death of A. In a few weeks I got another letter, informing me that my legacy was gone, as my uncle B had to call a meeting of his creditors, and was about being sequestrated—that is, made a bankrupt—and that all correspondence should cease between us—that is B's lawyer and myself. I got a newspaper some time afterwards—that was in January, 1870—containing my uncle B's statement before the Bankruptcy Commissioners. The liabilities amounted to over £76,000, and odd, and the assets to £67,000 and odd, the difference being £9,800, the dividend being at the rate of a fraction under 17s. 6d. in the pound. I am informed that there was a settlement, and that the concern is now in a flourishing condition, and doing more business than ever. My uncle B did not find himself in difficulties until six months after his brother A's death, and I am informed that it was to prevent me from getting my share of the estate that my uncle B sequestrated. Would this prevent me from getting any legacy left me by law. The other legatees are living on the spot, and I live in a far distant part of the kingdom, not in Scotland, and I am a poor man, and have no means of ascertaining the facts of the case; and were it not for an old newspaper just found after eight years, I would not be now asking these questions. I suppose if the other legatees got any means or shares under the will, I am enentitled as well. I am informed that my uncle B is also dead, but not for certain. In the will or settlement my uncle A calls his property—the whole heritable and moveable, real and personal estate, &c., and he appoints trustees, his brother, B, and some nephews being of the number. The estate was not sold (as far as I know) to pay the creditors, so I presume there must have been some arrangement made by which the business was continued without B becoming bankrupt. If this was the case, could I get my legacy? Could I get my share under any circumstances?—A POOR NEPHEW.

[33062.]—**Zincography.**—Will Mr. A. M. Hope, or Mr. E. A. Nuth help me out of my difficulty with regard to above? I have followed, as near as possible, Mr. Hope's direction, as given in his letter 13392, No. 656, Vol. XXVI. but have failed to succeed. The inks, both writing and printing, I obtained from a lithographer, but I find that on rolling the printing ink on plate, it "took" in so many places besides the writing that the paper looks as if it had been rolled as well. What is the cause? I used olive oil to rub down the ink before using. Is that right, or what should be used instead? What proportion of nitric acid should be used for the damping of the tracing, and should it (the tracing) be submitted to pressure? Is it right for the writing to disappear from the plate when wiped with turpentine? Any other hints will be gladly received.—G. A. P.

[33063.]—**Flint or Crystal Glass.**—Will any reader oblige by informing us how to make flint or crystal glass, as tumblers &c., suitable for the table; of what materials and proportions, and how long it takes to vitrify and anneal it?—J. B.

[33064.]—**Oroide Gold.**—Will any one inform us how oroide gold (used for Albert chains &c.) is made? of what materials and in what proportions?—T. G.

[33065.]—**Indiarubber.**—I have a solid piece of pure indiarubber as taken from the caoutchouc plant. Will some correspondent kindly inform me how I can soften it so that I may be able to make it into a solid ball?—CLEMENT.

[33066.]—**Legal Question.**—A bequeaths his property in equal parts to his four nieces, daughters of B and C. A then by codicil revokes the bequest to the daughters of B, and bequeaths the whole in these general terms: "To the daughters of C, my nieces, whether they are alive or dead." Before the codicil was executed one married daughter of C died. Can her husband claim her share or does the legacy lapse?—NON LEX.

[33067.]—**Tuning Forks.**—Was Mr. Thunder, of Brighton, some 50 years ago, the inventor of tuning forks? If not, who was?—FIDDLER.

[33068.]—**The Microphone and the Violin.**—I do not know if Mr. Shelford Bidwell is a violinist, but whether or not, may I desire him to apply his carbon blocks to the back of a violin in the same manner as described on page 267, and kindly report results. Now if the microphone increases the audibility of the sounds that will be a practical result indeed.—FIDDLER.

[33069.]—**Cleaning Carpets.**—I do not remember any queries or answers about this. Please say first how to clean them when taken up, and how to clean them without taking them up.—FIDDLER.

[33070.]—**Protecting Iron from Nitric Acid.**—Would any correspondent be kind enough to let me know of a composition for covering iron to resist the action of nitric acid?—W. D.

[33071.]—**Cigarette Making.**—Any information on this subject and the machines employed would greatly oblige—TOBACCONIST.

[33072.]—**Tanning.**—How much oak bark should I put with 3lb. of terra-japonica for tanning?—J. LEWIS.

[33073.]—**House Agent's License.**—Many persons who have a knowledge of houses and assist their income by acting as house agents are uncertain how far they may go without rendering themselves liable to the license duty. It is generally supposed that letting furnished houses, and some say houses of £25 rent and upwards, renders the agent liable. Can a subscriber state what is the law?—R. M.

[33074.]—**Chemical Examination.**—Could any of your readers inform me if there is any examination in chemistry held for which I might offer myself, without passing the whole collegiate course, and which would give me a qualification for following analytical or manfacturing chemistry as a profession? Also whose manual would be best to perfect me in chemical calculation and practical quantitative analysis? I am fairly up in the natural sciences.—ZIRCONIUM.

[33075.]—**The Microphone.**—Have made a microphone as described by you, and find it acts perfectly, the touch of a single human hair being clearly heard; but for articulate sounds it requires a much heavier connecting piece of carbon. The battery power necessary for a moderate distance is very small, a half pint bichromate cell charged with plain water will do well, and, of course, this will remain in action a long time without attention. Prof. Hughes says that a Bell's telephone should be used with his microphone, but I find that a Bell's telephone is neither necessary nor desirable. A bar of soft iron wound with insulated wire and placed behind a diaphragm of iron gives a louder and clearer sound; most likely because the soft iron is more sensitive to galvanic currents than the steel magnet is. Will not this fact do away with the necessity for using Bell's patent telephone?—R. P. G.

[33076.]—**Length of Curve of Arch.**—Would some kind reader show how the following formula is obtained for the length of the curve of an arch whose span is a, and height h?

$$l = 2a\left(\frac{1}{2}\frac{a}{h} + \frac{h}{a}\right) \text{arc tg.} \left(2\frac{h}{a}\right)$$

As used in a recent article in *Engineering*.—CHESTER

[33077.]—**Zinc of Fuller Cell.**—Will Mr. Clare (see reply 32736) say what insulation he uses for the zinc of Fuller cell? I have been experimenting with this cell (as described by Preece in his text-book on telegraphy) for some months, and find nothing better than Chatterton's compound (cable insulator). At the present I am trying the marine glue as used in P.O. ten-cell batteries, and I fully expect that it will equal the compound. Paint, Brunswick black, and sealing wax varnish were chipping off in a month's very moderate use on electric bell. With exception of changing colour the compound stands well. I have heard that the L. and Y. R. Co. had this battery in use at a cabin, where it was necessary to put new solution in the cells every day, and often renew the zincs in consequence of the varnish cracking off. Perhaps this may induce others to give their experience.—P.O. TELEGRAPHIST.

[33078.]—**London Conservatoire of Music.**—Is this a private speculation, or what? It, of course, can have no connection with the Royal Academy of Music. I see that the Conservatoire has appointed a Mr. Wentworth L. Scott as its professor of chemistry. What need has a "conservatoire of music" of a professor of chemistry, and what are supposed to be his duties?—E. C.

[33079.]—**To Watch Jobbers.**—Will any watch jobber tell me of any plan to drill up a pinion (or staff) for a new pivot so as to make a good hole? The way I do at present is, when I have centred it, to put it in a centre of the Swiss turns, a pivot drill in the other, and hold and gradually push centre and pinion with one hand, and I find it a very difficult job to keep the pinion perfectly true. Also, is there any method of hardening the drill so that it will penetrate a hard pinion?—COUNTRY JOBBER.

[33080.]—**Loco. Slide Valve.**—Would any of our locomotive correspondents be kind enough to inform me as to the L. N. W. mode of setting the slide valves of their locomotives? Whether they are set to the lead or the cut-off, and to explain the manner of setting to the cut-off?—EDINA.

[33081.]—**How to Make a Photo Print in Five Minutes.**—Yes, I can do this with chromate of potash, and developing with nitrate of silver, but I can't fix the picture. I have left the prints for days in water, but these things of beauty won't stay with me. Will some who can fix them show me the way?—FIDDLER.

[33082.]—**Viewing Transit.**—Will Mr. Blacklock give a more explicit description of the way to make the arrangement for viewing a transit with common achromatic telescope and piece of card? I tried but failed.—CHARLES ROBINSON.

[33083.]—**Estimating Power of Falling Bodies.**—Will any reader give me the rule for estimating the power of falling bodies? Say the ram of a pile-driving machine weighs 2cwt. and falls freely a distance of 12ft., with what force will it strike the head of the pile?—R. JOHNSTON.

[33084.]—**Electroplating Extraordinary.**—In a recent number (I think January) of *Cassell's Family Magazine* mention is made of a new method of depositing metals by passing the spark of an induction coil through a piece of the metal, placed between two carbon electrodes, and allowing the vapour to deposit on the article required to be plated. Can any reader give any further information on the subject?—R. G. L.

[33085.]—**Bleaching Human Hair by Means of Peroxide of Hydrogen.**—How can I bleach human hair white by means of peroxide of hydrogen? Is ether or ammonia used with the peroxide of hydrogen? If so, I should be glad to know how to go about it?—W. D.

[33086.]—**Plate Glass Electric Machine.**—Will any one kindly assist me by giving instructions how to fasten the metal spindle into a plate-glass electrical machine? I have had a piece of plate-glass cut into a circle 13in. in diameter, and have bored a ¾in. hole in it myself, from instructions got from the ENGLISH MECHANIC, but cannot succeed in fastening the plate and spindle together sufficiently to prevent their coming loose when turning between the rubbers. I may say that the spindle on which the plate is mounted has a screw thread upon it, and I have hitherto tried to fasten it to the plate by a nut on each side screwed as tightly as possible against it, but often find when I begin to turn the handle all comes loose. Should the hole in plate, and the portion of spindle on which it rests, be square instead of round, as it is at present; or could the spindle be raised to the plate or connected by any other means?—W. WAIT.

[33087.]—**Making Pure HCl for Laboratory Use.**—What is the best method of purifying the NaCl as the first step in this process? Is it possible or advisable to heat the NaCl and H_2SO_4 in glass vessels strongly enough to liberate the theoretical quantity of HCl and leave Na_2SO_4 instead of $NaHSO_4$? Water absorbs 480 times its volume of HCl, or one pint absorbs 60 gallons or 6,820 grains. Will it absorb so much (and, if not, how much) by letting the gas stream through it till no more is absorbed?—DAGHBERT.

[33088.]—**Link Motion.**—Would any reader kindly favour me by stating which is the best book on link motion so that any one could get out the size of link, &c.?—ARTHUR ALFRED.

The Largest Circulation of any Professional Journal in the Kingdom renders the BUILDING NEWS the best medium for all advertisers of Building Materials, Artistic requirements, and Contractors' Machinery, and for all those seeking situations as workmen. The number and excellence of its illustrations render it the unrivalled representative of the progress of modern art, and the most complete record of ancient examples. Among its contributors are the leading architects and art critics of the day, and no trouble or expense is spared to make it the most accurate and comprehensive guide to all information connected with the Arts of Construction and Design. Price Fourpence, of all booksellers and newsvendors. Post-free 4½d. Office: 31, Tavistock-street, Covent-garden, W.C.

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CHESS.

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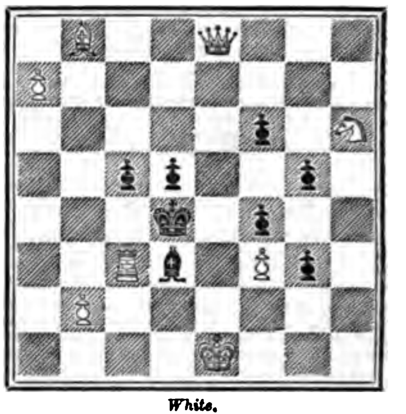
ALL Communications intended for this department must be addressed to J. PIERCE, Copthill House, Bedford.

PROBLEM CCCCXXVII.—BY A. F. S.

Black.



White.

White to play and mate in two moves.

SOLUTION TO 423.

White.	*Black.*
1. Q to Q 2.	1. Kt takes Kt (a).
2. Q to R 2 (ch).	2. Anything.
3. Mates.	
	(a) 1. K to K 3 (b).
2. Q to Q Kt 4.	2. Anything.
3. Mates.	
	(b) 1. Aught else.
2. Q to K sq.	2. K moves.
3. Q mates.	

SOLUTION TO 424.

1. Q to Q R 3.	1. R to Q Kt sq, Q B sq, or to K sq.
2. Q to Q Kt 2, Q B 3 or K B 3.	2. Anything.
3. Q or P mates accordingly.	

NOTICES TO CORRESPONDENTS.

ARCANUM.—In your solution to 424 you have overlooked that if 1. $\frac{\text{Q to R 5}}{\text{R to Kt sq}}$. 2. $\frac{\text{Q to Q 8}}{\text{R checks}}$.

NITRAM.—Your solution to 422 is correct.

ANSWERS TO CORRESPONDENTS.

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*** *All communications should be addressed to the* EDITOR *of the* ENGLISH MECHANIC, 31, *Tavistock-street, Covent Garden, W.C.*

HINTS TO CORRESPONDENTS.

1. Write on one side of the paper only, and put drawings for illustrations on separate pieces of paper. 2. Put titles to queries, and when answering queries put the numbers as well as the titles of the queries to which the replies refer. 3. No charge is made for inserting letters, queries, or replies. 4. Commercial letters, or queries, or replies are not inserted. 5. No question asking for educational or scientific information is answered through the post. 6. Letters sent to correspondents, under cover to the Editor, are not forwarded; and the names of correspondents are not given to inquirers.

A Hint to Advertisers.

I was recommending your columns for advertising this morning to . . ., a great advertiser, and I told him (which is the truth) that I got more custom from my small advt. in the ENGLISH MECHANIC than from all the Liverpool papers put together.—Yours truly,

Liverpool, May 23, 1878. W. H. DAVIES.

The following are the initials, &c., of letters to hand up to Tuesday evening, May 28, and unacknowledged elsewhere:—

V. CORNISH.—R. E. Sprott.—Geo. Hope.—H. Bowman.—John Hick.—E. B. F.—W. Wilson.—L. L. D.—G. R.—Qaf.—Willesden.—C. Steward, M.A.—Amateur.—Roscoe.—John S., Sunderland.—A. A. Watkins.—Petro.—J. J. M.—R. Milne.—The Vicar of Colerne.—Fellow of the Institute of Actuaries.—F.R.A.S.—H. R. Herbert.—C. P., Bolton.—J. J. Lake.—J. W.—Ignoramus.—Old Sub.—R. J. Johnson.—Perfect Flat.—Henry Warry.—Leichner.—Bob.—Wiesendanger.—Cupola.—Tangent Amateur.—E. W. Furrell.—Alpha Beta.—L. J.—Brickwall.—W. R. S.—C. E.—Glatton.—Parsons.—Français.—Wilfred S. Boult.—H. F. R.—J. M. W., Manchester.—E. Sergeant.—Home-brewed.—Robert Wark.—Bernard McGuire.—F. E. C.—G. F. H.—T. E. J.—Macatrick.—J. N. D., Tuxford.—H. R. H.—J. Brockie.—G. Bell.—E. L. P.—Perdu.—Tudocca.—Thomas Ray.—J. W. B.—A Poor Student.—W. E.—Practical Wheeler.—Mildew.—Albert Smith.—Barker, Harris, and Co.—Harry King.—G. Grout.

J. H. S., R. T. P.—See indices to back vols.

J. H. and "Another One."—Your queries are advts.

N. SIRCH, Springs Branch Ince, F. R. Waite, H. B. F., Kappa, Q. E. D., Americus, and others have replied to queries already similarly answered.

BAREBACKED (The stirrup was probably introduced into England by the Saxons. It appears to have been unknown in Europe at any rate before the sixth century. The famous equestrian statues of classic art—those of Trajan and Antoninus, for instance—are destitute of stirrups, and Xenophon [illegible] makes no mention of them in his work on horsemanship and riding.)—R. T. SHIPTON. (Broseley has been for centuries one of the chief English seats of pipe manufacture, and there are

; English Mechanic
AND
ɪLD OF SCIENCE AND ART.

FRIDAY, JUNE 7, 1878.

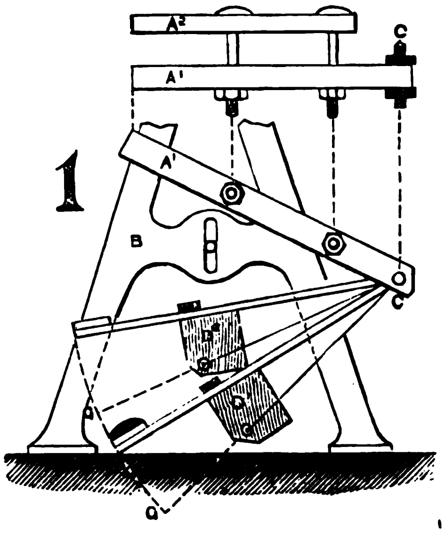
ARTICLES.

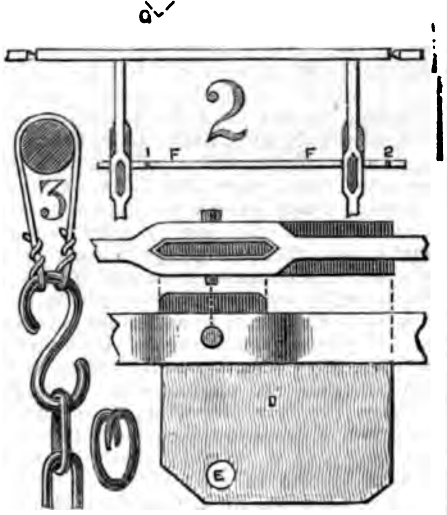
E FLYWHEEL AND TREADLE.

ɪPERIMENTAL ARRANGEMENTS.

equested by E. T. Scovell, in letter
4379, p. 270, I send sketch and ex-
on of the plan adopted for my own
nents, and trust that, although it
s may not supply a pattern that can
ɪtly copied in any particular case, it
et suggest some notion capable of
practical form. It will be seen that
not entail even the mark of a single
on any of the original fittings; and
her pair of centre screws are used
s ex-tempore fixture, a few minutes
ffice to knock out or replace the
fittings, and to hang it on the old
centres at pleasure. The great
age of this is that it puts an end to
vork and those delusive attractions
re so apt to hang about imagined
ements in mere experimental trials.
here be an automatic feed, the same
nd rate of cut can always be posi-
nsured with the same tool, and on
e work; and any imagined advan-
n be at once put to the test by
all else the same, and testing with
dle first in one position and then in
er.

l gives side elevation, and plan pro-
herefrom, of adjustable fixing for
of rocking-bar, C. This was
d by clamping to each standard
rt pieces of wood, A¹ and A², by
g bolts. In this way a little contri-
o suit any particular standard, may
e to give very wide range of adjust-
r the centres. One piece of wood,
t be long enough to carry the centre,
, of course, be put on either side of
ndard, as circumstances dictate;
er piece, A², need only be long
to furnish a clamp for the standard.
up the treadle, remove the pitmen,
the slots in treadle as mortices for
f strong wood, as shown at D¹ and
highest and lowest positions of the
oscillation in Fig. 1). An enlarged
this, in side elevation and plan, is
Fig. 2. These pieces of wood,
ored, as shown at E (or wherever it
desired for experiment), to take a
', as shown in Fig. 2. By shifting
dle to either side of its old position
n the slots were immediately under
ks) by means of the centre screws of
shaft, the rod, F F, will supply the
y pivot (as at 1 and 2 on F F) for the
re pitmen. These can be made
rt pieces of suitable chain, having
nd an S hook (or a split link, such
ed for mending cart chains, and
t side of chain in Fig. 3), to hook
ps made of strong brass wire (say
uge). One of these loops acts as
for the crank pin; while the other
n in Fig, 3), pivots (so to speak)
d, F F. If a little care be taken
each pair of loops for each pitman
e length, then each link of the
l supply a ready and simple way of
ening or shortening the ex-tempore
o suit any particular experiment.
e to Fig. 1 will show that the vir-
sequence of lowering the pivot to
E (in the piece of wood, D), is to
angular value, G C G, to the oscillation of the old straight treadle; although the floor would make it impossible to use the simple straight treadle in this way. Thus, in analysing or recording any results on paper, it is quite unnecessary to consider the floor at all, except so far as concerns the *lowest* point of the pivot of the pitman; and, in devising a permanent form of treadle after the best experimental results have been secured, it is only necessary to take care that the lines of the treadle cover the working centre, C, the pivot in the hole, E, and the end for footboard; or, as described in Fig. 3 in the paper on this subject, No. III., the line of treadle must cover R, P³, and D. In experimenting, the *feel* of the footboard under to the foot must not be judged of unless the footboard has been suitably packed, as suggested at the lowest point in Fig. 1 herewith. The *best-looking* form for treadle would undoubtedly be the arc of a circle sweeping through the three points just named.





Although the above arrangement is specially suitable for a case like my own, where the flywheel shaft is double-cranked, a very little contrivance would make the same system applicable to a single crank.

I would remind any one disposed to try the experiment, that its success depends on *two points*—the correct adjustment of the counterpoise, as explained in Fig. 2, in paper No. II. on this subject; and the best adjustment of the rocking centres for securing the best relations between crank, link, and treadle, for the down stroke, without making *any part* of the return lift sharper than 54° with the treadle. It may be well to say that the power of sustaining an even motion of the mandrel *under an extremely slow tread* is a far better test of the excellence of flywheel and treadle arrangement than the number of revolutions the wheel will make after the action of the foot has ceased.

I will only add that every day's practice since the alteration of my own treadle, convinces me more and more of its advantage in gain of power and comfort of tread. But in this case—as in so many others—it can only be a mere chance if any one succeeds who does not care to take the trouble of mastering the principles which the pattern is intended to carry out.

D. H. G.

THE STEAM ENGINE.*

If we agree with Mr. Rigg, that the older class of books dealing with the steam-engine are in many cases unreliable, we must, at least, acknowledge that within the past few years several works have been published that treat the subject exhaustively, both from a theoretical and practical point of view. It is unquestionably true, so far as our present knowledge enables us to form an opinion, that a steam-engine, scientifically designed and accurately constructed, may be defined as the best mechanical arrangement yet invented for the conversion of heat into work, and it may be, as Mr. Rigg suggests, that so far from having reached the limit of improvement, there is every justification for believing that ample scope still remains for further advances; but we are afraid that his practical treatise is scarcely the work required to assist in the further advances. To do the author justice, he does not put his work forward as one calculated to lead to a revolution in the modern practice of engineering, but, as its title implies, as a practical treatise for the use of makers and others interested in the construction of the steam-engine in its best form. Regarded in this light, it is one of the most useful treatises on the steam-engine published, and its well-printed and excellently illustrated pages will doubtless be frequently studied by designers and constructors. The volume is exclusively devoted to the consideration of the various forms of stationary or fixed engines; though some details, found valuable in locomotive and marine engineering, find an appropriate place in its pages. Mr. Rigg, indeed, has struck a happy mean between too much theory and too much practice, and has produced a work which, while attracting the engineer by its practical character, will compel him unconsciously to absorb just that amount of theory which will prevent him from wandering aimlessly in the wrong direction. The first chapter deals with units of measurement, and we have a reproduction of the old objections to the use of the metre, based on the fact that it is itself incorrect as a standard, as if the engineer ever troubled himself with the origin of his unit of measure. What is required is a unit which facilitates calculation and measuring, and it is immaterial whether it is called an inch or a metre, is or is not a true one-ten-millionth part of a quadrant of a certain meridian, so long as it can be easily verified and reproduced when desired. Mr. Rigg acknowledges that it is advantageous to use decimal divisions for some purposes of calculation, and considers that the existing duodecimal arrangement possesses many advantages for practical use. It is difficult to discover what advantages belong to the duodecimal system which do not also appertain to the decimal, but so long as practical men are contented to talk of a half and a 64th, three-quarters bare, and a quarter full, we can only hope for a better order of things when Sir Joseph Whitworth's measuring machines become more common in our engineering shops. It is a matter of very little importance whether the unit is an inch or a metre, so long as the accuracy which decimals do so much in practice to secure is attained. The second chapter is a brief account of what is meant by the terms matter, force, and motion, and contains a concise explanation of the term horse-power, which, so far as engineers are concerned, is known only as indicated and effective—nominal being a trade term meaning anything that the purchaser or seller likes. Mr. Rigg says it is a term giving an approximate idea of the diameter of an engine cylinder—an idea which would be much better conveyed by a definite statement in inches. He has taken the trouble to find out what it meant approximately as applied to small high-pressure engines as found in commerce, and arrived at an average of 10 circular inches for each nominal horse-power. Thus, a 10-in. cylinder is 10 nominal horse-power, a 12-in. 14 nominal horse-power—the real or effective horse-power depending on the speed of piston, the average pressure of steam, and, to a certain extent, on the character of the workmanship. The chapter concludes with an original method of calculating "centrifugal force," and then we are introduced to the practical part of the work by a description of the horizontal engine. Of this type r. Rigg says that it has had to encounter many prejudices which still cling to the minds of some engineers; but the long experience of its usefulness and durability, especially in the case of locomotives, ought at the present time to secure for it an unimpeachable good name. It must be remembered, however, that the horizontal type is the only one really adapted to the locomotive, and is, in that case, always well and carefully made, whereas its bad reputation has been earned by those varieties which have been treated simply as articles for sale. Mr. Rigg then describes in detail a 10-inch horizontal engine of good design, suitable for the wants of the average steam user, the drawings of the parts being on such a scale and so complete in themselves that a workman could easily construct an engine by their aid and the description supplied in the text. Several varieties of horizontal engines having been described, Mr. Rigg devotes a chapter to the cylinder, piston, and piston-rod, in which he describes the method of casting and the best mixture of metal for the purpose. In preparing the patterns for the cylinder many points have to be considered. There are the usual allowances for contraction and for turning off, and care must be taken to so distribute the metal as to obtain a sound casting when cool; but over and beyond these, the pressure of steam and the speed at which the engine is to work are points which the careful engineer studies in designing the cylinder. Into a consideration of all these details for all parts of an engine Mr. Rigg takes his readers—even the size and shape of a bolt receiving their share of attention. The slide-valve, an important portion of any steam-engine, and one that many makers, we are afraid, do not thoroughly understand, occupies a considerable number of pages, and is fully treated by Mr. Rigg in a theoretical and practical manner, the construction of various forms of slide-valve being shown in the plates. These chapters are full of information of much value to the engineer, for the slide-valve is one of the most important points to be considered in designing an engine, and the author goes very thoroughly into the practical part of the work, noting even such minor details as the following:—"A curious circumstance connected with slide-valves has been noticed—namely, that where both valve and cylinder are cast out of the same ladle, they wear together more satisfactorily than when dissimilar either in composition or hardness; and, as very little management is necessary to cast both valve and cylinder of the same kind of metal, so easy an improvement deserves general recognition in ordinary practice." But the old-fashioned unbalanced slide-valve must give place to the improved form—the Corliss—if nothing better is devised. Mr. Rigg gives the calculations in full by which it was found that the power required to move a slide-valve of the ordinary locomotive type was from one-fourth to one-third of the pressure exerted on the back of the valve by the steam. A consideration of that fact will lead to the conclusion that the face of the valve and its seat must be as smooth and true as possible, of the hardest metal, and be also kept well lubricated. The necessity for large surfaces becomes obvious from a consideration of the enormous pressures on, say, a locomotive slide-valve—not, of course, with a view to reduce the friction, but to expose sufficient area of metal to withstand the pressure and the rapid motion of the valve. Mr. Rigg gives illustrations of several forms of balanced valve, together with descriptions and the results of the experiments made to determine the power absorbed in moving the valve.

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* A Practical Treatise on the Steam-engine. By Arthur Rigg. London: E. and F. N. Spon.

An Elementary Treatise on Steam, and the Use o the I[illegible] By J. C. Graham, B.Sc., A.I.C.E. London: E. and F. N. Spon.

Passing over connecting-rods and crank-pins, fly-wheels, governors, condensers, and the other portions of a steam-engine, we reach the chapter in which Mr. Rigg describes the indicator, and explains the use of indicator diagrams. Here we have a number of engravings of good and bad diagrams accompanied by descriptive letterpress, explaining the cause of the wasteful use of steam and the manner in which a remedy was applied. Where Mr. Rigg confines himself to the practical part of the work he gives good advice, but when, in the few remarks he makes about the compound engine, he leaves practice for theory, he is an unsafe guide. If an engine runs at a slow speed, he tells us, and expands its steam to the full extent in one cylinder, then the rate of the expansion cannot be very high without causing great irregularities in the driving power—a sentence not remarkable for perspicacity, but the meaning of which is tolerably plain. In the compound engine such irregularities are retained within such limits as to be under the control of an ordinary fly-wheel. On the other hand, says Mr. Rigg (without indicating which hand went first), if steam is expanded in only one cylinder to any great extent, then a high speed is essential to modify the irregularities; and it would appear that economy will be sought in this direction rather than in a further development of the compound engine. On another page Mr. Rigg says, "it still remains to be seen whether an engine with a single cylinder, properly proportioned in all its parts, is not equal to the compound system in economy, as it is undoubtedly superior to that system in simplicity." On yet another page we find, "whether in constructing new engines the compound system is equally advantageous or not remains still a question in dispute among the most eminent engineers, and no conclusive experiments have ever been made to decide this important question upon its merits." All these sentences appear in a work in which we can find not a word about the liquefaction of steam and loss of heat in the cylinder, although we are told that "pure theory is apt to run to dangerous extremes unless restrained and governed by the sound dictates of practical expediency." There are two uses of the word "theory," common in English: the one is opposed to practice and the other is opposed to hypothesis: in which sense does Mr. Rigg use "pure theory?"—scarcely as opposed to practice, because all his practice is founded on theory. As a practical treatise for the use of the maker of engines, this work, with its 200 diagrams and its 96 lithographed plates, containing some hundreds of drawings, should find an appropriate place on the shelves of his library, but the student and the inventor will scarcely obtain much help from its pages in evolving the steam-engine of the future.

Happily, from the same publishers we have a work by Mr. J. C. Graham, which forms an excellent supplement to the practical treatise of Mr. Rigg, for in the "Elementary Treatise on Steam" we have not so much as a picture of an engine, although there is an illustration of an indicator and several diagrams. Mr. Graham's purpose is to provide those who are beginning their studies in connection with engines, with an account of the uses of the indicator card, accompanied by chapters on strains on the axle, on fuel, consumption of steam, and on gases and vapours. Under the head of fuel, however, the important questions of expansion, loss of heat in the cylinder, jacketing, superheating, &c., are well discussed, the author consulting, for that part of his book which treats of the steam-engine as a means of converting heat into work, the treatises of Regnault, Tyndall, Clerk-Maxwell, and others. His work is an excellent exposition of the theory, as Mr. Rigg's is of the practice, of steam engineering.

THE ORGAN: A COMPREHENSIVE TREATISE ON ITS MANUFACTURE, PROCURAL, AND LODGMENT.*

By John Watson Warman,
Associate of the College of Organists, London.

PART I.—GENERAL TREATMENT IN MANUFACTURE.

q. It is necessary to observe, however, that there are many cases in which the before-mentioned ratio is both exceeded and fallen short of. In the Organ, in the R.C. Cathedral of St. Mary, Newcastle-on-Tyne, the Reservoir occupies almost the entire base of the Instrument: such a magnitude is, however, unnecessary; and care should be exercised in all cases where it is desired to make the most of the funds at command, to keep the Reservoir—if really desirable—within reasonable limits, as demanding both *money* and *space*. In the Newcastle Organ there was no strict necessity for a Reservoir at all, none of the Soundboards being far from Base-line.

r. I have divided Reservoirs into *Intermediary* and *Auxiliary*; the first are those in which the whole of the wind supplied by a Bellows passes through the Reservoir; the second are those in which the Bellows has, in addition to the communication with the Reservoir, a Trunk which supplies some other portion of the Organ (as the Pedale or Pneumatic, or both) direct. Intermediaries are further divided into *Part* and *Whole*, the latter being when the whole of the wind used in the entire Organ first passes through the Reservoir.

s. Where an Organ possesses two Reservoirs, one may, if desired to save space to uttermost, be inside the other, the inner, of course, the heavier pressure (*see* also Design 7, i.): they will in no case have any communication with each other. This arrangement is never *recommended.*

t. One chief object with which Reservoirs are generally introduced into an Instrument (other offices will be gone into presently) is that of steadying the Blowing. It will be obvious that when the actual supply to the Windchest from the Reservoir is cut off from the Feed by Valves through which the wind from the Primary Feeding Reservoir is admitted, as it were, by driblets, that the effect of any jerk or unsteadiness imparted to the latter will be much weakened, if not altogether destroyed, before it ultimately reaches the Pipe; and thus it is undeniable that the presence of a Reservoir of this kind is in fact a safeguard against unsteady supply.

u. And if the task of blowing an Organ by manual labour were such as to demand much skill and practice before it could be properly performed, instead of being something which may be taught to and grasped thoroughly in three minutes by any ordinarily intelligent lad, there would be much to be said in favour of the use of the *Whole Intermediary* Reservoir: but facts being as they are, it will be obvious that in the vast majority of cases there is for them simply no practical need at all; and there are at this moment, scattered throughout the country, an enormous number of Organs, some of them of considerable size, without the slightest provision of this kind whatever. Among these may be selected at hap-hazard the Instruments in Quebec Cathedral (Bevington), Leominster Priory Church (Snetzler, believed), and St. Alban's Abbey (Hill): these are all three-Manual organs, the last having 38 Sounding-Stops, including 5 on the Pedale. Of two-Manual instruments, a good example is furnished by the Episcopal Church, Hoddesdon, Herts (Willis), 19 Sounding-Stops. The wind supply in the last two Instruments is simply perfect, with only average blowing; in the second named the want of Concussion-bellows occasions, at times, a slight tremulousness.

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At this point see 16, m.

v. It will thus, I think, be fully demonstrated that Reservoirs on the St. Mary's scale are not, in the ordinary course of things, necessary; and I must most strongly advise that in all cases, except where room and funds are really plentiful, to avoid them, except as will be presently be indicated: it must not be forgotten that even were Manual Blowing unreliable, there are at least two machine-motors to which, if of proper construction, unsteadiness of stroke is simply impossible. (*See* Gas and Hydraulic MOTORS, 16, y. and 18, t.)

w. One of the most marked instances of employment of an Intermediary Reservoir is furnished in an Organ lately erected by one who, although his name has not been before the public many years, seems to think himself already qualified for lecturing and laying down the law to the Organ-building profession at large. The Sounding size of this Instrument is only 32 Stops, so that on the score of volume it can lay no claim to special treatment; there are two Bellows, one to Pedale, and one to whole of Manual work; these (each having Horizontal Double-action Feeders) occupy the case wings; in the centre—taking up, in fact, the whole central space—is a Reservoir, with the usual Automatic Traps or Valves, and of sufficient size to supply the whole Manual work. There can be no question that in this particular case the presence of the Reservoir is *really unnecessary, indirectly unfair, comparatively defective*, and *possibly mischievous.*

x. It is really *unnecessary* because, as has been seen, perfect practical steadiness can with ease be obtained without it; but this is not all—if the object be steadiness, how is it that the Pedale is not made to participate? Are Pedale Organ blowists free from those weaknesses of humanity to which it is presumed Manual Organ operators are liable, or is the sudden draught upon the wind to be less feared when made by two large Pallets, each required to supply five heavy Pipes, than by the average demand of the comparatively light Stops of the Manuals? It will be said the Ped. was not included for fear of disturbing the Manual speech, but this has already been shown to be fallacious (*see* 12, q. to 13, a.), though, as is here seen, there are builders who have so far failed to realise that it is so. The fact is, staccato passages in a large Pedale do "drop," and consequently jar the Receiver very considerably unless Concussion-bellows be provided; but as these are, according to the printed critique, repudiated in this Instrument, a second Reservoir, became in it, if a necessity to Manual, undoubtedly to Pedale also. It must be borne in mind that all the Wind-trunks in this Organ are short, except one to half the Pedale.

y. It is indirectly *unfair* because it introduces an expensive appliance which does not add one iota to the real effectiveness of the Instrument. The supply of wind to an Organ is, as has been already gone into (*see* 4, r to w), in the square content of its *Feeder-surface*, and any talk of the superficial area of the *Reservoir* or *Receiver*, or of their cubical capacity, is in this view quite beside the mark, and rarely, indeed, indulged in by any really acquainted with the structure of the Instrument; hence such an Organ as the one of which we are speaking might have a Reservoir as wide as the entire Church, and yet, owing to the narrowness or shallowness of the Case-wings, be really short-winded.

z. (It must, of course, be understood that no *intentional* unfairness is here imputed to the builder—the Reservoir had to be paid for by him—only that, as profits are calculated on the percentage of sum total, it is necessary to point these matters out, for otherwise other makers may lie under the imputation of *cutting* in their contracts, or other meanness; or bad *construction.*)

[15. a.] It is comparatively *defective* because a Reservoir, however carefully adjusted, can never have the sensitiveness of the Concussion-bellows. Thus, suppose a heavy staccato chord put down in the Bass while the right hand holds on, the sudden demand will obviously cause a draught on the Chest; there being no Concussion-bellows to collapse and supply it, it is thrown upon the Reservoir, which is, of course, free to the Chest; the Reservoir consequently drops, and supposing it full, and the Valves all but closed (this will be *usually* the case, see 14, o), this dropping will necessarily open the Valves a little more, and the pressure be restored, but in the meantime the *jerk has taken place*, and the speech of the right-hand chord been disturbed; the counter-pressure cannot make itself felt in a moment, and it is just here that the Concussion-bellows is so valuable; properly poised and placed, and too light to possess appreciable *inertia* or *momentum*, it moves and compensates at the slightest jar. The Reservoir can never possess this extreme delicacy, and thus, though, as already said, a safeguard against careless blowing, it can only *mitigate* the draughts upon the Chest caused by the sudden putting down of a loud staccato chord.

b. It is possibly *mischievous* because it here takes up valuable room on the floor, and beneath and at back of the Claviers is the Touch-action. To get at this mechanism from within the Organ is a most imperative necessity; the want of such access converts, in numberless cases, the cost of a trifling repair from shillings into pounds: and wherever the requisite space is (as in this instance) procurable it should most unquestionably be left open, for even were the advantages of the Reservoir really palpable to a considerable extent they might easily, in many cases, be outweighed by this necessity of accessibility. In this Organ the presence of the Pedale Octave-coupler renders free access to the Pedale action, which is most interfered with by the Bellows, particularly essential.

c. It will, perhaps, be said that these disadvantages exist in all Reservoired Instruments, and that it is unfair to single out any particular one for strong criticism; this is true in the abstract, but there are here special reasons,—the position taken up by the builder of this Organ is positively amusing in its loftiness, and the Instrument itself has been the subject of eulogia of the most extravagant character. High pretensions and assertions demand a corresponding severity in examination; the vast majority of Organ purchasers know nothing whatever—at least structurally—about the Instruments they buy, and it is only just to Builders who are not quite such accomplished performers on the Trumpet that all claims of an exceptionally high character should be investigated with proportionate care.

It is difficult to find words of censure strong enough for those who, either through ignorance or rapacity, introduce into the Instrument an appliance of a costly and cumbering character, and such too, as in the present instance, displaces something of acknowledged necessity; and not content with this, vaunt (or allow to be vaunted) the contrivance as not only new and original, but as a matter of the highest importance, the truth being that it is one perfectly well known to the great majority of their fellow-builders, and omitted by them only from economical or conscientious reasons. The leaving out of the Concussion-bellows from the Organ in question was a grave and most unjustifiable error, whether the consequence of ignorance or conceit, and the assertion—made in a very elaborate criticism of it which appeared in a well-known mechanical journal—that the presence of the Reservoir here rendered the expedient unnecessary, is an unfounded and most flagrant departure from truth. And I have no hesitation in asserting that the wind-arrangement of this Instrument is clumsy, inartistic, and, in proportion to its cost, perhaps, the poorest in existence; it is based on a totally false assumption—viz., that the Manual wind *must* be kept separate from that of the Pedale; and it ignores one of the first principles of good apportionment—viz., that if there be more than one pressure the Pedale should have the benefit of both.

d. The foregoing is, remember, a *Part-Intermediary* Reservoir; it will be seen that the *whole* of the *wind* given by the Feeder in connection with the Reservoir passes through latter, and this constitutes it an Intermediary, but as the Pedale is excluded from the Reservoir the arrangement is not a *Whole-Intermediary.*

dd. A case in which the introduction of a Reservoir has done real mischief occurs in the Organ of St. James's, Norlands, London, as rebuilt by one claiming a good insight into things. Space being limited, the Supply-bellows were—to make room for the Reservoir—kept considerably under the amount I have named as a good minimum; and, Concussion-bellows being also omitted, the unsteadiness of the wind supply became soon apparent. It is necessary to say that room for the Instrument was most discreditably insufficient, and that it yet presents some most excellent features, and tells on the whole admirably; but it would have been far better (and cheaper to the builder)—all Soundboards being near Base-line—to have either been content with but one pressure, or have used a Combination-bellows (see 7, *f*); and the Concussion-bellows should, in any case, have been inserted.

The over-estimation of the importance of the Reservoir, the confounding of its functions with those of the Concussion-bellows, and the *ignorance* of the latter, are among the errors of construction committed by our French fellow-builders.

e. I now give five instances (the only ones so far as I am aware) in which the use of a Reservoir may be recommended as almost or quite necessary. It is to be distinctly understood that I am not saying one word against its employment as a complete Manual Intermediary (as in the Organ just treated of), where this can be done without occupying space otherwise required, and funds are sufficiently ample to admit of everything that can be proved of the least assistance; but Concussion-bellows must in no wise be dispensed with, for they fulfil a function which no Reservoir can be sufficiently sensitive to do thoroughly. It will be seen that the first three of these may come under the head of Auxiliaries.

f. The instances are as follows: (1) for saving in Trunking. (2) In some cases where space is limited, or of peculiar and inconvenient form. (3) In Instruments where the number of distinct pressures desired exceeds the number of distinct Bellows required. (4) In some cases for purpose of obtaining uniformity of pressure in the Supply. (5) When the distance from Bellows (Receiver) to its Soundboard is excessive.

g. No. 1 will only be likely to occur in large Organs. Suppose, for instance, that a Swell placed at some distance from its Bellows were desired to have its Reed-Bass and Mixture-Bass parted off in a lighter pressure (*see* INSTANCES, 10 y, No. 11 *a*), the main Trunk would pass from the supply Bellows in the usual way, the latter being large enough to supply the Full Swell; but *near*, or even in some cases even *inside* the Box would be a Reservoir of sufficient size to supply the said Bass, weighted of course the correct lightness desired, and communicating both with the main Trunk and with the Bass to be supplied. The proper Traps or Valves being provided, the Reservoir will obviously furnish its proper portion in the usual way, the remainder of the Swell being fed direct from the parent Bellows. The whole of the second Trunking from supply Bellows to Reservoir is thus saved.

(To be continued.)

BEE MANAGEMENT.

Section II.

(*Continued from page* 210.)

The Cheshire Hive.

THIS hive is a most serviceable and convenient one, and as it may be taken as a type of the improved form of the bar-frame hive, I shall describe it in detail, availing myself, at the same time, of the capital illustrations, which, by the courtesy of the publisher, I have been able to take direct from Mr. Cheshire's valuable work.

The hive, of which a perspective and a sectional drawing are given in Figs. 1 and 2, consists of a wooden double-sided box, 14½in. from back to front, 8¾in. deep inside measure, and of a length to suit the number of frames required, which is merely dependent upon the size of hive found best for a district. A glance at Fig. 2 will explain the construction of the body, the black portion representing the dead air space between the boards which compose the sides and ends; the boards are kept apart by a strip 1in. square, running round the top and bottom of the body. On to this body four legs, well splayed, are fastened, and between the legs the broad strip B is nailed round the back and ends. At each end two runners are nailed, on which the floor-board is slid in and out, and by the insertion of a couple of wedges between the floor-board and the runners, the board is pressed tightly and securely into its place in a moment. When the floor board is slid back into its place the front projects 2½in. so as to form a flight board. The central 10in. is grooved as shown, so as to give the bees a dry path, even during rain. The door, which has slides to admit of its being contracted at pleasure, is 10in. long and ½in. high, but the shutters (C C, Fig. 1) will instantly reduce it to ½in. long only. A couple of small studs prevent the actual closing of the door; but, should there be a necessity for such a stoppage, the slides are withdrawn, and the left put to the right, and vice versâ, when the studs coming outside are not in the way. The porch projects 3in., and has a gutter in front to catch and convey away all drip to the two ends of the board.

We now come to the internal arrangements of the hive which the section almost explains itself. The inner skin, back and front, of the hive does not come within an inch of the level of the outer skin, but a strip of zinc, 1in. wide, is nailed inside so as to project ⅜in. above the former (see Fig. 2), and on this strip the ears of the frames rest. The crown-board does not rest upon the bars, and the ¼in. space between should be filled with some material to allow of ventilation, and keep the bees from the crown board, as already explained in the Woodbury paper. The bars are kept in position by the insertion of a panel pin at the side of each top bar, as shown at Fig. 3, an arrangement far preferable to the Woodbury notches, but not so satisfactory as the "wide-shouldered frames," in my opinion. The frames are "Woodbury size," and in the ordinary hive are 11 in number, but, of course, may be increased or decreased as opinions differ. We now come to the consideration of a most important part of the bar-frame hive in its improved form, which has been christened "the dummy." It merely consists of a bar, to which a piece of board is fastened of such a size as will just slide easily into the hive, and so, by its position, either divide the hive into two portions, or, by being placed close to the hive side, admit, by its removal of the required play among the frames, to allow of them being withdrawn without damage to their living contents.

The dummy is formed of two thin boards, placed with their grains at right angles, to prevent warping or splitting. The value of the dummy in reducing the size of the hive on the introduction of a weak swarm will be readily found, while, should the season be a good one, the hive can be in a few moments enlarged to any extent up to its full size, and maiden swarms prevented. The crown board, which completes the hive, is not in one piece, but divided into five parts, which admits of one part of the hive being examined without disturbing the rest, and by changing the position of the two outer pieces a slot can be formed for the purpose of *supering*, as shown by the dotted lines in Fig. 4, the feeding arrangements in the central board being meanwhile quite undisturbed.

The hive is surmounted by a super cover, which is hinged to the body, and by means of a stop can be only opened till its sides are horizontal, when it forms a resting place for any articles one may be using during manipulation. A slate and pencil are attached for such notes as are likely to slip the memory if not immediately entered, and a ventilator covered with a slide of perforated zinc, which can be removed at pleasure for the use of the bee-trap, completes the whole.

Of the Cheshire feeder (shown in the central strip in Fig. 4), and other ingenious inventions, we shall speak in another place.

Wm. S. Travis.

FIG. 1

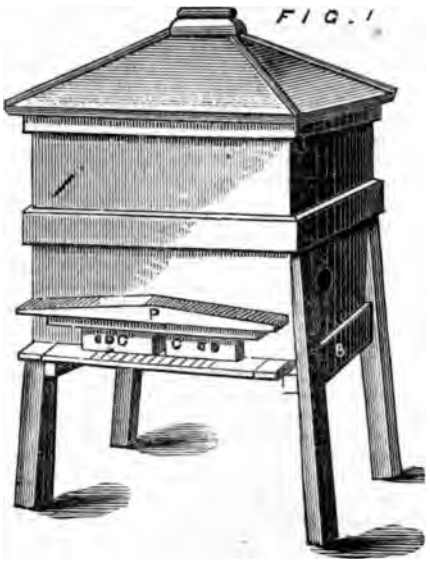


FIG. 2

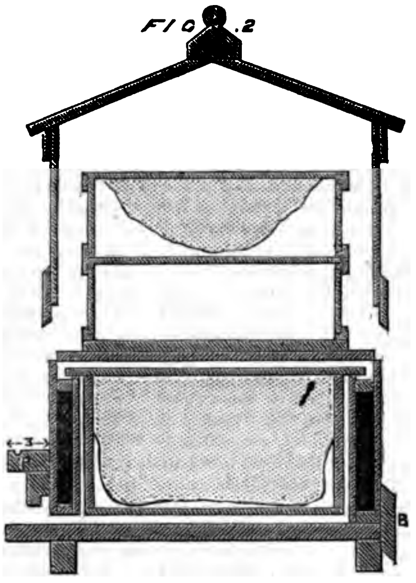


FIG. 4

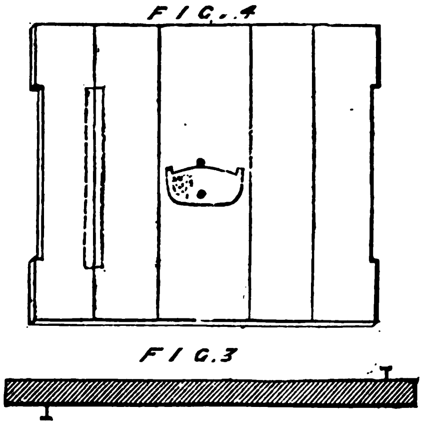
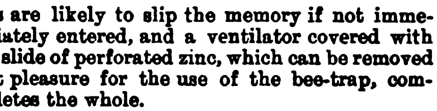


FIG. 3



BYRNE'S PNEUMATIC BATTE

THE extraordinary effects obtained wi
peculiar cell devised by Dr. John
of Brooklyn, have attracted considerable
tion in this country, and from a paper r
Mr. W. H. Preece, before the Physical S
we find that he has been making an exh
series of experiments with it. Dr. B
description differs slightly from that
Preece, and as the former considers his
negative plates to be the distinctive fea
the battery, it will be as well to quote h
cription verbatim. Each negative el
consists of a plate of copper, to one surf
which, as well as to its edges, a sh
platinum foil, compact, and free fro
holes, is soldered, and to the opposite s
or back a sheet of lead—the three metal
so united that the copper shall be effe
protected from the action of acids. Th
back and edges are then coated with asp
varnish, acid-proof cement, or any oth
substance; and lastly, the platinum face,
first rubbed over gently with emery pa
to be thoroughly platinised in the usual m
Each cell contains two such plates, be
which a single zinc is suspended, and wh
elements are immersed so that the ex
fluid reaches within an inch of the
negative surface of 20 square inches is b
into action. It will thus be seen th
platinum alone is the negative metal, a
copper core a conducting body merely,
the lead, being almost passive, serves no
purpose than to protect the copper, s
any other, and, best of all, a non-metalli
stance, capable of resisting the acti
bichromate solutions, might, with adva
be substituted for the lead.

The exciting solution is prepared b
solving bichromate of potash in warm
in the proportion of 2oz. to each pint
when cool adding sulphuric acid in th
portion of one part to five of the solut
bichromate chromate of calcium, inste
the potash salt, will give a much
electro-motive force, and consequen
greater thermal power. Poggendorff w
first to use bichromate of potash in 18
solution consisting of $K_2Cr_2O_7$ 3 parts,
parts, and water 18 parts. Some of the o
is held by a very weak affinity, and r
combines with the evolved hydrogen
negative plate. According to Mr. Pree
action of the battery is probably

$$3Zn + K_2Cr_2O_7 + 7H_2SO_4 = 3ZnSO_4$$

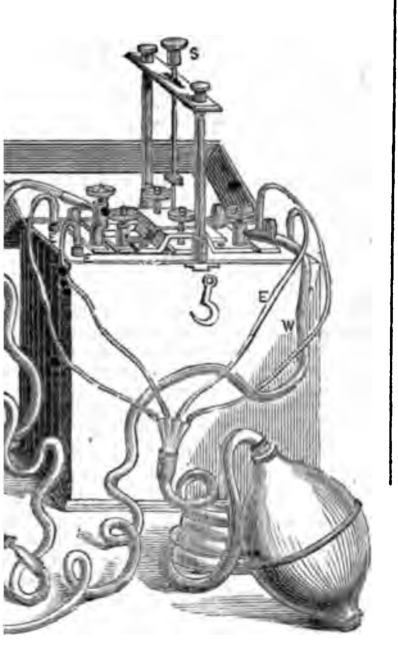
$$\overbrace{Cr_2O_33SO_3 + K_2SO_4} + 7H_2O$$

the resulting compounds being zinc sul
chrome-alum, and water. The result is
markable increase of electro-motive force
apparently not only have the electro-
force due to the contact of zinc and sul
acid, but an equal force acting in the
direction due to the contact of the pla
and bichromate. Hence the electro-
force present is about twice that of a Da
cell. Poggendorff thought that the efficie
the liquid was due to its depolarising eff
the negative plate, but its effect is not
storation of power, but an addition of
due to the introduction of a fresh electro-
force.

The general appearance of the battery
in the annexed illustration. The cells
ebonite or hard rubber, and the arrang
of the plates such that they can be lift
of the solution when the battery is not in
A thin lead or hard rubber tube descend
the cell, and extends horizontally alon
bottom between the opposing plates,
perforated along the horizontal portion s
allow a current of air which is pumped th
it by a syringe, hand pump, or rubber b
pass through the liquid and agitate it viol
C C, conducting cords; S, suspensio
and set screw combined, to connect be
second and third cells in series; A A, po
battery; B B, two set screws to coup
quantity; D, an extra binding post,
essential, but convenient when two cell
of the battery are required; E E, air tub
connect the battery for intensity, turn d
firmly and raise B B; and for quantity, r
the operation by turning down B B firml
releasing S from its contact with the
metallic connection. In galvano-cauter

urpose for which this little battery, as ted, was first devised, and is now being vely used more particularly during difficult and complicated surgical opera- this simple means of changing the character of the current to meet emer- is of the utmost importance.

a battery of ten cells tried in this , a stout platinum wire 32in. long of B.W.G. (·089in. in diameter) was lly brought to a glowing red heat which and flowed with the cessation or renewal air flow. A brilliant electric light was ied between two carbon points which ly varied in intensity with the flow of r. W. Spottiswoode's large induction s worked to its utmost limit, giving full sparks 18in. in length with the air flow, y 8in. without air. Indeed all the effects re ordinarily produced by seventy or ordinary Grove's were easily repeated hese ten cells when pneumatically d. According to Dr. Byrne, however, ls of his battery will heat more than f No. 14 wire, for four cells will heat



pumping in of air has no effect upon the motive force of the battery, and any eans of effecting the required agitation robably answer the purpose equally as Dr. Byrne says that the suggestion of or Adams, as to the air effecting a free ion in the fluid, by which the metallic are kept constantly clear, or, to use a gless term, depolarised, is undoubtedly n the right direction, and is in entire ity with his own views; and Mr. Preece es his exhaustive examination of the by saying that it is evident the ul strength of current produced by tery is due to the great reduction of its resistance, produced in the first place culiar compound construction of the e plate; in the second place, by the effect of the rapid flow of air through s; and in the third place, by the pro- of heat. The action of the air flow is lly mechanical, but by hastening the tion of the zinc, it tends to generate hich of itself tends to reduce the resis- The mechanical action of the air is to from the neighbourhood of the negative e chrome-alum which is formed there, m the neighbourhood of the positive e zinc sulphate, and to bring in contact th plates a constant supply of fresh . The principal defect of the battery pid consumption of zinc and reduction ichromate solution. The cell becomes d with zinc sulphate, and the bichro- potash becomes reduced to that peculiar alt, chrome-alum. It has to be freshly whenever it is wanted, if it is worked Nevertheless, it can always be kept r action; it is free from all noxious , and it is certainly a most valuable to the physicist's laboratory.

ON A METHOD OF RESOLVING AMPHIPLEURA PELLUCIDA AND OTHER TEST OBJECTS.

By George Williams (Q.M.C.).

THE merits and capabilities of microscopic objectives, both British and foreign, having been lately a good deal discussed in your columns, and much attention having been recently devoted by microscopists to the several condensers and other optical appliances by which the resolution of lines, beads, and *striæ* on diatoms and other test objects can be satisfactorily effected, I venture, with your kind permission, to submit to your readers an apparatus which I have contrived for facilitating the use of a small bull's-eye illuminator—a very simple but highly effective method of resolving the transverse *striæ* or ribs on *Amphipleura pellucida* — employed, and, I believe, first devised, by Messrs. Powell and Lealand. That method consists in concentrating an intense beam of light upon the frustules at a very extreme angle by means of a small bull's-eye of very short focus. For this purpose a super-stage is required which may be briefly described as a thin platform, slightly larger than an ordinary slip, raised upon uprights about an inch above the level of the principal stage; the base upon which the uprights are fixed sliding upon the dovetails which receive the upper stage plate, that having been removed. The platform, thus secured, assumes a position perpendicular to the body of the microscope, and has a ¾ central opening, horseshoe form, cut out from its edge to about two-thirds of its width; the light, therefore, on one side of the platform meets with no obstruction. The slide of diatoms being laid upon the platform beneath the springs, the flat side of the small bull's-eye is brought close up to the side edge of the slip, opposite the cover, and a brilliant beam of light is concentrated and thrown across the slide; the proper illumination is then effected by the necessary manipulation, and the lines or markings are displayed.

FIG. 1

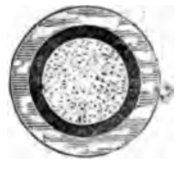
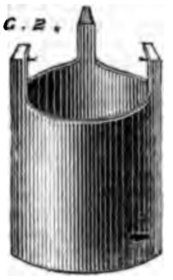


FIG. 2.



In order, however, to show the transverse lines or *striæ* with this bull's-eye, it is necessary that they lie at right angles to the direction of the light. A "selected" slide, prepared on purpose, of course provides for this; the mounter arranging the frustules parallel upon the cover, and placing it so that they lie across the slip. But to say nothing of the great difficulty of raising and thus placing uninjured the excessively fragile but obstinately adhesive valves of *Amphipleura pellucida* (which great patience and dexterity can alone accomplish), the number of the valves is generally limited to some half dozen, and those few mostly turn out to be extremely difficult of resolution, and otherwise unsatisfactory, so as to render these "selected" slides of comparatively little use. A good ordinary "strewed" slide, on the contrary, contains a great number of valves, and amongst them may be found, by diligence, many on which the lines can be resolved with reasonable ease; but it is obvious, from what has been said above, that the bull's-eye can be made to successfully operate upon those specimens only which happen to lie in the direction of the width of the slip, or within very narrow limits thereof; the rest of the specimens, and, possibly, among them such as might prove to be the very best for selection being wholly unsuitable, from their position, even for examination. To place any one of the latter in the right direction, it is clear that the only course is to turn the slide by rotating the stage of the microscope; but the length of the slide quickly interferes with, and pushes aside, the bull's-eye, and there is nothing for it but to abandon altogether the examination of that particular valve. To meet and overcome this difficulty, and be relieved from the annoyance of seeing crowds of frustules lying about the preparation, to resolve which no attempt can be made, I have devised a simple and inexpensive apparatus, and now describe it, trusting it may extend the use of this excellent bull's-eye illuminator, which will be found to give good results with *A. pellucida*, and to be equally effective in resolving *N. rhomboides* and other tests, always, of course, assuming that the objective employed is competent to the task.

FIG. 3

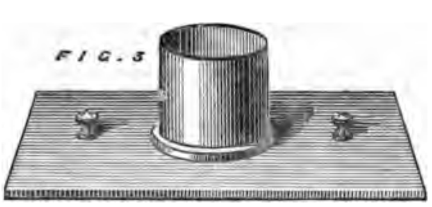


FIG. 4

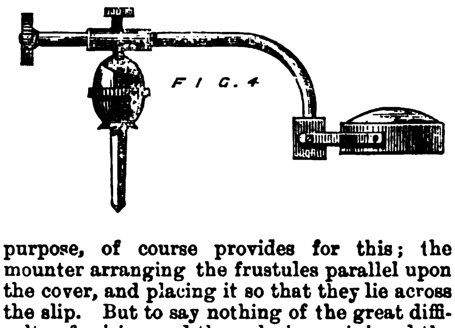


FIG. 5

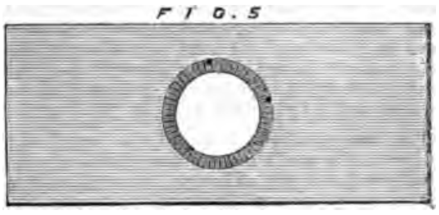


Fig. 1.—Disc of thin plate or crown glass, ¾in. diameter, on which may be mounted diatoms in balsam, or dry strewed on the cover. Any cover carrying dry diatoms can be easily removed from its slip, transferred to the disc, and fixed thereon by a ring of cement, as shown in the figure. A rough edge to the disc greatly facilitates its handling.

Fig. 2.—Tubular disc-holder, 1in. long, ¾in. diameter inside; the top cut out leaving three equidistant ¼in. uprights, having small lips upon which the disc rests parallel; the tips of the uprights are slightly inclined inwards to spring lightly against and steady the disc, to overcome the suction of immersion objective. The uprights should be as slender as possible, consistent with the needful strength, so as to present as little obstruction as may be to the passage of light beneath the disc.

Fig. 3.—Brass plate, 3in. by 1in., having a tube, ⅜in. long, screwed or soldered into central hole. The tube to accurately fit Fig. 2, the latter sliding over it, resting on the flange, and rotating easily and smoothly, but without "shake." The small milled heads screw the plate to the principal stage of the microscope (two holes being "tapped" in the stage to receive them) that the disc and its holder may be subject to the concentric rotating, and other mechanical motions, and the whole mount brought successively under the objective. Any other means of firmly fixing or holding the plate to the stage may, if preferred, be substituted for the milled heads.

Fig. 4.—Brass rod, carrying "Powell's Bull's-eye"—a plano-convex lens of about ¾in. diameter, and ⅛in. focus. It slides through the sleeve of a ball-and-socket joint, furnished with a binding screw, such joint to be inserted in the usual fitting, in the head of the carrier of the microscope (Ross model), or in the crane-arm (Jackson model). The rod is curved to advance the bull's-eye approximately into position, which is afterwards brought close to the disc by the ball-and-socket joint. The shape of the curve will depend upon the form of the microscope to which the rod may be fitted. The cell of the bull's-eye is attached to the rod by a small block and a tongue joint, that the

bull's-eye may be "kept square," whatever the inclination of the rod, which must be sufficiently long to allow the bull's-eye to be conveniently manipulated; it is divided and shortened in the figure to show the necessary milled-stud at the tail end. The pin of the joint should fit into a square hole, thus confining all motion to the joint itself, and preventing any tendency to "crawl." The socket will require to be carefully "bushed" to obviate all "jumping" in the joint, the ball moving freely.

Fig. 5.—Brass plate, 3in. by 1¼in., with central circular aperture, ¾in. diameter, turned out, leaving a very thin and narrow flange as shaded. This aperture forms a cell to receive and support the disc on the ordinary stage of the microscope, in case it should be desired to examine the mount or any marked specimen therein, as an ordinary slide by illumination from the sub-stage. The disc will require to be kept steady in the cell by a slight spring-ring, to counteract the suction of the immersion objective.

It will, I think, be seen that by mounting the diatoms on a small disc (instead of a slip), and placing it in the holder as above described, the whole of the frustules on the cover are brought under the control of the observer; who, by mere rotation, can bring any one of them into the requisite position, and thus ultimately succeed in examining, and, very possibly, resolving a large majority. It is proper to point out, however, that (a specimen having been selected and rotated into position) one of the uprights of the holder may chance to stand immediately in the passage of, and obstruct, the beam of light; in that case all that is necessary is to turn the disc in its setting, and again rotate the holder until the object is once more in position. A glance will show if the light passes between the uprights; if not, the turning of the disc and rotation of the holder must be repeated until it does so.

The turning of the disc and rotation of the holder can be easily managed, with thumb and finger, under a ¼in. objective; indeed, with a well-made apparatus but little difficulty has been found, even under a 1-20in., by the aid of a mechanical stage in good working order. The rotation can, of course, be effected by the use of the concentric motion of the microscope stage, but, in practice, it will be found preferable to rotate the holder itself to approximately place the object, resorting to the concentric motion to effect only the niceties of position: the milled-heads which work the mechanical motions will then retain their normal situation at the right side of the microscope, and be, consequently, much more convenient for the manipulation of the observer.

EXPLOSIONS IN COAL-MINES.—II.

By T. Wills, F C.S.

In my last lecture I referred to a calculation which had been kindly furnished me by Mr. W. Galloway, of Cardiff, regarding the heating value of the fire-damp escaping from a mine in South Wales; the figures of this calculation also exhibit the enormous pressure under which the condensed gas must be contained within the coal. In the particular pit referred to the upcast ventilating current equals 80,000 cubic feet of air per minute; one-fortieth of this, or 2,000 cubic feet, consists of marsh gas or fire-damp. The amount of coal raised from this pit per day is, on the average, 1,000 tons. One ton of coal approximately equals one cubic yard. The amount of coal raised, however, is really less than the amount excavated, the difference being about one fifth; this quantity being left in the mine. So that it may be considered that 1,250 cubic yards are excavated per day. Hence, from this, it would appear that the fire damp escaping in the same time occupies a space 85·3 times that of the coal excavated. Suppose one-half, which would probably be in excess of the true amount, of this gas to come from other seams through fissures, and not from the seam immediately being worked, there will still be fire-damp issuing from the coal representing 42·6 times the volume of the coal removed. Now, to compress this gas back again into the space occupied by the coal would require a pressure of 639lb. per square inch; but, in reality, the coal and the fire-damp must be considered as having occupied the same space—hence the pressure would have to be indefinitely multiplied. The gas so escaping from mines with the ordinary ventilating current through the up-cast shaft is discharged directly into the atmosphere, and becomes diffused.

Natures and Properties of Fire-Damp.

So far we have been speaking of the production and occurrence of marsh gas or fire-damp; it is necessary now to get some idea of its nature and properties. This substance forms the miner's most subtle and at the same time most disastrous enemy.

Marsh gas is the simplest compound of carbon and hydrogen; its chemical symbol is CH_4, which, giving to the C and H their respective numerical values, means that in every 16 parts by weight of the gas there are found 12 parts of carbon and four of hydrogen—*i e.*, 75 per cent. of carbon and 25 per cent. of hydrogen. The gas is without colour, taste, or smell In addition to its occurrence in coal-mins, it is found in marshy places, arising in such cases from the decomposition of vegetable matter, from whence its name of marsh gas; also it issues in jets from certain parts of the earth's surface, and it is found as a general result of the imperfect combustion of carbonaceous fuel; it occurs as a constant constituent of coal-gas, forming sometimes as much as 70 per cent. of the volume of such gas. The specific gravity of the gas about one-half that of air, being correctly 0 5576; this lightness forms one of its most dangerous properties, as it causes an accumulation of the gas in cavities and holes in the roof, places which are usually imperfectly ventilated.

Marsh gas is inflammable, burning with a bluish flame with a yellow tip; it is generally stated to give no light, but this is erroneous, although the amount of light emitted is very feeble. The gas does not support combustion, neither does it support life, yet it does not act as a direct poison upon the system, and if mixed with a fair proportion of air may be breathed for some time without producing any deleterious effects; this is the case even if it be mixed with only its own volume of air; a mixture of air with 30 per cent. of marsh gas is quite breathable. Marsh gas requires a high temperature for its ignition, a very important consideration; a red heat will not ignite a jet of marsh gas, neither will it explode a mixture of marsh gas and air; a temperature between 1,000 and 1,500°F. is required for its inflammation, supposing the gas to be pure, the mixture of other hydrocarbons causing it to ignite at a lower temperature. On the combustion of marsh gas taking place, either slowly or suddenly, the hydrogen burns to form water, and the carbon to form carbonic acid gas; the volume of the carbonic acid so produced is equal to the original volume of the marsh gas, if measured at the same temperature, but in the case of an explosion of fire-damp the volume of the produced carbonic acid is considerably greater, owing to the elevated temperature.

All inflammable gases, when mixed with certain proportions of either air or oxygen, become explosive, and it is in this respect that the serious dangers connected with the presence of marsh gas occur. As air contains one-fifth of its volume of oxygen to produce complete combustion, 1 volume of marsh gas and 10 volumes of air are required. If a mixture of this nature is ignited, combustion takes place almost at the same moment throughout the entire volume, and this sudden combustion is nothing more than an explosion. The calculated pressure produced by the explosion of marsh gas with oxygen is 37 atmospheres, or 555lb. upon the square inch Since the explosion with air is rendered much less violent by the presence of the four-fifths of inert nitrogen, the pressure exerted is also much less, being only 14 atmospheres, or 210lb. per square inch. The above figures refer to the absolute theoretic quantities of marsh gas and air in oxygen, but there is a margin on each side, within which explosion still takes place, with, however, a diminished intensity; thus when 1 part of fire-damp is mixed with approximately about 30 of air, it can be recognised by a candle flame, which will appear with a blue halo round it; if the fire-damp increases to 1 part to 15 of air the mixture will still not explode; 1 part of fire-damp to 13 of air becomes slightly explosive; as the theoretical amount of 1 to 10 is reached the explosion becomes more and more violent. The most violent explosion is stated to occur, in practice, when the fire-damp is in the proportion of 1 part to 9·4 of air. When the limit of 1 to 10 is passed the force of explosion will become less and less, until when there is 1 vol. of marsh gas to 5 of air, the mixture ceases to be explosive, but is simply inflammable; lighted flames go out on being introduced into such mixture. These statements must not be accepted as applicable to all cases, as the differences in the character and composition of the fire-damp will materially alter the results. If carbonic acid gas be present at the time it lessens the explosive force. One seventh part of carbonic acid, added to a perfectly explosive mixture, prevents any explosion from taking place on the approach of a light; these facts refer to fire damp itself, and if any other hydrocarbon be present in it certain modifications within narrow limits occur. It very rarely happens that in actual explosions of fire-damp the mixture of air and gas is precisely of the exact nature required for the maximum effect, and hence we have the very varying effects produced by explosions; were it not for the so called after or choke-damp produced, explosions of fire-damp would be nothing like so disastrous as they are.

A very large number of explosions are continually taking place in collieries, only a small proportion of which, however, are attended with fatal results.

It is necessary in the first place that, in order to be worked at all, a system of ventilation shall be adapted to every mine, in order that the air required for the respiration of the men shall be forthcoming. The amount of air supplied must be such that the men furthest removed from the inlet shafts shall receive the requisite amount; and the air must also be increased to such an extent as to dilute and carry off the gases escaping from the face of the coal. The absolute quantities supplied to different mines will vary with the circumstances of the district. In some of the northern coal pits 150,000 to 300 000 cubic feet of air per minute are passed through the workings; this draught of air may either be obtained by means of a furnace placed in the up-cast shaft, or by some form of fan placed at the top. In any case the air will descend the down-cast shaft, and it has then to be spread through the workings. This is accomplished by cutting off all direct air communication between the up-cast and down-cast shafts. In practice the plan adopted consists in a special arrangement of the roadways or drifts, as they are called; these being in reality galleries running from the base of the down-cast shaft to the several faces of the coal, and from the termination of these drifts others are carried back to the base of the up-cast shaft. If these two sections of the mine be perfectly isolated from each other, and the current of air be sufficient at all points, a thoroughly good system of ventilation is obtained.

For the ventilation to be effective the air must not be permitted to take a short cut from the one system of galleries into the other, or some portion of the mine, or more distant workings will remain in a state of stagnation. Now, as for the purpose of conveying the coals, and maintaining communication between the various parts of the mine, it is impossible to keep the two absolutely without connection, a series of doors are erected, which are usually kept shut, but can be opened for a short period for the purposes of passage. Upon the proper working of those doors depends largely the success of the ventilation. Brattice walls are also common, and are simply artificial wooden walls erected for the purpose of diverting the air current. Where the system here indicated is not adopted the coal is usually removed entirely from the further part of the workings, and the roof is allowed to fall in and fill up the excavated places; such old workings are called goafs. These goafs are considerable sources of danger, owing to the facilities which they offer for the accumulation of fire damp, which may remain for a time totally unsuspected. The neighbourhood of these places always requires careful watching, to detect the presence of fire-damp. The air under this system of ventilation has a simpler course, and is not dependent upon the proper closing of doors. One great source of danger, in either case, exists in the great irregularity of the form of the various passages; hollow spaces occur in the roof owing to a fall of the material; short unused passages are imperfectly stopped; differences in height and width occur, dependent upon the requirements of the pit, all of which have considerable effect upon the ventilating current, and afford the circumstances for the collection of fire damp. Now, an explosion may be produced in either one of the following ways:—

1. Supposing the fire-damp to be issuing from the face of the coal with tolerable regularity, so long as the proper current of air is maintained this is swept away in safety, but if, by a door being left open, or through an imperfect stopping, the air current partially or entirely takes a short cut, the face of the coal will be imperfectly freed from the gas, and an explosive atmosphere will gradually result; if miners enter this with naked lights, a disaster occurs of more or less gravity as the area of explosive gas is greater or less.

2. Gas is invariably found first in cavities in the roof and in the higher parts of the passages, and it is possible for an explosive atmosphere to be generated in the upper part of a gallery, while below the air is quite safe; if the gas is not dislodged, the limit of the stratum of explosive gas will get lower and lower, until by some accidental cause it becomes ignited. These spaces are sometimes ventilated temporarily by means of hangings of brattice cloth.

3. At one part of the mine a sudden irruption of gas may take place, which may vitiate the air current to an explosive extent, and may even in some cases overpower it altogether. If, however, safety lamps are used with caution, which are extinguished in presence of an excess of fire-damp, and the men are never permitted to work in dangerous atmospheres, such a result need not be the cause of an explosion. It may be said here that, however foul a mine may be, an explosion does not in any way necessarily follow.

4. Gas may not only be given off at the face of the coal, but in other parts of the workings through which the air travels on its way to the face, or possibly an over large extent of coal is traversed by the same air current, or the gas from the explosive

stratum (mentioned in 3) descends and mixes with the air current, in which case, as the air proceeds, it becomes charged to a larger and larger extent with fire-damp, until, before it reaches the upcast shaft, it may have reached its explosive point.

From these considerations it will be seen that the maintenance of the ventilation in a through state of efficiency, a result which can only be obtained by the most careful and constant supervision, is in reality the greatest safeguard from explosions. The safety lamp, of whatever form, should be regarded as a means of preventing accidents in unforeseen cases of emergency, and its use should never be allowed to render the attention to the ventilation of less importance.

ON PHONOPHORIC SUBSTANCES AND THE MAGNOPHONE.*

BY WENTWORTH LASCELLES SCOTT, A.S.T.E.

FOR some time past, during the uncertain intervals available for private research amidst the exigencies and duties of professional life, I have devoted very considerable attention to the relations naturally existing between sound and electricity, and also between the latter force and light. It is the remarkable results already obtained in the first division of this necessarily conjugate subject that I desire to lay before the readers of the *Electrician* upon the present occasion.

Fascinated, as so many others have been, by the telephones of Reiss, Dolbear, Edison, and Bell, I sought diligently in the course of these investigations for some practical development of the instrument in question which should rescue it from that oblivion to which all mere scientific toys are, sooner or later, consigned, with the avowed object of producing a "telephone" capable alike of diminishing or of largely increasing the intensity of the sounds conveyed thereby. Omitting all needless details, it may be briefly noted that my first distinct improvements upon the ordinary magneto-electric telephone were obtained by modifying the diaphragm or vibrating armature of this instrument; thus, it was of course quickly found that, *cæteris paribus*, the greater the weight of metal caused to vibrate by the impact of sonoric waves the louder was the sound emitted at the "listening end," although frequently at the expense of *clearness*. Increased *definition*, however —if I may be allowed to import a convenient *optical* term—was obtained by the simple expedient of avoiding the insensitiveness of heavy and therefore more rigid diaphragms, by employing a number of thin laminæ in place of one thick plate, and this arrangement is so far a practical improvement that instruments provided with five such vibrating plates (the outer four having central apertures) will receive and emit clearly a variety of sounds for which in the ordinary "Bell telephone" there is simply "no thoroughfare."

From several armature-plates to a considerable number would be a natural step, except for the weaker effect produced on each by those which are farthest from the magnet. Recourse was had, therefore, to other expedients (using sometimes a voltaic current to further exalt the effect) for multiplying the *number* of armatures without at the same time increasing their weight or their distance from the magnet, and always with advantage, until it was found that the most sensitive armature for a given weight of iron was that metal in the form of powder or filings. It is not too much to say ten grains of soft iron filings, affixed by suitable means to a duly stretched membrane, are capable of producing better results than forty grains in the shape of a "ferrotype disc."

Reverting, at this stage, to my former line of inquiry, and calling in the aid of the voltaic current† to intensify, if possible, the powers of the telephonic arrangement just described, no material progress was made upon the desired path, although some slight advantage appeared to result from the interposition. On carefully insulating the vibrating armature of the transmitting telephone, however, and including it in the circuit, a distinct and apparently inexplicable increase in the sensitiveness was observed, a phenomenon which still obtained when the "iron filings armature" previously described was employed. The whole of these experiments were performed with instruments somewhat roughly put together (and very frequently pulled to pieces again), and it was after noting the satisfactory step forward that seemed to have been made when I discovered that the bar magnet of the "transmitter" giving such good results had become accidentally loosened, and had slipped about an inch and a half away from the diaphragm, being therefore entirely "out of range" from a telephonic point of view. The fact that its entire removal did not affect the powers of the instrument occasioned me, therefore, but little *additional* surprise.

It was impossible to avoid believing that here might at last be a clue to the causes of a variety of phenomena hitherto uncertain and obscure—phenomena which have been observed by numerous inquirers, but have been accounted for by none. A number of substances in a more or less finely divided condition were introduced into the circuit in *place of the "transmitting telephone,"* with the general result that a little heap of metallic particles, whose conductivity (or "resistance") varies with sonoric vibrations absolutely inappreciable to the most sensitive ear, may be employed as a "transmitter" far transcending in delicacy any instrument yet described.

If, for instance, 40 or 50 short sections of silver wire (No. 25), about 1in. or 2in. in length, be laid in gentle contact with each other in the small porcelain "boat," or trough (such as is used in organic analysis), and made to form part of a "telephonic circuit" by connecting one end of its contents with the + wire from the battery, and the other with the "line wire" which passes onward to the "receiving telephone" at the other station, the "trough" may be sung or spoken to as if it were an ordinary telephone, and both notes and words will be faithfully repeated at the distant instrument. If *gold* wire sections of the same size and about the same number of points of contact be substituted for silver, the arrangement becomes apparently more sensitive; but so many factors necessarily enter into the question of phonophoric comparisons that accurate relations will probably be extremely difficult to arrive at. Precipitated silver is in a high degree phonophoric, but is again excelled by pure iron, the latter by mercury, and this last must yield in sensitiveness to platinum. Many metals (and some metalloids) influence the current in such a manner that the scratching of an ordinary quill pen upon paper can be heard through the connecting medium of half a mile of wire. Instead of the great diminution of sound common to ordinary telephonic systems, it can be very considerably (and, as I think, indefinitely) increased, by means of the arrangement just indicated, which I propose to call the "*Magnophone*."*

If either platinum, mercury, or silver (and doubtless other bodies in a different degree) be precipitated in an extremely fine state of division within the cavities of suitable porous substances, such as pumice-stone, asbestos, &c., "phonophoric tablets," spheres, or cylinders may be formed therefrom, which are sensitive to an almost incredible degree. By their aid the sound of a glazier's diamond is "magnified" until, without any great stretch of the imagination, it might be taken for the distant reverberation of a "split" in some mighty glacier; the "hum" of a minute induction coil (inaudible six inches from the "contact break") becomes a veritable "roll call" played by fairy drummer-boys, whilst the "material disagreements" of a couple of quarrelsome spiders are made apparent to our human senses in the "crashing sounds of battle."

By means of two little cylinders of platinised pumice, one end of each in good metallic connection with the "line wire" and the other extremities, which should be rounded slightly, just touching, it is possible to *hear the crystallisation* of various salts, the sulphate of potassium as formed by precipitation for instance; the "phonophoric" body for such experiments may be inserted conveniently in a glass U-tube, and immersed in this under the surface of the solutions. A variety of applications are probably open to whatever may prove to be the best practical form of "phonophore," not the least important of which, I opine, will be in the study of physiology and the development of plant-life.

ACCURATE SCREW CUTTING AND CENTRING.

WRITING on the subject of accurate screw-cutting, a correspondent of the *Railway Gazette* says, Sir Joseph Whitworth speaks most truly when he insists on the necessity of having perfect screws for slide or screw-cutting lathes, and the advantages of having the screw to fit the nut and coalesce all over from end to end. Some Western shops are unwilling to allow time to have the screw-cutting tool ground exactly to the gauge and set particularly, but prefer to have a man or boy grind the tool for a V thread any way, shove the tool in, and take one or two rough cuts over the bolt, and then dash into it by hand with a chaser, with the spindle of the following head-stock sticking out 5 or 6in., and not tightened. Of course a man will do a bigger day's work the latter way, and if the screw-cutting tool is not set and ground very particularly it is better to give the bolts a slight touch with a chaser, provided the chaser is cut with a perfect thread. But it is a bad plan to chase a thread too much.

A few words on centring and turning might not be out of place here. The fact is, in many Western shops far too little attention is paid in having the lathe-centres all turned to a standard gauge and the centres countersunk to fit exactly and drilled. Some men think it does not pay to centre light work any other way than with a centre-punch, where they do not have cutting-off and centring machines. But this is a most erroneous idea. In my opinion, using punched centres with a centre punch ground on the stone is a barbarous practice. No wonder the dead centre is always in bad order, cutting and speaking. The fact is, putting good centres in work is of as much importance as the foundation of a house, and every thoroughbred turner that has served an apprenticeship on the right side of 21 knows it. I have seen boys take work to the vice, drive a centre-punch into it, take it to the lathe, chalk the full sides, take it back to the vice, draw the centres, and try again; whereas if they would put a square of centre cutting in the spindle of the tail-block or head-stock and push a tool gently against the full side, it would come true in an instant. The main advantage of square centring is the superior quickness over all other methods. I have seen lots of light work from an inch and a quarter down, centred by sticking one end into a hollow V-shaped socket live centre, without putting a dog on one end or stopping the lathe at all. In almost any shop a boy for a few shillings a day could be kept constantly centring and drilling for all the light lathes, and then they would have good, permanent, properly shaped centre or counter-sinks, and their centres would last for many months. I have seen good centres put in car-axles by having the centres turned to the gauge and hardened to the proper temper by being fitted into each end of a wheel press and then pressed to ⅛ or ¾ diameter. The centres are much harder, wear better, are less liable to cut and squeak than if countersunk with a cutting centre. I have seen hundreds of axles centred in this way, and no perceptible wear on the centres that did the pressing, although in constant use for years. Some men have a great notion of turning wrought-iron dry with a very fine feed and quick speed, and then rasping into it with a file. That may do for old, dirty, sandy iron; but I contend that except for very light work a water-cut without filing is the better way and much quicker. A man that can scrape cast iron without chattering or jarring, and does not require files and sandstone, or can finish wrought-iron balls, handles, ogees, fillets, bulges, and hollows, without the use of files, has an immense advantage over one who can't. Sir Joseph Whitworth's male and female steel-hardened standard templates were in use in Manchester the year I went to the trade (1842), and probably some years before. They are now very generally used both in England and America. It would be well if link-pins, &c., could be fitted up in the same way.

It is seldom anything appears in scientific engineering journals from the pen of a practical workman. But, as Sir Walter Scott said there was no man, however ignorant, but you could learn something from, I make bold to try if my endeavour is worth a place in your columns.

EXAMINATION OF THE PHONOGRAPH RECORD UNDER THE MICROSCOPE.*

BY PERSIFOR FRAZER, JR., A.M.

AT a meeting of the Philosophical Society, held April 5th, 1878, I described the results of some examinations of the tinfoil which had been indented by the stylus, or needle point, of the phonograph. My object was to ascertain the shapes of the indentations made by different known sounds. For this purpose, Dr. Plush, the superintendent of the Philadelphia Local Telegraph Co., kindly offered his assistance. The vowels and diphthongs were spoken into the mouthpiece of the apparatus with small panels in the order seen on the diagram. These sounds were repeated thrice on each of three foils. They were then mounted on glass plates, separated, and labelled. Finally, at the suggestion of Mr. Knight, they were cut out and mounted on another piece of glass vertically, instead of horizontally, in order that a number of the dents produced by any given sound might be on the screen at once. I am much indebted to Mr. Holman for his kindness in adapting the apparatus, which he himself will explain a little later to the purpose of showing these phonographic records. Lissajous, Leon Scott, and König have provided the means of transforming sounds into form, in various ways—viz.: By bright points on the ends of steel bars of different thicknesses; by vibrating membranes at the extremity of a "phonautograph," and by flames reflected in a rotating mirror. It was natural to conclude that the same vibrations, imparted to a steel point by means of a metal diaphragm, would leave an equally characteristic trace.

It was intended to take a solid cast of these depressions in Canada balsam, or some other transparent substance, and then reproduce, in the mind's eye, the path of the stylus point. There has not been time for this. The same voice (that of Dr. Plush), speaking the following vowels and diphthongs as nearly as possible at the same distance from the mouthpiece, was relied upon for the matrices.

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* From the *Electrician*.

† No special form of battery can at present be recommended. In the experiments here described small cells of the "Marie Davy" and "Daniell" were employed indifferently.

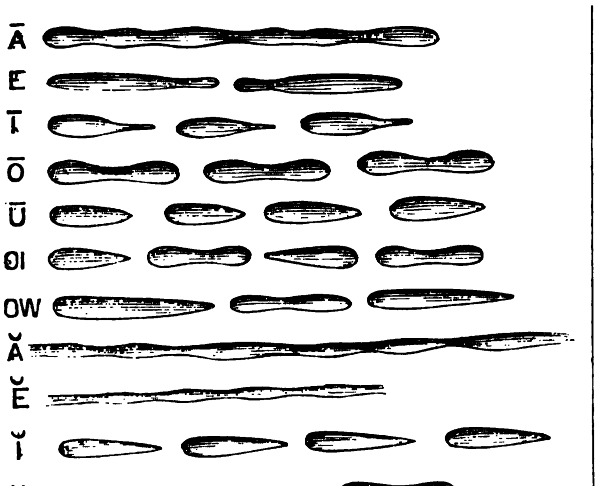
* I had the pleasure of explaining to the Rev. E. Davis on February 21st last, some of the effects of the "Magnophone," and the principle on which it is based.

* Presented at the meeting of the Franklin Institute, April 17th, 1878.

The first records tried, to ascertain whether the pronunciation was perfect, were afterwards thrown away, and the records which were studied were not in any way injured by a second passage of the point of the stylus. By following along the nearly vertical line of impressions, which are at the same time in focus, it will be observed that this line consists of one long followed by two shorts (or two shorts followed by one long), the indentations bearing a general resemblance to each other and to seeds. This is long A, or "Ah." A glance at short ă (as in "bat"), will show the same thing, but the seed-shaped hollows are narrower, and there are no abrupt terminations of the hollows by intervening parts of the foil which have not been touched by the needle-point.

E (or ay), on the screen, looked like the magnets of two Bell telephones, with the small ends turned towards each other. In the diagram they look like two Indian clubs with the handles together. The same general resemblance is observed in E short, except that, as in a short, the volume of sound being less, the intensity was less, or (what is the measure of intensity) the path of the needle-point was shorter, and it seldom entirely cleared the foil; the consequence being a continuous groove of irregular, but normally irregular, width.

Dr. Nolan, in faithfully transcribing the general appearance, to the eye, of these curves, was, of course, not able, in the limited time given him, to preserve the absolute thicknesses and lengths. These will be added in the memoir in the proceedings of A. P. S., in the form of micrometric measurements to the ·001 mm.



Note.—In the wood-cut the forms made by the excursions of the stylus for the short letters are wider than they should be.

I long and I short are much alike in general form, as also are O long and O short, the coupling of the pairs of the latter being the most striking feature. U long and U short, in the drawing, best show the difference in shape produced by less intensities, the short being drawn out, and more acicular.

OI is very interesting. The diphthong consists of OI short, and the very moulds which characterise their sounds are to be observed in the cut.

OW presents a composite character, but its derivation has not yet been made out.

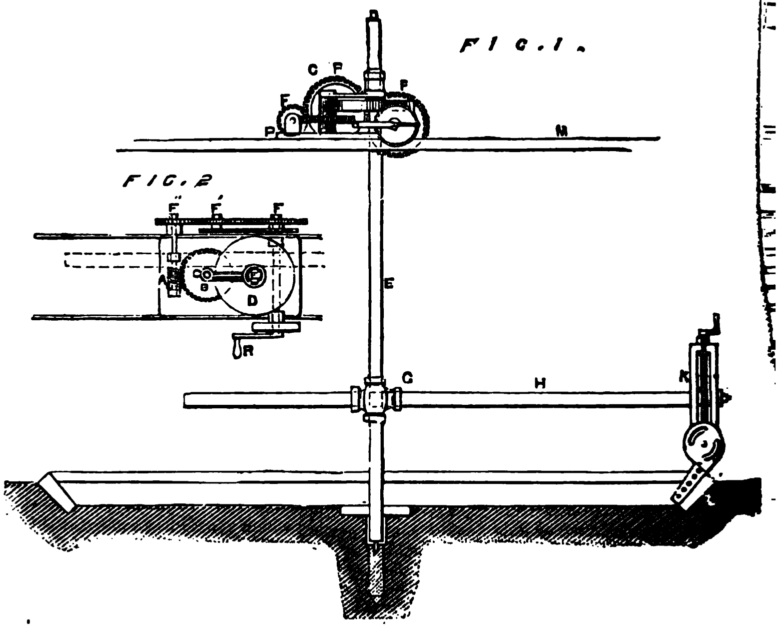
The above presentation of the subject is necessarily crude and imperfect, but will illustrate the possibilities of an exhautive investigation.

ENLARGING BY THE POWDER PROCESS.*

I HAVE just worked out a method of making what I call carbon enlargements—for such they are in reality—by a modification of the dusting-on process, which will prove valuable in special cases. The process is shortly as follows:—An enlarged transparency is made of the size of picture required, varnished, and retouched with lead pencil, &c. Patent plate should be used. A clean glass is now dusted with talc, and coated with plain collodion, dried, and, whilst warm, coated with sensitive mixture, as used in the dusting process, of which there are several formulæ. When quite dry and still warm, print under transparent positive, and develop with finely-powdered and sifted black-lead and Indian red. When dense enough, immediately coat again with plain collodion, which should be very thin in both cases, and, when set, place the plate in a dish of water slightly acid, until all the yellow colour is removed. Wash well, and place to dry. When you have finished printing, proceed to transfer like carbon printing, by soaking transfer paper in warm water and laying it down on the print, and passing the squeegee over it in the usual way, and leave them to dry, when they will strip off the glass with a brilliant surface. It is quite easy to make an enlarged transparency from carte size up to 14 × 12 without loss of sharpness or granulation, and by the means I have pointed out quite excellent prints can be made, and of any desirable colour, and, being permanent, they serve admirably as a basis for colouring.

MOULDING TOOTHED WHEELS.

IMPROVEMENTS in the apparatus hitherto employed for moulding toothed wheels, which, as is well known, is not looked upon with much favour by first-class mechanics, have been recently patented on behalf of M. J. Cardailhac, of Paris. The illustration (Fig. 1) represents an elevation of a portion of a machine, partly in section, adapted for the division and moulding in founders' sand of the teeth of wheels, in this case a bevel wheel. The dividing apparatus is based on the principle already adopted in machines for cutting out the teeth of toothed wheels; but it has applied to it improvements having for their object the obviating of the errors which are liable to occur in the division, in consequence of the play which, after a time, takes place between the different parts of a dividing apparatus. P is a flat table fixed upon a bearer, M, supported by two trestles (not shown), which table carries bearings for the reception of the spindle of an endless screw or worm, A (Fig. 2), and of a worm-wheel engaging therewith. The hub of this worm-wheel is prolonged in the form of a friction roller at C, the rotation of which imparts motion to a friction-wheel, D, of greater diameter than the roller, the said wheel being keyed upon a rotatory shaft, E, for carrying the plain trammel or apparatus, which serves to form the bed of the wheel in which the division and shape of the teeth is to be moulded, and also for carrying the improved trammel or apparatus for moulding the teeth. The friction roller, C, and wheel, D, are brought into contact by means of screws acting upon a sliding bearing carrying the spindle of the wheel, D. Motion is imparted to this friction-wheel by a crank handle, R, which turns a spindle carrying a pinion, F, which is in gear with an intermediate wheel, F^1, imparting motion to another wheel, F^{11}, fixed on the spindle of the endless screw, A. The combination of these three wheels, F, F^1, F^{11} (which may be changed to vary the proportion of the speed according to the division to be effected), causes the worm-wheel B, and consequently the wheel D, to describe arcs corresponding to one or more revolutions of the handle R. It is obvious that as the shaft, E, carrying the moulding apparatus is caused to rotate by the action of the roller, such shaft will describe similar arcs to the roller, as will also the carrier holding the pattern, and which is situate at any suitable distance from the centre of the shaft, according to the radius of the wheel to be moulded. The small dimensions of the worm-wheel would apparently be open to the objection of a liability of inaccuracy in the division of a wheel of considerable diameter. Heretofore, in the construction of dividing apparatus, it has been necessary to employ worm-wheels of considerable diameter, and the machines are consequently heavy, difficult to construct, and very costly; but the employment of friction gearing, according to the said invention, admits of divisions of great precision being obtained with a worm-wheel of small diameter. Should an error take place between two teeth it can only be very slight, by reason of the fineness of the pitch of the wheel, and being divided by the proportion of the diameters of the worm-wheel B, and the roller C, it becomes practically eliminated. A wheel and pinion may be employed in combination with the friction-wheel D, and roller C, the pitch lines of which correspond with the circumferences of the said wheel and roller, in order to ensure their simultaneous rotation, whilst at the same time obviating any liability to slip under the influence of a sudden jerk.



The invention also consists of a universal trammel or carrier, which is constructed in the following manner:—A double socket, G, formed by two tubes placed with their axes at right angles, is fitted so as to be free to slide upon the vertical shaft, E, carrying the apparatus, and through the horizontal portion of the socket is passed an iron tube, H, filled with wood to prevent it from bending. This tube, which is capable of sliding through the socket for its entire length, has pivotted to it at one end a carrier, K, to which is fitted a slide, J, carrying a segmental pattern, L, for forming the tooth. The slide, J, is so arranged as to be free to move vertically under the action of a screw, and also so as to be capable of assuming any angle of inclination requisite for the angle formed by the tooth of the wheel which it is desired to mould or adjust. The carrier is also capable of being turned on its pivot for the facility of making helical teeth. The screw, S, is caused to raise and lower as required the slide, J, holding the segmental pattern, L, by the act of operating a crank handle.

The machine operates in the following manner:—The bed in which the teeth are to be formed having been properly prepared, a toothed pinion, F^{11}, having the required number of teeth according to the division which it is desired to obtain, is in the first place fixed on the spindle of the endless screw,

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* By W. T. Watson in the *Photographic News*.

e dividing apparatus, and the position
irst tooth is determined in relation to
he arms of the wheel. The segmental
L, is placed in the position to be occu-
the first tooth, and the sand is rammed
he pattern, after which the latter is
y the act of turning the screw of the
The crank handle, R, of the dividing
us is then turned, whereby the seg-
pattern is moved a distance exactly
› the interval between two teeth, and
›w being then turned in the reverse
ı the segmental pattern is lowered into
tion for forming the second tooth, and
ı succession for the whole number of
ıich the wheel is to contain.

lition to its use for moulding toothed
nd other articles of a similar descrip-
› dividing apparatus, which may be
ıoved, can also be employed with ad-
for the purpose of verifying the exact-
he division either of the teeth of old
which have been distorted by time
or the recesses or mortices of the
cogs of cog-wheels, as well as for
the axes of cast-iron teeth when the
:urer, not having a cutting machine,
l to cut the teeth either by hand or in
g machine. This improved dividing
s may also be advantageously applied
nes for cutting the teeth of metal
· wooden cogs.

ENTIFIC SOCIETIES.

PHYSICAL SOCIETY.

neeting of this Society held on May 25,
f. W. G. Adams, President, in the chair;
Blaikley read a paper on

Wind Instruments as Resonators,

an attempt he has made to carry into
l certain acoustical investigations of the
. Wheatstone. A method by which the
f the nodal points in a cone and in a bugle
ıed was explained; and it was shown that
› cone cannot be used by the lips as a
·ument; that conic frusta cannot give
to the same series of notes as complete
that, therefore, the conical form must be
and, as this modification of form makes
ı of a node for every note required more
ncide with that of the lips, so will the
be more or less perfectly in tune.
ts were shown to illustrate the effect of
form in producing different qualities of
vidence was given of the existence of very
›nic or partial tones in the low notes of
uments. In the trombone the ninth
e (three octaves and a tone above its
thus proved to be sounding, and partial
the sixteenth have been heard. Sir W.
ointed out the connexion between the
musical instrument and the phenomena
a trumpet-shaped bay between high and
he also considered that an investigation
:tones due to the cavity of the mouth
repay research in explaining the influence
s on the vowel sounds.

rie placed on the table a communication
utions and attached water, and on the
of water from crystalline solids in
dry air, in continuation of his researches
already been published. He also showed
f a steam jet in boring through a block,
ı a view of obtaining suggestions as to
ıch a method in the commercial prepara-

erford then showed a photograph of the
ım from the line E to H taken by means
. By means of a heliostat he concen-
·ays on a lens within a collimator, which
o the observing telescope was of consider-
in order to admit as much light as
ıd the grating was moveable. The
; was effected by inserting a lens near
›int of the observing telescope, and he
itive collodion which gave the greatest
f definition about the line G.

ıomson, in continuation of the communi-
s to the society at its last meeting,
he effect of torsion on the electric
of a tube of brass. He showed that
of pull and thrust were different, and
ase of a tube, as in the case of a plate,
iminution in conductivity in the direc-
in the case of the tube, however, the
of the forces result in a sort of echelon
; as regards conductivity.

SCIENTIFIC NEWS.

THE microphone has already demonstrated its usefulness to the surgeon, in discovering the existence of stone in the bladder. On Saturday last Sir H. Thompson, while operating on a patient, showed that the smallest particle of stone could be detected. Mr. Erichsen, Dr. Yandell (U.S.), Mr. M. B. Hill, Mr. Clover, Mr. B. Browne, and others were present, and the opinion was expressed that in the detection of bullets or other foreign bodies, and in the recognition of diseased bone in deep wounds, the instrument would be found of much value.

Mr. Edison believes that some of his recent discoveries may be made of use to the deaf, and has set two assistants to work to test his ideas. He believes, rightly enough, that there would be a large demand for an apparatus which would render the deaf able to hear, and he feels sure that he can produce it within six months. There are, however, at least two kinds of deafness—one which the skill of the aurist can do much to relieve, if not permanently cure, the other, resulting apparently from some injury to the auditory nerves, which he is powerless to remedy.

The first part of the new edition of Thomson and Tait's "Natural Philosophy" is ready for the printer, and will shortly be issued from the Cambridge University Press.

The Cunningham medals of the Royal Irish Academy have been awarded to Dr. A. Smith for his inquiries into Irish numismatics, to Dr. Carey for his mathematical discoveries, to Prof. Dowden for his literary work, and Dr. G. J. Allman for his researches into the natural history of hydrozoology.

The tercentenary of Harvey was celebrated by a banquet at the College of Physicians, Prof. Huxley responding to the toast of the "Memory of Harvey." In the course of his remarks Prof. Huxley stated that Harvey's doctrine of the circulation of the blood was not only absolutely original as regarded himself, but absolutely novel in respect of all those who had gone before him.

A Mr. Fuller, of the United States, has devised a new form of electric lamp which somewhat resembles the Jablochkoff candle. The carbons of unequal size are placed side by side at an angle to the vertical, and are covered on one side by a slip of glass which rests upon them. The glass melts at the points, and, while increasing the radiating surface, secures the steady consumption of the carbons, and reduces the dazzling glare of the light. Mr. Fuller has also invented a means of dividing the current. The new Moderator electric light, invented by M. Rapieff, is stated to be a very gratifying success. The carbons, two for each pole, are arranged thus: $\overset{\text{V}}{\Lambda}$, save that the lower pair form an angle with the upper, and there is an ingenious arrangement by which the carbons are made to momentarily touch in case of a break in the current extinguishing the light.

The annual report of the Astronomer Royal was read at the meeting of the Board of Visitors last Saturday.

The experiments made last week on the London and Brighton line with the Westinghouse brake, and the automatic recording apparatus have yielded some important data, from a consideration of which it appears that several accepted doctrines will require modification. A skidded wheel is, for instance, shown to be much less useful as a train-stopper than a wheel rubbing against a brake block, and adhesion is found to decrease as speed augments. The whole subject, with an account of the experiments, will be laid before the Institution of Mechanical Engineers at their Paris meeting by Capt. Douglas Galton, and we shall wait for his paper before reporting the results of the experiments. Some remarkably quick stops were made by the experimental van: so quick that they would have been unpleasant if the passengers had not been prepared.

The report of the engineer of the Manchester Steam Users' Association contains notes on boiler explosions that have already happened during the present year. To May 24 there had been 16 explosions, killing 31 persons, and injuring 39 others. Speaking of the Dublin explosion, Mr. Fletcher says:—"It appears quite unpardonable that any one should be allowed to put down a steam boiler in a populous neighbourhood, and work it until the plates become as thin as a sheet of paper, and it bursts, dealing destruction all around." Quite so, Mr. Fletcher; but until a Lord Lieutenant is killed or injured, a boiler explosion in Dublin, if it does kill 14 common people, will not induce the Government to interfere.

Mr. Ward, the master cutler, some time ago gave notice that a reduction of wages must take place, or certain hands must stop work. The men declined to accept the reduction: accordingly sheep-shears of a certain quality will in future be made by machinery, the stimulus to the invention in this case being the obstinacy of the men.

The London and North Western drivers are much exercised by the threatened introduction of the trip system of payment—*i.e.*, so much for each journey. The directors aver that trains are "nursed" and purposely delayed to secure pay for more hours—overtime. The men point out that the trip system is calculated to rob them, for often they are miles away from their destination when the time allowed for the journey has expired. The public point out that the trip system is a direct encouragement to hurry and the running of those risks which have so often resulted in fatal so-called accidents. The company have been carrying matters with a high hand, reducing and suspending men who have acted as the mouthpieces of their fellows. Seeing, however, that a company can easily check what they term unnecessary delays and discharge men detected in "nursing," it would be as well if they gave up the trip system, or driving by piecework. The Government have promised to bring in a bill making the use of continuous brakes compulsory. It might be advisable if they made a few other "bye-laws" for the management of railway work.

The British Association for the Advancement of Science will meet in Dublin on August 14, Mr. W. Spottiswoode, president; the American Association will meet at St. Louis on August 21, Prof. O. C. Marsh, president; and the French Association will meet in the Palais des Beaux Arts, Paris, on August 22, M. Frémy, president.

A new pianoforte is attracting some attention in Paris. The keyboard is doubled on itself, and appears as two manuals, the lowest note of the upper being at the right hand. Amongst the advantages claimed are that the fingering is the same for both hands in similar passages, and that each hand has perfect command over the seven octaves.

The Society of Arts offers a gold medal for saving life at sea when a vessel has to be suddenly abandoned. The appliances must be sent in before the end of October next.

At a recent réunion of French learned societies at the Sorbonne, M. Duval Jouve mentioned some interesting peculiarities of the stems of Quercus ilex. These stems have always their medullary canal eccentric, and it is always on the side facing southwards that the woody layers are thickest. The proprietors of the trees remove the bark in May for tanning purposes, and in October cut down the trees for firewood. From May to October the trees become covered with a fresh layer of wood and bark, but very unequally distributed, and even absent on the side opposite to the sun's rays. Sometimes, after a first crop of bark, the stems are left for five or six years, and they then make fresh wood and fresh bark, but these new layers present all sorts of anomalies, and particularly appearances of stems with concentric woody layers, medullary rays, and bark placed between the new stems and the old stem to which they are added, reminding one of the abnormal stems of Malpigiaceæ. M. Duval Jouve explained some of these anomalies, and left others as subjects for future experiment.

After describing Prof. Hughes' microphone, the current number of Naturforscher remarks that it is based on essentially the same principle as a telephone arrangement lately devised by M. Lüdtge, and described to the Berlin Physical Society in April. In both the Bell telephone is used as receiving apparatus; in both it is the variation, by means of sound vibrations of the mutual pressure of two conducting surfaces inserted in the circuit, that causes a variation of the resistance, and so of the intensity of the current. Only M. Lüdtge employs two metal plates in contact, or plates and clippings; while Prof. Hughes uses prepared carbon. M. Lüdtge stated also that his apparatus was so sensitive that one easily heard, with the receiving apparatus, conversation in a neighbouring room, the slightest shaking of the table on which the instrument stood, by placing the hand on it, &c.

To the question put a short time since by a committee of the German Society of Railway Companies, what means were in use, and had been well tested, for preserving the cushions in railway carriages against moths, 43 replies have been received by the directors of the Dutch Railway, from which it appears that the following means are employed:—Constant cleaning, airing, and beating of the cushioned carriages (especially in the developing time of moths in the end of May), avoidance of fold in the cloth used, avoidance of a mixture of horse-hair with pig's hair, Persian insect powder, insect powder with Spanish pepper or phenyl, camphor, Russian leather, powdered alum, hemp leaves, phenol, pine oil, zinc-chloride solution, heating of the cushions in dry air from 70° to 80°C., use of plush instead of woollen cloth, use of seaweed instead of horse-hair, avoidance of sheep's wool, occasional use of general compartments as smoking compartments. The directors express themselves to the following effect:—A generally approved means of keeping moths away from the cushions of passenger carriages has not yet been discovered. Frequent airing, beating, and cleaning are useful in this direction; as also, in greater or less degree, a number of the above-mentioned substances when applied to the cushion material. After entrance of moths a thorough cleaning of the material is necessary.

An old French ship, the Argonaute, destined for torpedo experiments, was recently being towed from one place to another by the Desaix. A conducting wire was wound round one of the towing cables; it terminated in the ships, and was connected with telephones. The circuit was completed by means of the copper sheathing of the ships. In this way, M. Tréve says, conversation was as easily carried on between the vessels as if the speakers were in the same cabinet, and it seemed to him as if the return circuit by sea improved the distinctness of the sounds. A lieutenant on board the Desaix also conceived the idea of adapting the telephone to the diver's dress. One glass of the helmet is replaced by a copper plate, in which is fixed the telephone, and the diver has merely to make a slight turn with his head to receive communication or to speak. This arrangement gave quite satisfactory results.

An account is given in the *Deutsche Banzeitung* of a recent interesting operation in Berlin—viz., the demolition of a workshop chimney by means of dynamite. This chimney was 51·80m. high, and contained about 540 cubic metres of masonry, weighing 864 tons. It had a division in the centre. It was necessary to make it fall towards the east, and the charge was required to be as small as possible, that the materials might not be much damaged by projection. Eight blasting holes were made from the exterior near the base, on two opposite sides, and their charge was placed as near the middle of the thickness as possible. The two chambers nearest the clearing hole on the east side were each charged with 3 kil. of guncotton; those next the clearing hole on the west side received only 500 grammes of dynamite; the four other chambers were charged with 1 kil. of dynamite. The tamping was effected with bricks and mortar. The total charge of 15 kil. was exploded by electricity, all the parts simultaneously. The dull explosion shook the ground only to 300m. distance; the chimney did not fall, but took an evident inclination, while three great cracks rose to 15m. height and the lower part of the wall was laid open. Two other holes were now made in the part of the wall remaining vertical, and a charge of 600gr. of gun-cotton was inserted and exploded; the chimney then fell slightly towards the east.

A new form of pen for drawing dotted lines has been devised and patented by M. Dörffal, of Berlin (*Ding. Pol. Jo*). On the lower part of the ivory handle is fixed a steel rod, on which slides a piece attached to a spiral spring round this rod. The piece has below a steel nose, which by the spring is pressed against a toothed wheel which runs on the paper. It has also connected with it the pen, whose point is at the level of the circumference of the wheel. The wheel being forced round by pressure on the paper alternately depresses and raises the pen, and thus a dotted line is produced.

An American contemporary states that twenty-four years ago a gentleman packed several eggs in a box of oats and put them in an out-of-the-way-place in the attic of his store, intending to test their condition after a year. Forgetting all about them nearly a quarter of a century had passed, when, in overhauling the contents of the attic, he came upon the box. On breaking the eggs, the shells of which appeared sound, the whites were found to have totally disappeared, while the yolks remained dried and quite hard. The oats in which the eggs were packed were as sound as the day when they were put in the box, and the gentleman has planted several in order to test their vitality. In the box was found a memorandum giving the date on which the eggs were deposited. The effect in question was no doubt due to the dryness of the locality. Eggs can be easily dried by being surrounded with substances that absorb the evaporating moisture. In New York there is a company that manufactures dried eggs and sells the contents in pulverulent form. They perform the drying very rapidly by means of a vacuum generated by an air pump, which removes all moisture as soon as it escapes from the albumen, on the same principle that vacuum pans are used in sugar refineries.

The Russian manufactory of arms at Toule, which has long employed 1,600 workmen, has now (we learn from *Revue d'Artillerie*) increased the number, and by working night and day 650 Berdan (No. 2) rifles are made daily. The manufactories of Sestrovetz and Ijewsk furnish together about 400 arms daily. The artillery are having manufactured their new field guns, 4 and 9 pounders, which are to be made of compressed bronze. The arsenal at St. Petersburg is constructing the gun carriages on the Englehart model, and transforming two wheel into four wheel caissons. The initial velocities got with the two new cannons are respectively 457 metres and 396 metres.

The existence of an allotropic modification of copper, distinct by its physical and chemical properties, has just been established by M. Schutzenberger, who has described those properties to the French Academy (*Comptes Rendus*). The surest way of obtaining it is by electrolysis of a 10 per cent. solution of acetate of copper, previously boiled some minutes (to expel acetic acid and render it slightly basic). Two Bunsen or three Daniell elements are used, and all rise of temperature in the bath is avoided. The electrodes, platinum negative, copper positive (and larger), are arranged parallel about 3 to 4 ctm. apart. The face of the platinum next the copper is then covered with allotropic copper, while the other face receives a thinner deposit of ordinary copper. The new form has a bronze appearance, with metallic lustre, slightly rugose surface; it is brittle, and can be bruised to impalpable powder in an agate mortar, &c.

Among subjects on which investigation is invited by the Belgian Academy (and prizes are offered for 1879) are the following:—Study of torsion, and extension of our knowledge regarding it, either from the theoretical or the experimental point of view; composition and mutual relations of albuminoid substances; functions of the various anatomical elements of dicotyledonous stems, especially as regards circulation of nutritive substances and the use of the fibres of liba; does the germinative vesicle in eggs, that are developed without previous fecundation (by parthogenesis), behave as in fecundated eggs? cycle of evolution of a group of the class of algæ.

LETTERS TO THE EDITOR.

[We do not hold ourselves responsible for the opinions of our correspondents. The Editor respectfully requests that all communications should be drawn up as briefly as possible.]

All communications should be addressed to the Editor of the English Mechanic, *31, Tavistock-street, Covent-garden, W.C.*

All Cheques and Post-office Orders to be made Payable to J. Passmore Edwards.

*** *In order to facilitate reference, Correspondents, when speaking of any Letter previously inserted, will oblige by mentioning the number of the Letter, as well as the page on which it appears.*

"I would have everyone write what he knows, and as much as he knows, but no more; and that not in this only, but in all other subjects: For such a person may have some particular knowledge and experience of the nature of such a person or such a fountain, that as to other things, knows no more than what everybody does, and yet, to keep a clutter with this little pittance of his, will undertake to write the whole body of physicks: a vice from whence great inconveniences derive their original."
—*Montaigne's Essays.*

THE TRANSIT OF MERCURY IN 1868 — OCCULTATION OF α SCORPII — AERATED BREAD—BOOKS FOR THE STUDY OF ASTRONOMY—TWILIGHT —BOOKS ON BOTANY—DIAPHRAGMS IN A TELESCOPE—NAUTICAL ALMANAC FORMULÆ FOR THE TRANSIT OF MERCURY—RIDING—CHROMATIC O.G.

[14414.]—If Mr. H. T. Vivian (letter 14351, p. 264) will communicate his observation of the Transit of Mercury in 1868 to Mr. John Brett, he may, I think, quite possibly learn from that eminent astronomer that the phenomenon which he witnessed simply had its origin in "specular reflection" from a large surface of mud surrounding the north pole of the planet.

Mr. Stevenson (letter 14355, p. 265) appears to me to be a little too confident when (in connection with his supposed observation of "rays shooting out from behind the dark limb of the moon for fully three seconds before 'Antares' reappeared") he says "I am positive it was not an optical delusion." Nothing is much more deceptive than a naked-eye observation of an occultation by the crescent moon. I remember well, when Saturn was occulted in 1859, how a lady, who observed it without any optical aid, assured me positively that the planet penetrated far between the horns of the moon before disappearing; and that I had the utmost difficulty in persuading her of the physical impossibility that this could have happened. For one occultation that Mr. Stevenson has observed I am probably speaking within bounds when I say that I have watched twenty, and I can assure him that in the whole course of my extensive experience I have never witnessed anything in the smallest degree resembling the appearance of rays of light previous to the emersion of a star. Such an emersion (and notably when it occurs at the moon's dark limb) is as absolutely instantaneous a phenomenon as occurs in Nature.

Inasmuch as I invariably eat the Aërated Bread whenever I visit London, I have been rather interested in the correspondence which commenced with letter 14316 (p. 220). Having nothing to [illegible] proximately or remotely, with the Company which makes the Aërated Bread, I may perhaps be allowed to bear my own testimony to its delicious flavour and entire purity. Even had I not seen the disclaimer of the Secretary in letter 14361 (p. 267) I would have trusted to my own sense of taste [illegible] decide that this bread is free from adulteration. Doubtless the preference given by a large [illegible] of people to perfectly pure bread, which has [illegible] been touched by human hands, must have [illegible] the profits of those who vend loaves made in [illegible] cellars by men reeking with perspiration, and [illegible] the composition of which alum, potatoes, and [illegible] really *do* enter as ingredients. Hinc illæ lach[illegible]

As "Cornishman" (reply 32743, p. 27[illegible]) [illegible] intimates his wish to study Stellar and Pla[illegible] Astronomy in their instrumental aspect, [illegible] better at once get Webb's "Celestial Objec[illegible] Common Telescopes" and (should he be ignor[illegible] the face of the Heavens) Proctor's "Smal[illegible] Atlas." These will give him ample work for a long day—and night, too. In order to get rudimentary ideas on the subject of mathe[illegible] astronomy he may procure Hunter's "Plane [illegible]nometry" and its "Key" in "Gleig's [illegible] Series," Chambers's "Mathematical Tables," the "Astronomy," by the late Rev. R. M[illegible] "Weale's Series," or Ball's eighteenpenny "[illegible]nomy," not long published. He will also [illegible] great deal of information from Sir Edmund Be[illegible] "Astronomy without Mathematics," [illegible] mastered these may proceed to Loomis's "Pr[illegible] Astronomy."

If "X." (query 32962, p. 276) will turn to [illegible] graph three of letter 14349 (p. 264) he will [illegible] once upon what principle the duratio[illegible] of twi[illegible] latitude may be calculated. Twilight per- ng as the Sun is only 18° b-low the horizon, ı may use the formula I gave (loc. cit.), by e Sun's Zenith Distance 108° (*i.e.*, 90° + us we find the hour angle from apparent 'hich twilight begins or ends, and subtract- this the hour angle from noon of the Sun's setting, we shall get the duration of twi- f course whenever the difference between N.P.D. (in this part of the world), and de is less than 18°, twilight lasts all night ondition of things which obtains at present. no publication containing the amount of .ight in London.

sorry to say that it is wholly out of my assist "E. M. M." (query 32988, p. 276), nowledge of botany being practically nil. The flowers which I can certainly recognise are love, gorse, heather, and wild convolvulus. ch circumstances, then, my recommenda- ›oks upon the subject must almost certainly than useless.

cope Tele" (query 32994, p. 276) must fix ragms in the tube of his telescope in such a hat on removing the eyepiece, putting his place, and looking up the tube, the edge of t-glass is just seen. Thus, to give a very ample, we will suppose that the aperture of t-glass is 3in. and its focal length 40in.; ve had a diaphragm of 1½in. aperture, it ıve to be placed exactly 20in. from the , or half way up the tube. Or, if we sup- diameter of the opening in one diaphragm , then must we place it 5in. from the eye- ɜ tube, and so on.

rtson" (query 33000, p. 277) is to be sym- with in his inability to decipher the for- ən on p. 402 of the *Nautical Almanac*. I t an example of one of them only, worked ɜ appendix, would have materially helped heir apprehension by the ordinary observer; such example has been given, I will take 'ormula and exhibit the operations which nts. Premising, then, that 3h. 12m. 25s. ndicates the instant of external contact as om the Earth's centre, if we require such ›r any other place, we say—

CONSTANT LOG. 1·8758.
of Earth's radius.............. . . . .
sin. lat. N. ....

$x =$

CONSTANT LOG. 1·9180.
of Earth's radius ....
Cos. Latitude N. ....
cos. (long. E. — 56° 43·4′) . . . .

$y =$

ı time required = 3h. 12m. 25s. — $(x + y)$

. A." (query 33010, p. 277) should ride for :le time without any stirrups at all. He orce soon shake down into an upright .

mo" (query 33047, p. 301) can do nothing object glass. The "wings," exhibited ›right star is viewed through it, doubtless r origin in the fact that the glass of one or the constituent lenses of the objective is, ot, homogeneous, so that all the regrinding orld will not set it to rights. He had much ll it for what it will fetch.

ıow of the Royal Astronomical Society.

ıALL STAR NEAR CASTOR— CASSEGRAIN TELESCOPES.

5.]—IT was with much pleasure I perused the ing communication of "Hyperion" (14352, , more especially as we are not often thus d. Not that I can detect any "double" near being only too pleased to divide Castor itself, ptical means, unlike "Hyperion's," are very but one can always learn something inci- ı from a person who writes from the love of ject. For instance I never dreamt of a ›eing better in one part than another, thereby the use of eccentric stops, which, again, is ng new to one who always associated a stop idea of a perfectly annular figure or central omething analogous, however, is mentioned lev. T. W. Webb's book, in which he says object-glass is sometimes defective in one d recommends a piece of sticking-plaister, rhaps is new to many of your readers.

want to say something about the Casse- Hyperion's" favourite form of instrument he has altered his opinion of late). I sup- ɜ 8¼in. With he mentions is the one he ted so successfully, and described in Vol. ı page 91. The 18in. Calver, about which ms, should like to hear something, is, I sup- a Cassegrain, or rather a convertible one. as I am going to try to construct one, I have looking in "our" pages and elsewhere for anything relative to telescopes in general, and the Cassegrain in particular, and on which I respectfully ask "Hyperion's" advice and opinion. I may remark *en passant* that those who grind mirrors professionally are slow to take "Hyperion's" (and, to my mind, excellent) advice about selling them perforated (except ordered otherwise), thereby enabling the purchaser to make any form of instrument. I read in one edition of the "Encyclopædia Britannica" that it "does not appear that Cassegrain ever constructed a telescope of the form he suggested," which perhaps accounts in part for the almost general neglect of his invention; but it seems to me that it is precisely the thing for amateur speculum-grinders, because there appears to be no necessity for parabolising (and this is the rock on which we are wrecked), thereby making us independent of those gentlemen who hold the secret of working them to that figure. Now, in the Newtonian form it is well known that a parabola is required if you wish perfection, but there is a general idea that a parabola is always a necessity, and that a spherical figure is, as one of our noted opticians says, totally useless.

But both of these ideas require, I think, a considerable amount of qualification: for instance in the "Herschelian" form "it is useless to insist on a parabolic figure in preference to a good spherical one." ("Herschel on the Telescope," page 81.) I come to the conclusion that a good spherical figure, as long a focus as is convenient, and the "Cassegrain form of instrument, is the right thing for amateurs, for the reasons following: "Hyperion" is the fortunate possessor of a perfect parabola by With, which he converts into as good a Cassegrain as it was before a Newtonian, by adapting the small convex to it, and Mr. Calver says that he prefers an elliptical curve for the large mirror, as the small convex is easier to figure—so that, if both parabola and ellipse can be fitted with small mirrors, there seems to be no reason why a spherical one cannot be so suited. If, therefore, an amateur gets a good spherical figure, his only difficulty (as far as figuring is concerned) is the small convex, and it would be better to grind several small mirrors until the desired shape was attained than to risk altering the large one.

With regard to a long focus all admit its advantages, I think, as it favours any form of telescope by reducing the spherical aberration ("Herschel on the Telescope," page 17). Again, Herschel says that the two mirrors in the Cassegrain tend to correct each other, and this is a point I especially wish to be enlightened on—does he mean by reason of the focus being lengthened only? I think not; but, if so, then the more convex the small mirror is the better (as far as spherical aberration is concerned). If not, does he mean that it is possible to make them correct each other by observing a proper proportion between the two curves; if so, what is that proportion?

Mr. Calver says in his "Hints" that the Cassegrain admits a little more light than the Newtonian, which is very puzzling, considering the very small hole you have to look through, and the rays from the large mirror having to undergo almost a perpendicular reflection, the second reflection in a Newtonian being performed at an incidence of 45° generally, but even a more oblique incidence has been suggested by Sir David Brewster to increase the light, or rather to prevent so much of it being lost. Any remarks on the above will oblige.

A. N. H.

DOUBLE STARS.

[14416.]—MR. LOCKYER, on page 165 of his late work, "Stargazing," speaking of ζ Orionis, says it "is a capital test, both of dividing and space-penetrating power, as the two bright stars of the second and sixth magnitudes of which the close double is composed are exactly 2½″ apart, while there is a companion to one of the companions of the twelfth magnitude about ¾″ distant" Will "F. R. A. S.," or some other correspondent, state what is the authority for this close new star, or by whom it was discovered? The distance does not seem to be a misprint for ¾′, as the 10th magnitude star, 60″ distant, is referred to in the next sentence. The following are among late measures (letter 14246) of ζ Cancri:—

Dembowski	P=108° 69 :	D=0″·682	(1877·17)	7 obs.
	131°·62	5″·312	(1876·99)	4 obs.
Schiafarelli	108°·18	0″·819	(1877·18)	4 obs.
	130°·63	5″·268	(1877·18)	4 obs.

The double star Σ 1529, though not discovered by Herschel I., was observed twice by Sir John Herschel ("First Series of Micrometrical Measures" and "Seventh Catalogue"). The components seem to be relatively fixed.

My attention has been called to a star (R.A. 12h. 52m.; decl. + 18° 25′) given in Birmingham's revised list of red stars as a close double. A recent examination of this star with the 18½in. refractor of the Dearborn Observatory resulted in finding it apparently single, and very uninteresting in colour, being at most only yellowish.

S. W. Burnham.

61 VIRGINIS.

[14417.]—SIR WILLIAM HERSCHEL entered this in his list of wide double stars as No. 90 of Class VI., the small star being about tenth magnitude. The change in the angle and distance of the companion since Herschel's time has been very great, in consequence of the proper motion of the large star. The following are all the measures made of this pair:—

Herschel I.	P = 345·°	D = 73″·25	1783·0
Knott	22·6	169 29	1862·3
Burnham	25 2	189·34	1878·3

There is an observation of this in the "Cycle of Celestial Objects," but, as in a great many other instances of similar stars, it is widely erroneous in both angle and distance. Smythe gives for the angle, 340°·6, and difference of R.A. 2·8s. The apparent movement of the small star is in the direction of about 44°, the real motion of the large star of course being in 224°. Flammarion gives the proper motion of 61 Virginis in R.A. — 0 075s., and in P.D. + 1″ 04. The last observation given above was made with the great equatorial of the Dearborn Observatory.

Chicago, May 13. S. W. Burnham.

SUNSPOTS.

[14418.]—THE extraordinarily long period of total absence of spots from the sun's disc is at last ended. On March 16 there was an insignificant group visible, which I estimated to be about 5′ off the W. limb: overcast weather now prevented me getting even a glimpse of the sun till the morning of the 20th, when I could see no spot whatever. From this day on I examined the sun on every possible morning and afternoon, with a uniform negative result as to the presence of spots, until the afternoon of the 21st of the present month. I then saw a very minute round spot, not yet quite half the diameter on; this I could not catch the next day, but the circumstances were unfavourable, as I observed during a break in the clouds which was by no means a perfectly clear one, and the spot was very small indeed. So there was a space of sixty-two days, or nearly nine weeks, during which I could not see any spot, large or small. I should think that we have at last arrived at the absolute minimum of the present sunspot period.

During the past two months I have noticed on many occasions the unusual clearness and visibility of the "mottling" which some observers remarked at the late transit of Mercury. Very bad weather (as well as the drawback of being from home) has, since the 21st, only permitted me to take a short look at the sun yesterday (27th) afternoon, when I noticed a group of spots, which I think was quite a new one, not far from the E limb. By the bye, I have found that, my red sun glass although not dark enough when the sun is very bright, when it is smoked to a proper density the views are very pleasantly cool and clear.

Mac.

MORE SUNSPOTS.

[14419.]—OUR readers may like to know that a neat group of spots was seen on, and nearly parallel with, the sun's equator, and just within the western hemisphere, at 4 p.m. on Saturday, June 1. They were not visible two days previously.

Kensington. I. V. V.

A METHOD OF FINDING THE EARTH'S DENSITY.

[14420.]—IN my letter, p. 295, your compositor has put a small *g*, instead of a capital G, at the end of the paragraph which explains why the value of *v* is taken as equal to 2*g*. The manuscript had it G, which means Gravity, and not *g*, which means the accelerating force of gravity in one second of time. There is also a dash and a comma too much in the paragraph, which should read "then one volume of water would equal in weight the present weight of a volume of matter that is 5·106·8 times as dense as water." I may state that this is the first time I have corrected printers' errors in my letters. Some of such errors certain correspondents have not been slow to make capital out of, to my great amusement.

G. Pinnington.

UNFERMENTED BREAD.

[14421.]—I THINK "Daghbert" is right in preferring unfermented to fermented bread (though many do not), but there is one danger attending that made by decomposing bicarbonate of soda with muriatic acid that is often not attended to. The acid frequently contains a small quantity of arsenic, seldom enough to kill, but sufficient to produce gradually very unpleasant effects, the cause of which may not be immediately discovered. I knew a physician, who was a good chemist, whose family suffered from this cause some time before it was suspected, and it is a danger of which many are not aware, but which is easily avoided by those who are.

Philo.

MICROPHONE.

[14422.]—As I have been successful in making a microphone, perhaps a description of it may be useful to others. I followed Mr. Lancaster's instructions, which were distributed at the conversazione of the Midland Union of Naturalists' Club, held in Birmingham on the 27th inst. Procure a box, A (see Fig. 1), about 2in × 6in. × 1in., and on the end glue a piece of thin wood, G, such as used for fretwork, 2½in. × 2in. On A lay a piece of sheet zinc, 2in. × 6in. Above this place several layers of blotting-paper, C, moistened with a solution of sulphuric acid 1 part, and water 10 parts. Above this place a piece of gas carbon, about 2in. × 6in. × ¼in. At right angles to G glue or fasten a piece of gas carbon, E, 2in. × 2in. × ¼in., making a notch in the middle of the free end, so that the stick of gas carbon, E, which is about 1¼in. long and of ¼in. diameter, may lean against it. A depression is also made in D to receive the end of E, which is pointed for that purpose. Elastic rings, J J, are now slipped over the whole to keep all in position. If wires are now attached to the zinc, B, and the carbon, F, by holes through them or by binding screws, the microphone is complete. The connection with the telephones is as follows (see Fig. 2). A is the microphone; B, one telephone; C, the line wire; D, the other telephone. By placing a watch on F, or by talking just over it, the ticking or the voice is distinctly heard at the telephone, D. The cost of my microphone was about 1s. 6d., and took me half an hour to make.

Wiseaf.

FIG. 1

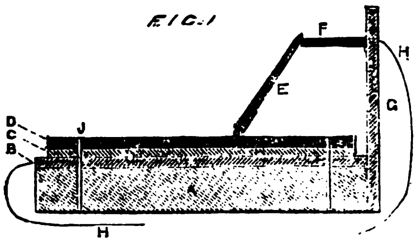
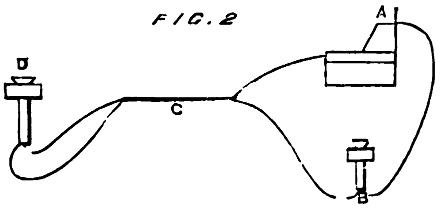


FIG. 2



THE PHONOGRAPH.

[14423.]—I have recently been experimenting with the phonograph with a view to ascertain whether it would not be possible to make use of a continuous narrow strip of tinfoil in lieu of the cylinder of tinfoil at present in use. My principal difficulty, however, has been in preventing the impressions made by the pointer of the receiving diaphragm from becoming obliterated when the foil is coiled round a wheel, and I have come to the conclusion that the strip of foil should have a "backing" of some kind, both for the purpose of giving it a certain amount of elasticity, and to prevent it from tearing. I fancy that a strip of very thin guttapercha, similar to that used in making the joints in telegraph wires, would answer the purpose; but I am not quite sure whether it is possible to attach tinfoil to guttapercha, and on this point I should be glad of a hint from some of "ours." The band of tinfoil should be wound round a wheel, say, of 10in. diameter, having a groove ½in. wide, and 1in. or more deep. A similar wheel should be provided for winding up the band of foil after it has passed the pointer attached to the diaphragm. These wheels can be so arranged that the band may pass either horizontally or vertically in front of the pointer. In either case it will be necessary to have a piece of ivory, or other suitable substance, attached to an upright support placed in front of the vibrating diaphragm, in order to serve as a guide to the strip of tinfoil as it passes the pointer, and to keep it steady. I venture to make these suggestions in the hope that some of the readers of the English Mechanic will give them a trial, as I feel convinced that the phonograph will never prove of any practical utility as long as its operations are limited to the size of its cylinder.

C. Stewart, M.A.

50, Colebrooke-row, N., May 27.

TELEPHONIC.

[14424.]—Your correspondent (letter 14363, W. C. Lockerby) is in error as to the theory of articulation in the telephone. It must be noticed that the influence on the diaphragm is always at the same *point whatever the pitch* of the note or articulation; also the diaphragms vibrate equally at all points—that is, of course, at an equal rate. The correct theory of the articulation of a telephone diaphragm is the capability of the disc to answer to any vibration forced upon it. The magnets have such control over its vibrations that any and every change of potential in them must, and does, influence the diaphragm. The loudest part of the sounds always proceeds from the centre of the diaphragm where the vibrations are most intense, and to this there is no exception. If your correspondent will consider the phonograph he will at once see his theory incorrect. In that apparatus the centre of the diaphragm answers to all numbers, strengths, and variations of every sound.

May 27. **J. Brockie.**

THE TELEPHONE IN THUNDERSTORMS.

[14425.]—I fully intended informing your readers before now what I had noticed on this subject, and the paragraph in "Scientific News" reminds me afresh. In the storm of Saturday morning, 18th May, when it was fully half a mile distant from my residence (judged by interval between flash and thunder), I placed the telephone, which hangs close to my bed head, to my ear. The wires go perpendicularly down the outside of the house to four stories below, and the earth circuit (that is, the gas-pipe) is included. I distinctly heard a crepitation of the diaphragm in the two last flashes of the storm, and I fancied the first of the two crepitations was compound—that is, that a quantity of vibrations occurred nearly, but not quite, instantaneously. I had noticed crepitation in the storm some weeks ago, but was not sufficiently certain to affirm the same positively.

Lightning.

ISOMERISM OF METHYL AND ETHYL HYDRIDE.

[14426.]—I have read the passage in Frankland's "Researches" bearing on the above subject, to which Mr. Grey was good enough to refer me, but cannot find anything to alter the views I have already stated in the English Mechanic. Perhaps Mr. Grey will kindly let us have his opinion on the matter.

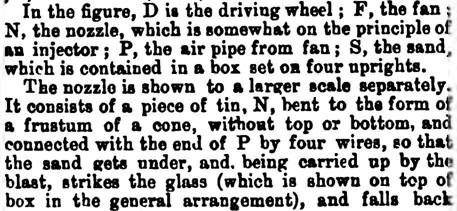
Hugh Clements.

THE SAND BLAST.

[14427.]—I inclose sketch of a design for the above, on which I invite your readers' criticism. The object is to use the same sand repeatedly without the usual complication of endless band, &c., for lifting it up, which is necessary in those forms in which the glass is placed below instead of above the jet, as shown on p. 235, Vol. XVI.

In the figure, D is the driving wheel; F, the fan; N, the nozzle, which is somewhat on the principle of an injector; P, the air pipe from fan; S, the sand, which is contained in a box set on four uprights.

The nozzle is shown to a larger scale separately. It consists of a piece of tin, N, bent to the form of a frustum of a cone, without top or bottom, and connected with the end of P by four wires, so that the sand gets under, and, being carried up by the blast, strikes the glass (which is shown on top of box in the general arrangement), and falls back ready to be used again.



I see on p. 235, Vol. XVI., that the velocity acquired by sand falling through a tube, 8ft. long, was sufficient for engraving glass, &c. This would mean a velocity (allowing for friction) of something under 22ft. per second—say, 20ft. per second.

How many feet per second must the current of air in P move, in order to raise and carry forward the sand at this speed? How many revolutions per second must an 8in. fan make? Air pipe, ⅜in. diameter; ¼in. nozzle. Fan to be made of six tin blades, fixed to a wooden centre.

Glatton.

KNAPSACK TOURS.

[14428.]—In reply to "R. G." (letter 14366), I beg to state I use the Tourist's Waterproof Check Knapsack, manufactured by a waterproofing firm near Trafalgar-square, value about 18s. to 20s. I cannot recollect the exact address or value. I find perfect freedom of the arms during its use; a light strap across the chest, with two loops through which the shoulder straps pass, keep it comfortable. I have also used the straps crossed at the chest with equal comfort.

I have not seen the new military knapsack. If it is serviceable for the tourist, and of the value mentioned (7s. 6d.), it will probably become a favourite with many. I give a rough sketch of a method I have invented and use, of converting the ordinary trousers, if sufficiently loose, into knickerbockers in a few minutes. Measuring from the bottom, at about 4in., on the seams of the inside hooks, and higher, about 14in., eyes are sewn; the trousers drawn up as shown in sketch, No. 1; the attachment, with hooks and eyes made, the loose portion then drawn down forming sketch No. 2. The comfort of this simple arrangement will be appreciated.

FIG. 1

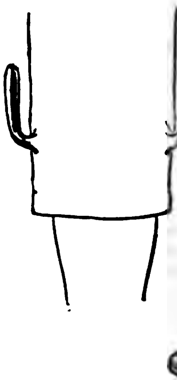
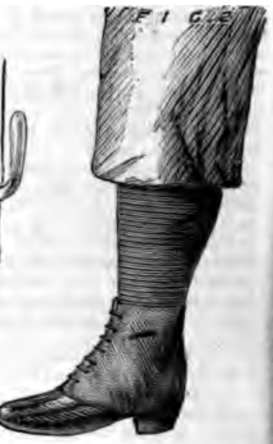


FIG. 2



I omitted to mention in my previous note that a small pocket compass dial should form an important part of the tourist's kit. When in doubt of the road to pursue, place the dial upon the map, turning the top, the north, to correspond with the north shown by the dial, the route is easily ascertained.

J. J. M.

PROFESSOR MILLS ON DESTRUCTIVE DISTILLATION.

[14429].—Your correspondent writes a long letter in No. 688 (p. 289) with the result of refuting himself. He wishes to prove that I had charged him with expressly stating what he can only show I alleged he had "seemed to imply." He admits that a quotation of his did not contain the two (vital) words "at most," which, it must be evident, very materially alter the sense. He shifts his ground from his assertion as to quantity of naphtha, and now lays stress mainly on the specific gravity. He cannot distinguish between the two terms "purified" and "pure," as commonly used in commerce. He is astonished that any one professing to understand the manufacture of ammonia should state that lime can act as a purifier in the still, the notorious fact being that it has been successfully so used for years, and for very good reasons. It would be a fruitless task to argue farther with a person who cannot appreciate simple distinctions in language, who knows so little of the practical experience of others, and who declines to give his own name, as I have done, in support of what he says. I am myself a manufacturer—of figures and principles, if not of ammonia and naphtha In this capacity I venture to give your correspondent some additional information, which will probably astonish him still more. 1. Light naphtha may have as low a specific gravity as 0·6. 2. Sometimes it contains no benzol at all. 3. Coal yields from 1 to 65 per cent. of tar, according to the coal and the mode of working. Lastly, amateur reviews are very unsatisfactory, especially when disguised in the unusual form of letters to a scientific journal.

Edmund J. Mills.

Anderson's College, Glasgow.

BEDS AND WINDOWS.

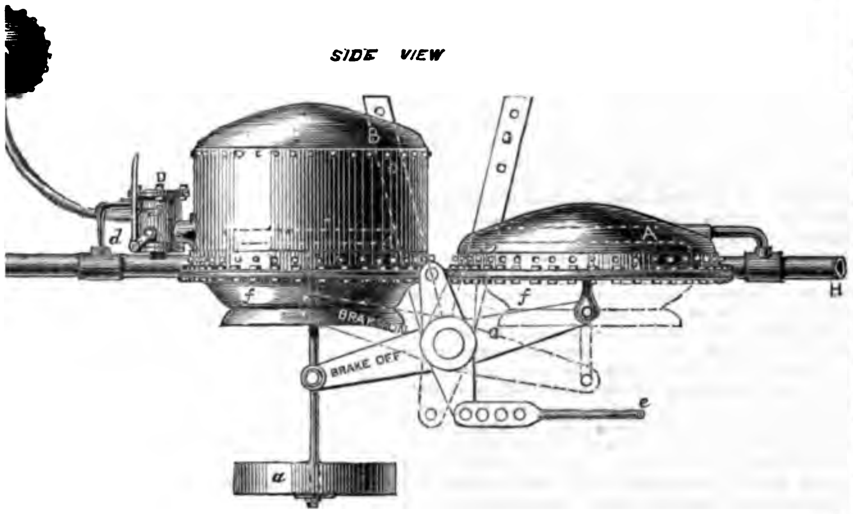
[14430.]—It is often said, though I do not say it, that no one makes good tea who does not intend to drink, but it does seem that few care to put beds in proper positions who do not mean to sleep in them. I travel a great deal and sleep in a great variety of beds, both in inns and in private houses. In the latter the beds are nearly always so placed that the sleeper can turn his face from the light, and lie undisturbed until it is time to get up. In inns, three times out of four at least, I find the beds fixed with the foot towards the window, so that sleep is apt to be broken by early daylight, long before we are accustomed to arise. When, as is usual, the window is at one side or end of the room, there [illegible] in which the bed can be placed, but towards the light, and yet, queerly enough, ng way is chosen three times out of four in ot once out of four in private houses. Can ner reason be suggested than that those who beds in inns do not mean to sleep in them, hose who do have no choice? **Philo.**

TINUOUS BRAKES—SANDERS'S AUTOMATIC VACUUM.

1.]—The Sanders automatic vacuum brake been at present illustrated in the English NIC. Although it is considered to be the the vacuum brakes, its construction is little ood, and its merits have frequently been over-

lrawing shows this brake as in use upon the Western Railway, and the following descrip- l make the details clear. The Sanders auto- acuum brake is a continuous brake, which s upon the brake blocks throughout the train, e exception of those fitted to the engine and wheels. A single line of pipe runs the entire of the train, in which a constant vacuum is ined while running by a pump working from shead of the engine and by an ejector pre- to starting. The brake is applied by destroy- vacuum in the brake pipe, which is done by air in either accidentally or by the driver or The brake is therefore self-acting in case lent, and the pressure gauge upon the engine ach van, is a "tell-tale" upon its action.

pull off" drum; B, "pull on" drum; C, lever; D, stop and release valve; E, extra chamber; F, rocking shaft; G, rocking racket; H, main brake pipe (2in. gas pipe); "pull off" weight; *d*, lever to raise release *e*, brake rod to the usual brake fittings; *f f*. diaphragm. The "pull on" drum moves es with a maximum brake force of 2,500lb.



vehicle has two brake cylinders or drums of diameters. Each drum has one end closed d, and the opposite end by a rubber dia- , firmly bolted between a flange on the drum ron ring. Each diaphragm is also clamped ntre between two circular plates of iron, and ates have rods that connect to two levers in manner that one diaphragm or drum acts the other, at the same time turning a rock- t that applies or releases the brake blocks.

lrums have communication with the brake When air is exhausted from the main brake the apparatus on the engine, a vacuum is n both drums.

ese drums pull against each other, and as a larger area than the other, it follows that hragm or piston of the large one will be nto its drum when the vacuum is created, the diaphragm of the small drum will be its extreme outward position. In this posi- brake is "off."

onvenience the larger drum is called the ff" drum, and the smaller one the "pull m.

en the brake pipe and the "pull on" drum ck valve that permits air to flow from the to the pipe, but not from the pipe into the The "pull on" drum has a large space in to that required for the movement of the m, and when the vacuum is once created , it serves as a store of power for the appli- the brake blocks.

the "pull on" drum cannot be made large separate vacuum chamber is employed, and sted by a pipe to the valve case containing bined release and stop valve that governs of air from the "pull on" drum to the pe.

The vacuum in this "pull on" drum remains, after being once formed, until it is destroyed by leakage, or by lifting the release valve to let air in from the brake pipe.

To save space the brake blocks and rods are omitted in my diagram, as they are simply the ordinary brake fittings. When a train is "made up" ready to start the hose couplings are first connected; the one at the rear of the train is closed by being fastened to the "blank" or "butt coupling," with which each carriage is provided at either side. The ejector upon the engine is then put in operation, and in about 20 seconds a vacuum of 10lb. to the square inch, in the brake-pipe and in all the brake drums, is created. The superior pressure on the large diaphragm of the "pull off" drum holds the brake "off" in the position shown in the drawing. As soon as the train starts, the "vacuum" is maintained by the pump on the engine, the steam being shut off from the ejector.

For some time past surprise has been expressed that the action of the Sanders brake is "slow" compared with the Westinghouse, and the question is often asked, "Why does the air get out of the Westinghouse brake pipe quicker than it can get into the Sanders brake pipe?" The radical defect in all vacuum brakes is, and must always be, that compressed air is used at a pressure of 70 to 100lb. per square inch, whereas a vacuum brake can have only the pressure of the atmosphere to work with. A perfect vacuum gives a pressure of about 15lb. per square inch, but in practice a partial vacuum only can be obtained, and this pressure does not exceed 12lb. per square inch.

For a carriage, the "pull on" drum occupies a space of 2ft. in diameter by 1½ft. high, and the "pull off" drum 2¼ft. by 1ft. high. As the engine and tender weigh three or four times as much as a carriage, the drums for an engine and tender would have to be three or four times as large as those used on a carriage. Apparatus of the necessary size could not be placed on either the engine or the tender; they are therefore deprived of the advantage of an automatic brake, and are not under the control of the guard.

As only a low pressure of air is obtainable, the drums have been made large, so as to bring a sufficient force against the brake blocks. As the "pull off" drums have to be entirely filled with air to get the brakes full on with as little delay as possible, the pipes have been made 2in. in diameter.

The space in the "pull off" drum and pipes amounts to 3,000 cubic inches for each carriage, and 2,400 cubic inches of air have to enter the pipes and drum of each carriage to fully set the brakes, by destroying the partial vacuum of 12lb. pressure; or, on a train of 15 vehicles, 36,000 cubic inches of air have to flow, at low pressure, into the pipe through the brake valve in the engine, and distribute itself throughout the pipes and "pull off" drums, some of the air having to pass the entire length of the train, or a distance of over 400ft. Careful experiments show that to destroy a vacuum of 12lb. in pipes and vessels of the above dimensions thus arranged requires about ten seconds.

It will thus be seen that the reason the Sanders brake is slow in its action is on account of the enormous quantity of air which has to enter the brake pipe at a low pressure. Whereas, in the Westinghouse brake, a reduction of 20 per cent. of the pressure in the brake pipe only causes the triple valve pistons to move down and set the brakes with full force by means of the air stored in the small reservoirs.

The distance from the reservoirs to the brake cylinders averages about 2ft., and consequently there is no perceptible loss of time in the air passing from one to the other. The space in the pipe of each carriage is about 200 cubic inches, and therefore only 40 cubic inches per carriage, or 600 cubic inches for a train of 15 vehicles, have to escape at high pressure to "set" the brakes with full force. This is found in practice to take only 1¼ second. And when a train "breaks loose" the time is reduced to only three quarters of a second, as the coupling hose are drawn, or rather jerked apart, and the air escapes from two apertures instead of only through the three-way-tap, as in an ordinary stop.

Another defect in the Sanders brake is that the size of the brake pipe prevents the use of stop-taps at the end of each carriage, so that if the hose couplings are separated, whether by accident or otherwise, the brakes are "set" upon all of the carriages, and can only be released by going to each individual carriage to destroy the vacuum in the "pull on" drum, by opening the release valve to let air in from the brake pipe. Thus no vehicle can be taken from the train without "setting" all of the brakes and then releasing them by hand. The same thing happens when the engine leaves the train, or a fresh one is attached. **C. E. S.**

May 29.

CONTINUOUS BRAKES.

[14432.]—Will you excuse our troubling you with a few remarks on your correspondent "C. E. S.'s" letter referring to our patent hydraulic brake. The misstatements made by this gentleman scarcely justify the authoritative tone he has thought fit to adopt. The train fitted with what we term our direct-acting hydraulic brake, which has run daily between Bedford and London since June, 1876, is not as "C. E. S." states, the experimental Barker train tried at Newark in June, 1875. On the contrary, there is a considerable and important difference between the mechanism of the brakes used on the two trains. This difference has enabled us to achieve results with our Midland train which we never could have obtained with the one tried at Newark. "C. E. S." has taken it on himself to deny the accuracy of the particulars of some stops made by our brake at a trial on the Midland Railway. He says it was found "on inquiry" that the speed had only been "estimated" at 50 miles an hour, and that the time had been inaccurately taken.

The trial alluded to was conducted by the authorised officials of the Midland Railway, and the report of it, which we quoted, was signed by them; every care was taken to insure accuracy, and no doubt has ever been entertained that the times and speeds given were correct. This trial, moreover, was the only official one ever made; we have never heard of the one proving the results of the first trial unreliable, which "C. E. S." quotes.

As to the "inquiry" alluded to by him, if made at all, it was made privately, and the results kept equally "dark," since no public contradiction was ever given to the statements made by us in the *Times*.

"C. E. S." seems not to understand the meaning of the word estimate. He evidently thinks because the speed was estimated at 50 miles an hour, that on that account the result given was incorrect. It is not necessary to occupy time and space in refuting such a simple verbal fallacy.

Barker, Harris, and Co.,
Proprietors of Barker's Hydraulic Brake.

45, Bedford-row, London, W.C.
May 28.

SINGLE v. COUPLED ENGINES.

[14433.]—In reference to this interesting controversy I scarcely think that the matter can be brought to an absolute verdict in favour of either type. I don't think either "C. E. S." or "C. R. M." will back the actual working of a 7ft. single on a wet day, with frequent stoppages and heavy gradients, against a coupled 6ft. 6in.—granted that the maximum of a single is greater, but they are considerably longer in attaining it, so that one finds a coupled engine with a lower maximum rate of speed keep equally good time. "C. R. M." asks why the L. and N. W. R. coupled don't run the speed of the G. N. R. Certainly not on account of inability, but rather from the policy of the directorate, which has always been slow to meet the public in the matter of speed, as well as other conveniences, and it has only been, when reluctantly compelled, that they have followed in the wake of their spirited rivals. The L. and N. W. would have gone on for ever running from Liverpool to Manchester in an hour though only 31½ miles, only the Midland coming forward to compete by running (with coupled 6ft. engines) it in 45 minutes, compelled the similar performance of the N. W., or to have the alternative of being forsaken by the public. If, as I daresay, we shall some day see the Midland accelerating the running between London and Liverpool, then, and not till then, will the N. W. do the distance, which they could well do now, in 4½ hours.

When a driver is timed with his train an average of 45 or 47 miles per hour, although his engine could do more, cui bono? Let us take the 10 a.m. down train—the average is about 47 miles per hour. The train is generally a very heavy one, but behind Prince Leopold, Snowdon, Lowther, Princess Beatrice (6ft. 9in. coupled), I have scarcely ever been a minute late at Crewe, despite all weathers or winds, and formerly have been 20 minutes late with Prince Oscar and Prince Alfred — two capital 7ft. 6in. singles. When Webb's 6ft. 9in. are asked to do it, I have little doubt they will warm to the work, and give at least as good an account of themselves as the G. N. 8ft. singles. I have known Penrith Beacon do the splendid run with the up Scotch express from Nuneaton to Willesden, 92 miles without a stop, in 97 minutes, or 58 miles an hour, and 16 coaches behind; and down the Whitmore incline Patience, not long since (and the driver will bear me out) ran the 12 noon down at 78 miles an hour, making up lost time. I grant that in dry weather I have kept equally good time with Japan, Trentham, Knowsley, Torch (Bloomer's), and Napoleon, Clive, Soult, and Lady of the Lake (7ft. 6in.), but with a strong head wind and with slippery rails, it has only been on long runs without stoppages they could keep up to time, and up an incline at starting, such as Edgehill Tunnel, Liverpool, they lose far more time than either Webb's or Ramsbottom's. The manner in which Cambrian, Avon, &c., can get rapidly up to the timed speed with 20 or 24 coaches on is quite "a caution," and though the chance is not yet afforded them, when it does come it will be seen they can let out a good deal extra, and be at least capital matches for their fleet and more graceful rivals the 7ft. and 8ft. singles on a 100 mile run, while admittedly better suited to work a stopping train or heavy "special."

W. J. S.

THE GAS ENGINE.

(*Continued from page* 292.)

[14434.]—No. 3620 (1876), M. P. W. Boulton, "Combustion Engines."—This invention relates to engines which are worked by the elastic pressure caused by the combustion of an inflammable fluid mixture, such as gas or inflammable vapour, with air. An inflammable mixture of elastic fluids is introduced into a cylinder or chamber connected with it, and is ignited so as to produce pressure or elastic force acting on the piston. While the products of combustion are acting on the piston, and while they are still at high pressure, a valve is opened, and air or elastic fluid which has been raised to high pressure by a pump or forcing apparatus worked by the engine mixes with the hot products within it, and acts conjointly with them in propelling the piston. This air or elastic fluid enters the cylinder from the pump or high-pressure chamber which supplies it without passing through a regenerator, and without having its temperature raised otherwise than by the compression to which it has been subjected. After a certain determinate quantity of this fluid at high pressure has been admitted into the cylinder the valve by which it entered is closed. The elastic fluid in the cylinder continues to expand, its temperature being reduced by the expansion; but no cooling agent is applied to the cylinder in order to reduce its temperature. When the pressure has been reduced so low as is thought desirable the piston completes its stroke. In the return stroke the waste fluid may be discharged into the atmosphere, or into a refrigerator maintained at low pressure. The degree of compression given to the air which is introduced into the cylinder in order to perform work may be much varied. I consider that the best result is obtained with respect to thermal efficiency when it is raised to a pressure not far short of the highest pressures produced in the cylinder by the combustion of the inflammable mixture. The rotary pump, which compresses the fluid used in the cylinder, forces the air or fluid into a chamber of considerable capacity, in which it is contained at high pressure, and from which a certain determinate quantity is admitted into the cylinder while the valve for its admission is opened. The regulation of the quantity of fluid thus admitted into the cylinder is effected nearly to the point desired by the size of passage governed by the valve, and the time during which it is open; but it is adjusted to greater nicety by means of a regulator provided for the purpose. In order to lessen the shock produced by the ignition of the inflammable mixture, and the consequent sudden rise of pressure on the piston, I employ a secondary piston between the charge of inflammable mixture and the working piston. This piston is furnished with a valve, which allows of the passage of the fluid from the space between the pistons into the cylinder behind, but prevents passage of the fluid in the contrary direction. A spring is also placed between the two pistons. At each stroke, air or elastic fluid is supplied in the space between the two pistons by a valve provided for the purpose, worked by the engine. After this has been done, a charge of inflammable mixture is introduced behind the secondary piston. When the inflammable mixture is ignited, and the sudden rise of pressure consequent on the ignition takes place, the ignited fluid drives the secondary piston towards the main or working piston, compressing the air or elastic fluid between them, and, as the pistons approach, compressing the spring. Under these circumstances the force produced by the sudden rise of pressure of the elastic fluid is communicated gradually to the working piston. As the pressure of the products of combustion falls, the valve in the secondary piston opens, and the compressed fluid within escapes into the space containing the hot products of combustion, with which it mixes and performs work along with them. At the end of the exhaust stroke the two pistons are brought close together. At the commencement of the succeeding stroke they separate, while the air or fluid is introduced between them through the valve provided for the purpose. All the air or fluid employed to co-operate with the products of combustion might be introduced in this manner between the pistons, in which case the compressing pumps or instruments previously mentioned might be dispensed with, but I prefer to use them as previously described, since, by their use, the length of the cylinder is shortened, and the action of the engine rendered more uniform.

No. 765 (1877), M. P. W. Boulton, "Producing Heat by the Combustion of Inflammable Gases and Vapours."—This invention has for its object to produce the greatest amount of heat from a given amount of gas and air by means of special apparatus for use in gas-engines, or for heating boilers to produce steam to be used in connection with gas-engines; but the details given by the patentee are very lengthy, and unsuited for either extraction or abridgment.

No. 776 (1877) M. P. W. Boulton, "Improvements in Engines worked by Products of Combustion, either alone or in Conjunction with other Elastic Fluid."—This invention relates to engines worked by products of combustion, either alone or in conjunction with other elastic fluid. The products employed may be derived from the combustion of an inflammable gaseous mixture, one ingredient of which may be air or oxygen, or gas containing oxygen; while the other may be an inflammable gas or vapour, or a mixture thereof with air or other elastic fluid. Otherwise one ingredient used for combustion may be air or elastic fluid, carrying in suspension particles of combustible matter either liquid or solid. In the following description I shall, for simplicity, speak of gas and air as the materials used for combustion, it being understood that the constructions described are also applicable when other materials, such as above mentioned, are employed. Also, I shall suppose the elastic fluid to act on a piston in a cylinder, and where the heat is employed to generate vapour, I speak of this as vapour of water or steam. I employ two cylinders, each fitted with a piston. I shall call one of these the charging cylinder; the charge of inflammable mixture is admitted into it, and ignited in it. In the other, which I shall call the main cylinder, the piston that drives the engine works. Between these two cylinders is a valve worked by the engine. After the ignition of the inflammable mixture in the charging cylinder, this valve is opened, and the opening takes place gradually, so that the elastic fluid passing from the charging cylinder to the main cylinder is at first wire-drawn, and the pressure in the main cylinder is raised gradually so as to avoid violent shock. The cooling of the hot products of combustion may be effected in various manners. In one method air or elastic fluid is compressed by the engine, and after the piston in the main cylinder has performed part of its stroke a portion of the compressed air or fluid is admitted through a valve into the charging cylinder, where it mixes with the hot products of combustion, and the mixed and cooled elastic fluid acts on the piston in the main cylinder. In another plan the cylinders are surrounded by a casing of water, the vessel containing this water forming portion of a boiler, and the steam generated from this boiler rising to a steam space, whence it passes to perform work. It may be used for this purpose either in conjunction with the hot products of combustion or separately—the latter plan being preferable when it is desired to condense the steam. In another method of construction I cause the hot products of combustion to come into direct contact with water or wetted bodies, and so generate steam, which acts along with them in the main or working cylinder. For this purpose I place between the charging cylinder and the main cylinder an apparatus which is wetted with a certain quantity of water between each stroke, and the hot products of combustion passing through passages in this frame convert the water into steam, which acts together with the products of combustion on the piston in the main cylinder. The wetting of the evaporating frame may be effected in various ways. I prefer generally to do it by giving a motion to the frame, so as to dip it into the water. Another plan is to cause the water to move so as to wet the material. The evaporating frame may consist of one or more thicknesses of wire gauze or perforated metal, or it may consist of numerous plates or tubes or rods, having narrow passages between them, or it may contain porous material such as asbestos. I claim in respect of engines worked by products of combustion of a gaseous inflammable mixture—First, the use of a separate charging cylinder immersed in water or liquid whence by the heat within the said cylinder vapour is generated, which co-operates with the products of combustion. Second, "so arranging the valves and passages connected with the separate charging cylinder that its piston always works nearly in balance or with pressures nearly equal on both sides." Third, "the construction of engine worked partly by the cooled products of combustion of an inflammable gaseous mixture, and partly by steam or vapour generated in cooling the said products." Fourth to eighth claims are synonomous with the third, except in referring to different figures shown in the drawing; and, lastly, I claim producing fluid for working an engine by burning in a combustion chamber gases or elastic fluids supplied under regulated pressure from reservoirs, and mingling the products of their combustion with cool air or elastic fluid, which is also supplied under regulated pressure. The specification describing this invention is very elaborate, consisting of 16 pages of letterpress and 10 sheets of drawings. Mr. Boulton must have engaged in a labour of love to continue his labours for fourteen years, to have, from time to time, taken out twenty-eight patents for as many inventions, without, after this expenditure of money and labour, bringing any result of his exertions practically before the public. Let us hope that he has found his reward in the work itself, and that the seed which he has so ungrudgingly sown may fructify, if not in pecuniary results, at least in the honour and admiration of those best able to judge of what he has laid down, both in money and labour, in order to accomplish his voluntary task.

Leicester. Jno. F. Dickson.

(*To be continued.*)

AN APOLOGY—TO MR. ALBERT SMITH — MANUFACTURE OF SULPHURIC ACID—ANALYSIS OF TEA—A PECULIAR REACTION—SEPARATION OF MANGANESE — PREPARATION OF OXYGEN—METALLURGY OF NICKEL

[14135.]—I HAVE been completely laid up lately with overwork, and forbidden to read anything for a time; but if querists who have applied to me specially, and still lack the required information, will repeat their questions, or give me the necessary reference, I shall be happy to help them if I can.

Mr. Albert Smith has, I believe, never answered my question as to certain statements he made in his letter on mustard adulteration. On p. 220 he recommends for the determination of water in lard that the sample should be "gently warmed until it ceases to lose weight." May I ask whether he has tried such a plan; and, if not, what grounds he has for supposing that it would effect its purpose?

Mr. Grey, on p. 221, in reference to Arthur Alfred's reply to query 32533, respecting sulphuric acid, says the method given is "new and amusing." So it is to those not concerned, but Arthur Alfred should not be allowed to amuse himself at the expense of other readers, and those who know better hardly care to be amused by the exhibition of Arthur Alfred's crass ignorance.

"Paraffin candles" (query 32882, p. 226) are not made of a mixture of paraffin and fat as the querist supposes, but of nearly pure paraffin. Pure paraffin would be used if it were not so liable to crystallise. To prevent this about 2 per cent. of white wax is added. "Civis" can obtain paraffin wax of any wholesale chemist.

Mr. Hugh Clements' capital letters on organic chemistry contain an enormous amount of information in a small space. I am sure he will excuse me if I point out that the analysis of tea which he quotes on p 192 must be very old. The tannin is stated at fully twice the amount really present in black tea, and at more than exists in green. Almost the same remark applies to the gum, while the ash and water err in the opposite direction.

A question was asked some time since as to the cause of the effervescence which ensues on mixing glycerine, bicarbonate of sodium, and borax. A paper has been recently read on this interesting and curious fact, and the authors believe and adduce some evidence to show that borax is partially decomposed by glycerine into boracic acid and a neutral borate, and the former then acts on the carbonate with evolution of CO_2.

"T. G.," in query 32850, p. 202, asks me how manganese can be commercially separated from an ore containing nickel and cobalt? I hardly understand him. If he wants to utilise the ore, he can either extract the nickel and cobalt, and ignore the manganese, or he can use it as a manganese ore, and disregard the nickel and cobalt. If he wants an analytical separation of the metals he should precipitate the iron as basic acetate, and pass sulphuretted hydrogen through the filtrate. This will throw down the nickel cobalt (and zinc), and, after filtering, the manganese can be precipitated by adding bromine to the filtrate.

I see Mr. Helliwell (letter 14233, p. 143) has been using sand instead of oxide of manganese for mixing with chlorate of potassium to be employed in preparing oxygen. The plan is a very old one, and has the disadvantage that the oxygen evolved is [illegible] inated with chlorine, and so acts rapidly on s and fittings. Why not always test a fresh of manganese in a test tube before using it etort?

Mr. Paterson (letter 14235, p. 143) takes n to the process of Christofle and Bouilhet, d by me in my paper on "Recent Improve- the Metallurgy of Nickel." I am not dis- o defend the above process, and if Mr. will read my paper again he will see that arks are partly ironical. My paper would n incomplete without a reference to a method good metal has been extracted from the edonian ore.

ld, June 1st. **Alfred H. Allen.**

CHROMIUM.

.]—It is frequently not by any means an : to get any certain information as to the of complex compounds in solution, but ect to the point which Mr. Streatfield (let. ge 269) inquires about, I think an argu- avour of the view that potassic dichromate as such may be found in the fact that the the solution has a more reddish tinge than ither potassic chromate or chromic acid. rence is certainly slight, but it does seem to he conclusion that a chemical change has

Too much stress must not be laid upon eaction of the dichromate, for normal salts s react acid, as, for instance, plumbic and sometimes alkaline, as potassic car- It may also be remarked that the normal dissolves in twice its weight of cold water, dichromate requires ten times its weight, romic anhydride is very soluble) this also how that the $Cr_2O_5K_2$ is a chemical com- n when in solution. I quite agree with my to the great interest which attaches to , whether we consider the number and y of its compounds, or have regard to the colours from which the metal derives its

Wm. John Grey.

tle-upon-Tyne, May 29th.

L CHLORIDE, CHLOROFORM, LENIC BROMIDE, PRUSSIAN UREA, AND CYANIC ACID.

—Methylic chloride, MeCl or CH_3Cl when marsh gas, MeH is mixed with the daylight, thus: $MeH + Cl_2 = MeCl$ It is also formed by heating sulphuric ylic alcohol, and common salt together, $HO + H_2SO_4 = MeHSO_4 + OH_2$, and $+ NaCl = MeCl + NaHSO_4$. Chlorine, methylic chloride, forms CH_2Cl_2, $CHCl_3$, having boiling points of 41°, 62°, and 77° y. Methylic chloride boils at − 21°. Its weight is 50·5, and one litre of the vapour 25 criths. Chloroform $CHCl_3$ is prepared a thin paste of four parts of chloride of hing powder) and water, to which add one ylic or two of methylic alcohol. Place re in a retort capable of holding twice the nd heat to 82° C, when chloroform with a little alcohol, distil over. The water l forming the upper layer are poured off , and the remaining chloroform is agitated potassic carbonate, which abstracts traces The result, when re-distilled, is pure ready for use. $2Me\cdot HO + 4CaOCl_2 =$ $3OH_2 + (CaO)_2O(CaCl)_2$. $EtHO +$ $= 2CHCl_3 + 2OH_2 + (CaO)_2O(CaCl)_2$. It pared by the action of potassic hydrate on us—$C_2Cl_3HO + KHO = CHCl_3 + HCOKO$. uced by the action of chlorine on methylic hus—$CH_3Cl + 2Cl_2 = 2HCl + CHCl_3$. luced by the decomposition of potassic tate by potassic hydrate, thus: CCl_3COKO $COKO_2 + CHCl_3$ It can also be produced one measure of methylic hydride and one e anhydride with four of chlorine, in the thus—$2MeH + 7Cl_2 = 7HCl + CCl_4 +$ The CO_2 is merely added to prevent explo- loroform is a colourless, limpid, mobile, iquid, having a pleasant, characteristic d a pleasant, sweetish taste. Its molecular 119·5, and one litre of the vapour weighs hs. It boils at 62° C, and the liquid weighs f as heavy again as water. It is scarcely water, but ether and alcohol dissolve it in portion. It dissolves resins, fats, alkaloids, s, sulphur, caoutchouc, bromine, iodine, n thrown on a red-hot fire, it burns with , smoky flame; but does not burn when y light is brought into contact. When with H_2SO_4, it should swim on the surface , and both layers should remain colour- n a little is evaporated on the hand, no r other odour should be observed, if pure does not affect it, but alcoholic potash it into the potassic formate and chloride, $H + 4KHO = HCOKO + 3KCl + 2OH_2$. ht decomposes it. Chlorine, in the sun- laces the remaining hydrogen of chloroform, thus—$CHCl_3 + Cl_2 = CCl_4 + HCl$. Ammonic hydrate, and powdered zinc acting on it, replaces hydrogen, thus—$CHCl_3 + H_2 = CH_2Cl_2 + HCl$. Chloroform is generally considered to be the analogue of methylic chloride, from which it is regarded as being formed by the substitution of chlorine for hydrogen; thus we have CH_2Cl_2, $CHCl_3$ (chloroform), and CCl_4. By the substitution of bromine or iodine for chlorine in chloroform, we have bromoform or iodoform. It is extensively employed to produce insensibility to pain during surgical operations. In America ethylic ether is preferred Dr. Richardson recommends the bichloride, CH_2Cl_2, as a substitute for chloroform. Nitrous oxide and carbonic anhydride are other anæsthetics. Chloroform can be administered by placing it before the mouth on a sponge or other porous substance and inhaling it, when an insensibility to pain is produced, but it should only be taken under medical advice, for on certain constitutions it produces fatal effects. It was first used by Simpson, of Edinburgh, about 1848, and has since that time increased in estimation. It is one of the greatest boons that chemical research has rendered subservient to suffering humanity.

Ethylenic bromide, $C_2H_4Br_2$, is prepared by agitating bromine water with ethylene. Its molecular weight is 188, and one litre of the vapour weighs 94 criths. The liquid has a specific gravity of 2·16, boils at 130°C., and fuses at −18°C. When heated with alcoholic potassic acetate, it produces monacetic glycol and acetic acid, thus: $Et''Br_2 + 2MeCOKO + OH_2 = 2KBr + MeCOHO + \left\{\begin{matrix}CH_2(CMeO)O\\CH_2HO\end{matrix}\right.$. When boiled with alcoholic potash it forms vinylic bromide, thus: $Et''Br + KHO = OH_2 + KBr + C_2H_3Br$.

Prussian blue, $Fe_7Cy_{18} + 18H_2O$, is produced when a ferric salt and potassic ferrocyanide are mixed together, thus: $2Fe_2Cl_6 + 3K_4FeCy_6 = 12KCl + Fe_7Cy_{18}$. It may be prepared by mixing a solution of hydroferrocyanic acid with one of ferric chloride, thus: $3H_4FeCy_6 + 2Fe_2Cl_6 = 12HCl + Fe_7Cy_{18}$. It may be prepared by mixing solutions of ferric sulphate, $Fe_2S_3O_{12}$, and potassic ferrocyanide, thus: $2Fe_2S_3O_{12} + 3K_4FeCy_6 = Fe_7Cy_{18} + 6K_2SO_4$. The blue settles to the bottom of the vessel, is collected, dried, and obtained as a powder, or in cakes, according as it has been dried by exposure to the atmosphere or by applying heat. Prussian blue possesses neither taste nor smell. It is not soluble in dilute acids nor water. It is sold in cubical or irregular lumps of a dark-blue colour. When rendered soluble by triturating with oxalic acid after washing in dilute HCl, it is dissolved in water forming a blue writing ink. Prussian blue is soluble in ammonic tartrate. Strong acids, chlorine and the alkalies decompose it. The water contained in Prussian blue cannot be removed without breaking up the compound.

Urea $CO(NH_2)_2$ or $\left\{\begin{matrix}NH_2\\CO\\NH_2\end{matrix}\right.$ was originally prepared from urine by concentrating it, decanting from deposited matter, adding an equal bulk of pure strong nitric acid, when nitrate of urea is formed. Then the liquid is separated from the crystals, which are put in water, to which baric carbonate is added, when baric nitrate is formed and urea is set free. The mixture of urea and nitrate after evaporation is treated with boiling alcohol, which dissolves only the urea, which is deposited on cooling in long colourless prisms. It is obtained by the action of carbonyl chloride on dry ammonnia, thus: $COCl_2 + 2NH_3 = \left\{\begin{matrix}NH_2\\CO\\NH_2\end{matrix}\right. + 2HCl$. It is prepared by mixing aqueous solutions of potassic cyanate and ammonic sulphate when potassic sulphate and ammonic cyanate are formed. The ammonic cyanate is dissolved by alcohol, and urea crystallises out on the cooling of the alcohol. It is also prepared by heating a mixture of carbonic ether $(C_2H_5)_2CO_3$ and an alcoholic solution of ammonia to a temperature of 180° C. in a closed tube. From the formula $\left\{\begin{matrix}NH_2\\CO\\NH_2\end{matrix}\right.$ it will be seen that urea is built up on the type of two atoms of ammonia, and is, therefore, placed among the amides, being a diamine. When pure and allowed to crystallise slowly it forms white four-sided prisms, having a streaked glistening appearance, but when it crystallises rapidly white silky needles are formed. It resembles saltpetre in colour and taste. It is inodorous and deliquescent. It is very soluble in water and alcohol, and sparingly in ether. When heated in a tube it is decomposed, evolving ammonia. The solution will keep for a long time in distilled water, and may be boiled without decomposition. This solution is neutral to test paper. It melts at 120°C., and at a higher temperature it yields ammonia, ammonia cyanate, and carbonate. When chlorine is passed into an aqueous solution of urea hydrochloric acid, nitrogen, and carbonic anhydride are formed. A strong aqueous solution of urea, stirred with excess of strong nitric acid, on being allowed to stand, deposits nitrate of urea in scaly crystals. By substituting oxalic acid for nitric, crystals of oxalate of urea are formed. Mercuric nitrate produces a white precipitate in the same solution.

Cyanic acid, CNHO, can be prepared by heating urea with phosphoric pentoxide, or by heating cyanuric acid $Cy_3H_3O_3$. It can also be obtained by heating dry potassic ferrocyanide with binoxide of manganese, or by the oxidation of KCy. CyKO is decomposed by strong HCl or H_2SO_4, with liberation of CyHO. Cyanic acid is a colourless thin liquid, having a specific gravity of 1·14 at 0°C., having a strong pungent odour. When mixed with water it breaks up into ammonia and acid carbonate, thus: $CyKO + 2OH_2 = NH_3 + COHOKO$. Cyanic acid readily changes into cyamelide Cy_nHO_n, a white inodorous substance like porcelain. The cyanates are distinguished from the cyanides by not forming precipitates with the chlorides of iron and tin, and by the formation of a dark green precipitate of nitrate of copper. The cyanates of the alkalies, alkaline earths, and some of the metallic oxides are dissolved by water and are decomposed, ammonia being evolved. When potassic cyanate is decomposed by ammonic sulphate, ammonic cyanate is formed, and when the solution is concentrated urea crystallises out. It is generally purified by recrystallisation from alcohol.

Hugh Clements.

ADULTERATION OF FOOD DETECTED—PICKLES AND BOTTLED FRUIT AND VEGETABLES.

[14438.]—Some persons have an idea that pickles, to be pure and wholesome, must be of a bright lively green colour. They look upon the dull yellow-looking pickle with some amount of suspicion as to the freshness of the vegetable when put into pickle; but those who have carefully prepared their own pickles know fully well that such is not the case, and the freshest of vegetables soon lose their bright colour when they have been long in pickle, unless something be added to preserve it. Now, copper has a very extraordinary effect of heightening and preserving the colour of vegetables that are mixed with it, and in many old cookery books you will find recipes given for making colouring for pickles and preserves, such as to boil the vinegar in a copper or brass saucepan, and leave it until cold, or to put some sulphate of copper into the pickles. Now, such practices cannot be too strongly condemned, as copper, being very poisonous, serious consequences might be the result (and as the vinegar sometimes contains copper and other metals which will be mentioned in article on vinegar), the presence of copper in pickles, bottled fruit, and tinned vegetables can almost be detected by the eye alone, without recourse to chemistry, by the bright green colour of the pickles. Special care should be taken in preparing pickles that nothing containing copper, lead, or zinc is used, as vinegar has a very powerful effect upon those metals, and in consequence of such some of our large wholesale pickle merchants have had constructed boiling vats, &c., with platinum coils, heated by steam, so as to avoid metallic contamination.

For the detection of copper the following simple method will be found useful, as it can be easily applied: Pour into a wine-glass a small quantity of the vinegar, and place in it a bright steel needle; in the course of a few hours the needle will become coated with a bright coating of metallic copper. Another method is to decolourise the vinegar with animal charcoal, and apply a little ammonia, when, if copper is present, a bright blue colour will be produced. Also by the addition of some ferrocyanide of potash a reddish-brown precipitate will be produced. But a better method is to incinerate some of the pickles in a porcelain crucible (the ash should be of a greyish-white colour; if it is of a pinkish colour it is nearly sure to contain copper), and a few drops of nitric acid added, and after standing some time a little distilled water added, and tested with ammonia or ferrocyanide of potash, or the copper might be deposited upon a strip of platinum foil by the battery process, and weighed as metallic copper.

For lead, upon the addition of chromate of potash a bright yellow precipitate of $(PbCrO_4)$ is formed; to another portion a little sulphuric acid should be added, when a white precipitate will be produced. Iodide of potash produces a bright yellow precipitate. If zinc is present a little hydrosulphuret of ammonia will produce a white precipitate.

Albert Smith.

BINOCULAR PERFORMANCE WITH WENHAM PRISM AND HIGHER POWERS THAN USUAL.

[14439.]—It is commonly stated that it is not possible to utilise the ordinary binocular microscope with higher powers than the ¼in., and not with a ¼in. of greater angle than 40°. Indeed, I know some practical microscopists who place its performance lower than that, and deny its service beyond a ¼in. I can use well, without any special appliances, a 4-10th of 90°, the stand being Collins's best Harley, and the 4-10th a so-called ¼in. by Swift, the field of both eyepieces being well illuminated, and the performance first class. But my object now is to show that with the ordinary Wenham prism it is easy to use either a ¼in. or a ⅛in., with a field as well lighted as with the inch. I was led to this conclusion before actually seeing it done, by observing that using a Webster condenser I could, with the ordinary mirror, get either field well illuminated, but not both at once. Now, by placing two mirrors underneath and bringing the face of condenser close up to slide, I was soon able with very little manipulation to light both fields equally and well. This was with a ¼in. of 160°. Having substituted a Gundlach ⅛th, I found the same results, except that looking at each field separately, a slight shade was visible on the extreme right of one field and extreme left of the other. But I think the best result is obtained with a parabola. Bringing the focus as high up as possible, I lost even the shade at the edges. The definition with a fine diatom is perhaps not quite so good as with other means of illumination, but the relief is unmistakeable. Let other microscopical correspondents try this and report progress. I have no doubt if Mr. Wenham will bring his skill and knowledge to bear on this point, he will soon arrange a condenser to give even better results than I have yet obtained. In fact, I have to experiment further myself, but meanwhile, I place on record the fact that the Wenham prism is quite equal to stereoscopic binocular performance with a wide-angled ⅛th, and I confidently believe with a 1-16th also. This I shall take an early opportunity of trying. I dare say some will feel disappointed that the relief obtained with a ⅛th is not exactly like that with a 1in. or 2in., but this is not to be expected, since the foci of such wide-angled lenses necessarily lie strictly in one extremely shallow plane, and no definition is to be got in any other than the exact focal point, but it is easy to see that planes lie one above another, with the binocular effect obtained; and equally easy to see which is the higher of the two or more planes as it may be. I have not yet had an opportunity of trying more than my own instrument, but I cannot think there is any speciality about it, and expect any other will work equally well. To those who only use a microscope for show, and who already possess what I regard as a deceptive and unsatisfactory part of the instrument—the second tube—this aid to using high powers will be a real addition, but I do not recommend any one to go to the expense of a binocular, on account of such an improvement, any more than I would have done so before. If study is their end, I say stick to the simple instrument, and spend your money on first-class objectives and eyepieces. If money superabounds, and show is the object, go in for milled heads, and condensers, and double barrels, and the rest of the show. I wait for others to report on their success with the binocular with high powers. **Essex.**

NEW MUSICAL NOTATION.

[14440.]—The party who first drew out a staff of lines and spaces on which to write a piece of music made a great mistake. They represented the sounds of music, but not the intervals of music, and to have these intervals properly represented has puzzled the ingenuity of inventors since the time that the first stave was written.

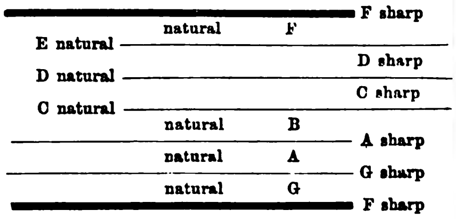
Every piece of music is made from seven sounds; these seven sounds are of two kinds; five are called whole tones, the other two are half tones or natural semi-tones. The five whole tones can each be divided into two parts, making ten, and the two natural semi-tones added to ten make twelve; so that there are twelve sounds, and twelve intervals in music, which must be represented on the staff of lines and spaces, and yet there are only seven real sounds from which all tunes are composed; and how to make the number twelve, which is even, and the number seven, which is odd, fit into one another, is the difficulty, and till once this difficulty is overcome we will never have a simple, natural, scientific, pictorial, and comprehensive notation.

The principal difficulty in the performance of music, either vocal or instrumental, is in measuring the distance in pitch from one sound to another, and the more correctly these distances are represented on the music-sheet, so much better will be the performance of the music. The distance in pitch from one whole tone to one of the natural semi-tones, is only about half the distance that there is from one whole tone to another whole tone; but the old notation represents all the distances as equal. Consequently something had to be done to correct this false representation. They introduced characters called sharps and flats; the flat was to lower a whole interval into the size of a half interval, and a sharp was to stretch out a half interval into the size of a whole interval. In the staff of five lines and four spaces a line stands for a whole tone, and a space for a whole tone—a line and space for two whole tones.

Did they never think of doubling the number of lines and spaces, making a line to be only half a tone, and a space to be only half a tone, a line and space to be a full tone? and then they would have been on the fair road to a correct notation. Did the idea never enter into their heads, or were they frightened at the number of lines and spaces? I have never seen it mentioned in books, nor yet in conversation. The duties of a paymaster might have taught them to double the stave. The paymaster can get on as long as he has plenty of small coin; he can pay a shilling with 48 farthings, or a pound with 960, but he cannot break a silver shilling into 48 pieces, nor a pound into 960 parts. Now, it does not in reality take double the number of lines to double the stave; less will do as will be seen.

In this method there are six lines and six spaces which make twelve, so that we have now a place for every interval in music, and we require neither sharps nor flats. The old notation has another defect besides sharps and flats—namely, it has no mile-stones, if we may so speak, along the road of absolute pitch.

The astronomer has his constellations, the geographer his lines of latitude and longitude, the designer of patterns on design paper has his broad lines, that he may know how many small squares he is covering, but the musician has only a monotonous assembly of small lines from top to bottom; besides, the same letter which is on a line in the one octave will be on a space in the next octave, which ought not to be. In the new notation there is a broad line for every octave, and there are only five small lines between the broad lines; so that it is nearly as easy to learn and remember five lines in the new as five lines in the old notation.



Robert Wark.

98, Reid-street, Bridgeton, Glasgow.

PROPERTIES OF NUMBERS.

[14441.]—With regard to the curious "figure square" given in your last number by R. Miles (14375), I would remark that having when a boy placed the first 9 digits in similar order, I was induced to attempt the same for 25—this being the next square of an odd number—and having succeeded in doing this, I discovered a key to the arrangement which applies to the "figure squares" of all numbers, so far as I have tested it. And as I have done this for several hundred consecutive numbers, it is probable that the arrangement is practicable for any number of consecutive numbers, such number being the square of an odd number—such as 9, 25, 49, 81, 121, &c.

Having been so far successful, I was curious to know whether there was more than one such arrangement, and puzzled out a second. I give them both:

I.						II.				
3	24	1	22	15	...	17	24	1	8	15
20	8	7	14	16	...	23	5	7	14	16
21	17	13	9	5	...	4	6	13	20	22
10	12	19	18	6	...	10	12	19	21	3
11	4	25	2	23	...	11	18	25	2	9

It now appears that for 25 digits there is a third arrangement—viz., that given by R. Miles:—

III.

3	16	9	22	15
20	8	21	14	2
7	25	13	1	19
24	12	5	18	6
11	4	17	10	23

In each of these three figure squares, the sum of the numbers in each line, whether horizontal, vertical, or diagonal, amounts to 65. There is, I think, only one such arrangement for the first nine figures, viz.:

8	1	6
3	5	7
4	9	2

Though I have some recollection of having formed another; if so, it is clear that 5 must be the centre digit.

It is, therefore, probable that for higher numbers there is an increased variety of possible figure squares Mr. Miles' method would no doubt apply to other numbers, though it is different to my key. It does so for the first 9 digits.

Assuming an arrangement to be possible for all consecutive numbers commencing with unity, and which are in number ten squares of an odd number, it follows that it is also possible for any such number of consecutive digits not commencing with unity; for if $a + 1$, $a + 2$, $a + 3$, &c., represent such numbers, it is clear that—for instance, in the case of 25 terms—these numbers can be arranged in a figure square, the sum of each line will amount to $5a + 65$, and that the same will generally hold good (α).

Also, this will be true for any such numbe
terms of any arithmetical progression.

Let $a, a + d, a + 2d \dots a + \overline{n - 1}\,d$ (
arithmetical progression, and let $a, a + 1, a$
$a + \overline{n - 1}$ (γ) be a series of consecutive nu
which may be denoted as $A\ A_1\ A_2 \dots A\ n$
Then by (α) the numbers (γ) or (δ) may be
into figure squares; (β) may also be w
$A + o \,.\, \overline{d - 1}, A_1 + 1 \,.\, \overline{d - 1}, A_2 + 2\,\overline{d -}$
&c. (ε), and the sum of any of these will be
$+ A_2 + A_3 +$, &c., $+ (o + 1 + 2 + 3 +$
$\overline{d} - 1 +$, &c. But we may arrange the term
so that each line in the figure square—for in
$A_r + A_s +$, &c., $+ A_o + (r + s +$, &c., $+$
—may amount to the same sum, inasmuch as
do this in the case of both $A_r\ A_s$ &c., and r,
by (α), each being terms of a series of cons
numbers, and their sum amounting in each
a constant quantity.

ZINCOGRAPHY v. GELATINE

[14442.]—I give your correspondent, E. A
credit for understanding the process of en
zinc blocks, judging from the description he
the process in a previous paper; but I think
not understand all that can be done with gel
his letter of May 17th. He suggests "
lithographer must undergo an apprenticeshi
he can print from gelatine surfaces." I incl
herewith a print from a gelatine surface, 4
and with it a letter which distinctly states
is only the 2nd time of attempting to print
gelatine surface, and I shall be glad if th
will say if it has the evidence of "prentice
about it. [No.] In a previous letter Mr. Nut
a comparison of the difficulties of printing
gelatine surface and from zinc. No person
a master of both processes would think of
gelatine surface for the reproduction of line s
such as zinc or stone will carry, except for a
number of copies. But the points where
has a value is that a printing surface can
duced without either the costly and cum
apparatus required to print from zinc or st
in consequence of the elastic character of t
the pressure required to print is not one-
either. It is also a much more simple pr
produce the surface. The gelatine surface
greater delivery than stone or zinc. It will a
vide any number of transfers, so that it
both for a small number of copies at m
trouble and cost, and for good quality wh
numbers are wanted. **A. Pump**

DIVING AT GREAT DEPTHS

[14443.]—It is a great impediment to su
operations, such as raising sunken vessels
covering salvage from submerged wrecks,
any depth exceeding 40ft., the divers feel s
inconvenience from the pressure of the wat
they cannot remain under for more tha
twenty minutes at a time. If no return pip
surface is used, the air breathed by the dive
jected to a pressure due to the column
above him; and, if this is avoided by the
return pipe to the surface, then at a depth
he will have to contend with a pressure of
ton on his chest, unbalanced by any comp
effect of compressed air inside. This is
obviated only by inclosing the whole body in
water-tight casing of metal, which should fit
and would thus relieve the chest, abdo
head from all external pressure by the wat
limbs would be covered with the ordinary c
indiarubber cloth, whose joinings with th
would be made carefully water-tight. The
of the water upon the limbs would be of
quence, while the case, which need not be lar
the body of the diver by more than one
round, would in no way interfere with the
of the workman's arms. This additio
greatly extend our power of submarine exp
and there are really no difficulties in the w
adoption. **Leigh Cl**

THE "ALL ENGLAND" BICY
CRANK.

[14444.]—As the inventor of the "All E
bicycle crank I must beg a small space in yo
to reply to the remarks of "56in. Superb
14369, p. 268). "56in. Superb" says of th
it "doesn't work easily, and when down is
get up again."

It is unfortunate that a pair not worki
should have been sent out, as the fault
tainly is not in the principle. This is, at onc
from "56in. Superb's" own statement,
mechanical action for lengthening the
identically the same as for shortening; ye
that the crank works better one way
other. Any intelligent mechanic should b
set this right in a few minutes.

However, in order to settle the question,
happy to supply a pair of cranks for testin
following conditions—viz., th[illegible] as you appoi

ıt rider to try them (say, for a week or two, ; at least one fairly long run over a billy nd that his report is published in the t MECHANIC. Messrs. Boult Bros., Tower s, Liverpool, will send the cranks, and pay ises. They will also, if anything is the ith "56in. Superb's" cranks, have them free of charge. **Wilfrid S. Boult.**

ınnot undertake to act in the matter, but ' 56in. Superb" or Mr. Striffler may care themselves of Mr. Boult's offer. Should o, we will publish the result.—ED.]

TRAMWAYS IN TOWNS.

]—THOUGH tramways in streets are of blic convenience, they are far from an unvantage, chiefly because of two evils. The ovided for the guiding rims on the wheels lly wide enough to admit also the rims of ow wheels of gigs, and of some other and the carriages or trams cannot leave the think both of these inconveniences might d. There can be no objection to the grooves y just wider than the guiding rim, so narno wheel can enter them. If the rim e fixed upon a guiding wheel, and held to on by springs, which would allow of a slight ıotion, and if the rim were so fixed the wheel could be raised whenever the driver leave the tram, and dropped again into the hen he wished to rejoin it.

ıt perceive the necessity for a groove to guide for, if two wheels with rims were provided, ng against the near, the other against the he carriage would be kept from deviating the right or the left. All that would be r would be leaving a very narrow interval—wide between each rail and the pavement. ıddition to getting rid of wide groove, the e made about 9in. wide, so as to admit any hose wheels are not less than 4½ft., or more apart, and if the rails were grooved across, ıt horses slipping that tread on them, there little to complain of. **Philo.**

NEW TEMPERED SCALE.

.]—The many letters that have appeared in LISH MECHANIC on the construction of the scale, and the mutual relations of the notes have set me thinking, and the result has discovery of what I believe to be a new scale, in which the 4th and 5th have the same number of vibrations as in the cale; and the 3rd is a closer approximathe 3rd of the ordinary tempered scale. ree notes—the 5th, 4th, and 3rd—being important in the scale, I reckon it but a :ter that the 2nd, 6th, and 7th have wanrther away than in the tempered scale, r as they seem to me to have taken a step ht direction—the 2nd being flattened, and, , having more tendency to descend, which, he 5th of the dominant, I consider is approther than otherwise; and the 6th and 7th ırpened, have a greater tendency to ascend, they are the major 3rds of the subdominant nant respectively, I consider no advantage. ımber of vibrations corresponding to the notes are given below. I have given the ctions, thereby making the scale look rather affair; but, as will be seen, they are very proximations to much simpler fractions, practice may be substituted.

PERFECT.

	E	F	G	A	B	C
8	320	341⅓	384	426⅔	480	512

TEMPERED.

7½	322½	340⅞	383⅞	423⅞	483	512

NEW SCALE.

[illegible]	321[illegible]	341⅓	384	431[illegible]	483[illegible]	512

the construction. There are 12 semitones ıle. C has 256 vibrations in a second. Let ıave x more; D $x + \frac{x}{12}$ more than C sharp; $x + \frac{2x}{12}$ more than D; E, $x + \frac{3x}{12}$ more ıarp, and so on. Then $x + x + \frac{x}{12} + x + \ldots + x + \frac{11x}{12} = 256$, the difference beupper and lower C's.

, there is nothing new under the sun, and good-natured friend finds this scale has l before, well and good; but it is new to same.

' of postscript, I will mention that I desire ıct a pitch-pipe, and any information will a particular I shall be glad to know whether ıces should be reckoned to the centre or end of the holes, or how otherwise; also ll the holes should have the same size.

Qaf.

ALBERT HALL ORGAN.

[14147.]—THE following is the general specification of this instrument. There are 111 sounding stops distributed as under:—

CHOIR ORGAN, CC TO C IN ALTSO., 61 NOTES, 20 STOPS.

1 Violone, 16ft.
2 Viola da gamba, 8ft.
3 Dulciana, 8ft.
4 Lieblich Gedact, 8ft.
5 Open Diapason, 8ft.
6 Vox Angelica, 8ft.
7 Har. Principal, 4ft.
8 Gemshorn, 4ft.
9 Lieblich Flöte, 4ft.
10 Celestiana, 4ft.
11 Flageolet, 2ft.
12 Harmonic Piccolo, 2ft.
13 Super oct. (15th), 2ft.
14 Mixture, 3 ranks.
15 Corno di Bassetto, 16ft
16 Clarionet, 8ft.
17 Cor Anglais, 8ft.
18 Oboe, 8ft.
19 Har. Trump., 16 & 8ft
20 Clarion, 4ft.

All the pipes in this organ are of metal—1, 3, 6, 8, 9, 11, 14, and 17 form the "*Echo*" organ.

GREAT ORGAN, CC TO C IN ALTSO., 61 NOTES, 25 STOPS.

1 Flute conique, 16ft.
2 Contra Gamba, 16ft.
3 Violone, 16ft.
4 Bourdon, 16ft.
5 Open Diapason, 8ft.
6 Open Diapason, 8ft.
7 Viola da Gamba, 8ft.
8 Claribel, 8ft.
9 Flute harmonique, 8ft
10 Flute à pavillon, 8ft.
11 Quint, 6ft.
12 Flute octaviante harmonique, 4ft.
13 Viola, 4ft.
14 Principal, 4ft.
15 Quinte octaviante, 3ft.
16 Harmonic piccolo, 2ft.
17 Super octave, 2ft.
18 Furniture, 5 ranks.
19 Mixture, 5 ranks.
20 Contra Posaune, 16ft.
21 Posaune, 8ft.
22 Har. Trump., 16 & 8ft
23 Tromba, 8ft.
24 Har. Clarion, 8 & 4ft.
25 Clarion, 4ft.

The basses of the Bourdon and Claribel only are of wood.

SWELL ORGAN, CC TO C IN ALTSO., 61 NOTES, 25 STOPS.

1 Double Diapason, 16ft
2 Bourdon, 16ft.
3 Salcional, 8ft.
4 Open Diapason, 8ft.
5 Viola da Gamba, 8ft.
6 Flute à cheminées, 8ft
7 Claribel Flute, 8ft.
8 Quint, 6ft.
9 Harmonic Flute, 4ft.
10 Viola, 4ft.
11 Principal, 4ft.
12 Quinte octaviante, 3ft
13 Super octave, 2ft.
14 Harmonic Piccolo, 2ft
15 Sesquialtera, 5 ranks.
16 Mixture, 5 ranks.
17 Contra Posaune, 16ft.
18 Contra Oboe, 16ft.
19 Baryton, 16ft.
20 Voix Humaine, 8ft.
21 Oboe, 8ft.
22 Cornopean, 8ft.
23 Tuba Major, 8ft.
24 Tuba, 4ft.
25 Clarion, 4.

The basses of Bourdon and Claribel Flute only of wood.

SOLO ORGAN, CC TO C IN ALTSO., 61 NOTES, 20 STOPS.

1 Contra Bass, 16ft.
2 Flute à pavillon, 8ft.
3 Viola d'Amore, 8ft.
4 Harmonic Flute, 8ft.
5 Claribel Flute, 8ft.
6 Voix celeste, 8ft.
7 Flute traversière, 4ft.
8 Concert Flute, 4ft.
9 Harmonic piccolo, 2ft.
10 Cymbale, —
11 Corno di Bassetto, 16ft
12 Clarionet, 8ft.
13 Bassoon, 8ft.
14 French Horn, 8ft.
15 Ophicleide, 8ft.
16 Trombone, 8ft.
17 Oboe, 8ft.
18 Bombardon, 16ft.
19 Tuba Mirabilis, 8ft.
20 Tuba Clarion, 4ft.

Nos. 11, 12, 13, 14, and 17 are enclosed in a swell box.

PEDAL ORGAN, CCC TO G, 32 NOTES, 21 STOPS.

1 Double open Diapason, wood, 32ft.
2 Double open Diapason, metal, 32ft.
3 Contra Violone, metal, 32ft.
4 Open Diapason, wood, 16ft.
5 Open Diapason, metal, 16ft.
6 Bourdon, wood, 16ft.
7 Violone, metal, 16ft.
8 Gt. Quint, metal, 12ft.
9 Violoncello, metal, 8ft
10 Octave, wood, 8ft.
11 Quint, metal, 6ft.
12 Super octave metal, 4ft.
13 Furniture, 5 ranks.
14 Mixture, 3 ranks.
15 Contra Posaune, wood 32ft.
16 Contra Fagotto, wood, 16ft.
17 Bombarde, metal, 16ft
18 Ophicleide, wood, 16ft
19 Trombone, metal, 16ft
20 Fagotto, wood, 8ft.
21 Clarion, metal, 8ft.

COUPLERS.

1 Solo sub octave (on itself).
2 Solo super octave (on itself).
3 Swell sub octave (on itself).
4 Swell super octave (on itself).
5 Unison Solo to Great organ.
6 Unison Swell to Great organ.
7 Unison Choir to Great organ.
8 Swell to Choir.
9 Solo to Choir.
10 Solo to Pedals.
11 Swell to Pedals.
12 Great to Pedals.
13 Choir to Pedals.
14 Sforzando.

Eight pneumatic combination pistons to each manual. Six pedals governing stops of pedal organ, two pedals apply and detach a movement, causing those six pedals to act also upon the combination movement of great organ. Two pedals govern great to pedal coupler. Two tremulants, one to swell and one to solo, acting on suitable stops and governed by pedals, one pedal to sforzando. Six pedals govern and combine all the other accessories in various ways. The pneumatic action is used throughout. The patent atmospheric contrivance for actuating the swell, independently of the swell pedal is also applied.

The wind is supplied by 6 pairs of bellows and 2 blowing cylinders. The bellows are placed three above and three below a three-throw crank shaft driven by a 13 h.-p. steam-engine by John Penn and Son. This engine is horizontal, direct-acting, with two 7in. cylinders, 22in. stroke, having a throttle valve connected with the receivers placed over the feeders, by means of which the speed of the engine is regulated, the steam being shut off when receivers are full of air, and turned on when empty. The three upper feeders supply air at 6oz. per square inch above atmospheric pressure—the three lower ones at 6oz. per square inch below.

The blowing cylinders are 24in. diameter, 2ft. stroke, and are driven by a 13 h.-p. beam engine, having 2 throttle valves also connected with the vacuum and pressure receivers, so that when one is reduced in pressure to 1½lb. per sq. in. below atmosphere, the other is filled at 1½lb. per sq. in. above atmosphere.

The reservoirs supplying the pipes yield pressures varying from 3 to 30 inches.

The stops are opened and shut by the pneumatic action, the movement to the pedal organ being also governed by the tubular atmospheric system, thus dispensing with trackers.

The internal metal pipes are made of ⅓ tin and ⅔ soft lead; front pipes of tin, 90, and lead, 10, in 100 parts; the total number being nearly 8,000, from the size of a straw to 32ft. C, which weighs nearly a ton. The manual sections are built in two stories, the fluework being on the lower, and the reedwork on the upper level. **J. E. B.**

The Well at Crossness.—At a recent meeting of the Metropolitan Board of Works, the finance committee presented a report of the proceedings of the Board for the year ended on the 31st of December, 1877. After enumerating the various Acts under which powers to the Board are given, it referred to the large quantity of water required for the pumping station at Crossness, amounting on the average to 866,500 gallons a day, and the attempts which had been made to obtain water from beneath the surface by sinking a well. In July last the contract depth of the bore-hole having been exceeded by some few feet without reaching the lower greensands, samples of the strata found at the depth attained—namely, 1,037½ft.—were submitted to Mr. Prestwich, Professor of Geology at Oxford, and Mr. Ethridge, F.R.S., for their opinion as to the probability or otherwise of either water or coal being found by pursuing the boring further. Mr. Prestwich was of opinion that the old red sandstone had been reached, and that, therefore, there was no probability of the Board's efforts being successful; Mr. Ethridge, on the contrary, considered that the samples had been washed down from the upper part of the boring, and that no certain opinion could then be formed as to the existence of coal, but he thought no water would be obtained. In the circumstances the Board thought it right to continue the boring to a depth of 25ft. further, and by the end of the year the bore-hole had reached a depth of 1,060ft. from the surface, but still, unfortunately, without any satisfactory result. It was well, however, that no way of obtaining a supply of suitable water should be left untried.

The Elevated Steam Railway in New York.—The first trip over the "Gilbert" Elevated Railway from Trinity Church to Central Park, in New York, was made on April 30th. The train consisted of a locomotive and four cars containing some 200 passengers. The speed, at first slow, was gradually increased to about 25 miles an hour, and the terminus in Fifty-ninth-street was reached in 17 minutes. It is expected that the same distance will ordinarily be run by through trains in 12 minutes, and by way trains in 22 minutes. A failure in steam caused a delay on the return journey, which occupied 32 minutes. The curves were passed easily and without jarring, and over the entire line the motion was smooth and uniform. The new passenger cars are 37ft. 10in. in length by 8ft. 9in. width, and will accommodate 48 persons each. The doors are placed at the ends, but it is intended that some of the vehicles shall be fitted with compartments. The decorations inside and out are very tasteful, and the unusually large windows will render the cars airy and comfortable for summer travel. The passage of the trial train was, says the *Scientific American*, received with much enthusiasm by people along the route. Several trains have run over the road carrying passengers, but operations will probably not be regularly begun until the completion of the stations now in rapid process of erection. The distance is about 4½ miles. With the east side division of this continuous iron bridge railway, on which work has not yet begun, the total length of the line will be 22 miles, "occupying and disfiguring the finest avenues in New York city."

REPLIES TO QUERIES.

⁂ In their answers, Correspondents are respectfully requested to mention, in each instance, the title and number of the query asked.

[31976]—**Compound v. Ordinary Condensing Engines.**—I apologise to "D. L. B. A., Londonderry," for not replying to his letter sooner. He is perfectly correct in surmising that I do not believe in compound engines; nevertheless, I will do my best to answer fairly the questions he puts. If, as he states, the steamers plying between Glasgow and Londonderry make the voyage in three hours less time, and with less than half the quantity of fuel, when fitted with compound engines than those fitted with single cylinder engines, it must not be taken as conclusive that the compound system is 50 per cent. better than the simple or single-cylinder system, as the above example would make it appear, but only that in this particular case one engine (the compound) is constructed with a view to economy, whilst the other (the single-cylinder engine) is badly constructed in the first instance, and in the second is probably in a wretched condition as to working order, as otherwise there could not be so great a disparity in the performance of the two engines under consideration as 50 per cent. Again, he asks how it is that one of the steamers running between Londonderry and Liverpool, having had her old engines compounded, makes the voyage in considerably less time, and with less fuel, than before. Nothing could be easier to explain than this, for if these engines were running with from three to four pounds of coal per ind. horse-power per hour, as most single-cylinder engines do, it would be no difficult matter to reduce the consumption to 2½lb. or 3lb. per ind. horse-power per hour by increasing the boiler pressure and compounding the engines—thereby being enabled to carry out the principle of working the steam expansively to a much greater extent. But this being so does not necessarily imply that the same results could not be obtained with a single-cylinder engine, and I maintain that a single-cylinder engine of the best possible construction, with the same initial and terminal pressures as in the above case, would have given better results than the compound engine above referred to. Perhaps some one will say, then, if that is the case, why not have put in new single cylinder engines instead of compounding the old ones? To such a question I should say that the extra cost of new engines would more than cover the increased saving to be obtained from them; therefore, in some cases where parties already possess engines it is cheaper to compound than to get new engines at a great cost, and at the same time be obliged to dispose of the old ones at a sacrifice. But this is according to circumstances, and not any fault of the single-cylinder system. "D. L. B. A." also goes on to say that he fancies that eminent firms, before fitting up these engines, must have found out that, both in theory and practice, they are the most economical of the two. I quite agree with him if he will add, "as the single-cylinder engine is at present constructed," as I have long since found that out myself. But I have also discovered something else—and that is, that if engineers will look into the matter they will perceive that by a revision of the mode of proceeding in constructing a single-cylinder engine they will be able to produce an engine whose prime cost will be less, durability greater, and which will do an equal amount of work with a much less expenditure of fuel than any compound engine yet produced. I was very glad to see a letter from "Marine Engineer" in your impression of May 17th, and am very sorry that he is so hard pressed for time, and I hereby offer him my humble sympathy. As to my being prejudiced in favour of the single-cylinder engine I feel called upon to inform "Marine Engineer" that it appears very inconsistent to talk about reason, as he does a little higher up, and the next instant accuse me of prejudice simply because my views do not coincide with his. Might not I, with an equal amount of reason, accuse him of the same thing—an accusation which, I am sure, he would resent with just indignation as something unworthy of the pen of any one who appreciates the value of honour and fairness in argument? I may effectually refute the charge of prejudice by telling him and all the readers of the ENGLISH MECHANIC that I am in no wise interested in the construction of steam engines as a commercial speculation, and therefore it makes no difference to me pecuniarily what kind of engine is the most popular—the expensive or the comparatively inexpensive. My interest is not in the construction of engines, but in the running of them after they are constructed. And now, as "Marine Engineer" is so constantly occupied that he cannot find time to reply to me, I will refrain from asking anything concerning his letter, and as there are no new arguments in it, but only the same in other words as appeared in his letter of March 29th, the reply to them will be found in my last letter to the ENGLISH MECHANIC. If "Marine Engineer" should happen to be less occupied at some future time I shall be happy to give due consideration to any arguments he may bring forward, and in the meantime I shall be pleased to give any information in my power to the readers of the ENGLISH MECHANIC at any time.—JOHN S. SUNDERLAND, Armitage-bridge, near Huddersfield.

[31976.]—**Compound v. Single-cylinder Engines.**—If I were to say that the practical effect of firing off a cannon was to produce a vacuum (!) in the powder chamber, because the gases rushing out of the muzzle tend to draw everything inside the cannon with them, I wonder whether your readers would laugh. And yet a man who has discovered what your other correspondents couldn't, tells us, with a gravity that is amusing, "the practical effect of this transference of steam from one cylinder to the other is to give us what is tantamount to a vacuum at the end of first cylinder about equal in amount to that which we get by condensation at the end of the second." Oh! if we could get steam so obliging as to press in one direction only, what might we not do! Would it surprise your correspondent to learn that the back pressure on the piston of the first cylinder is as nearly as possible the same as the pressure exerted on the piston of the large or second cylinder? I think if those who are unacquainted with the real cause of the economy of the compound engine were to refer to the "history" given in Vol. XIX., they would discover that it is not exactly a novelty, and, at the same time, the reason it was not brought into more extensive use soon after its invention by Woolf.—J. B. C.

[32260.]—**Systematic Memory.**—I am afraid I am very late in following Theo. Izod's information on this subject in the ENGLISH MECHANIC for April 26 last, but as I think his illustrations somewhat misleading, and having studied the subject for some years, I hope you will find space for the following. Many confuse themselves on this subject by not considering that the word memory is used to convey two perfectly different ideas—viz., 1st the *retention* by the mind of a fact; 2ndly, the power of *recalling* facts retained. The mental impression can only be made by the exercise of the senses with attention and observation. Every mind has thousands of facts retained, but they cannot be mentally viewed at will, as a whole, at any time, but are only to be recalled by the aid of the association of ideas, our minds being so constituted that we are able to attach the idea to be acquired to the idea already possessed either by putting like to like, or mentally placing facts together ridiculously or in strong contrast, or by associating words by sound, or by mental view of several words which form the symbols of a corresponding number of ideas, so that when any one link or point of the mental chain or picture thus produced is presented the mind can run along the chain or glance over the picture and find the fact wanted. Many are tolerably conversant, I think, with association under all these heads, but what I want to point out is the necessity of being able rapidly to form a definite mental symbolical picture in order to excel in mnemonics. The strength of the mental picture is shown in the case of figures into which alone T. I. has entered. Figures are confessedly the most difficult subject to master by the uninitiated, as there are only ten of them, and they so constantly recur that a mental impression of one combination very quickly becomes confused with another; but when we can clothe figures with words and form mental pictures to recall the words, figures are mastered more easily than anything else. Words no doubt are symbols and pictures themselves, but then they, like figures, are apt to become confused and lost, as a word can seldom be permanently appropriated to any single idea; but the mental picture, like the picture drawn by hand, retain its individuality. I hope by reviewing some of T. I.'s illustrations to give a few hints which I am sure will be found useful. First learn to make as definite and compact a mental picture of the subject and figure-word, or of any two or more ideas, as possible. To take the first example:—Godfrey invented the quadrant, 1740; the picture wanted is one which will show a quadrant and the date together. Now mentally view the quadrant and its degrees, and then by looking at the instrument itself you see the date upon it. Nothing could be better; but note if you have not seen a quadrant there is a difficulty, and you would then have to turn to the artificial or ridiculous association for help. Thus: Man in *quod* for *rent* getting out by *degrees*, see him filing away at the bars of his cell; or what would do for a time till you could look up the word quadrant; write the two in this way: Quad-rantdeg-rees; by this you join the two words by eye and sound, uniting last syllable of one to the first of the other. The association for vaccination is unsystematic and misleading. True it is that words merely placed together become associated, and for some minds this alone will suffice. But the key to the mnemonic art lies, as I said before, in making one mental picture of the acquired and to be acquired fact. Here this cannot be done; you cannot picture Jenner, nor is there any connection between vaccination and equipage except through Jenner, and the only connection between Jenner and equipage is through the association of Jenner being a doctor, and doctors generally driving in good equipages. After a time the mind would very likely be led away to brougham or some other vehicle. My association would be as follows: Picture your arm vaccinated and tied over it, to keep it cool the leaf of a *cabbage* = 794. Here the vaccination and cabbage leaf form one definite mental picture. So with the date of the invention of the microscope, picture the microscope in a wash-tub. Otherwise, good as it may seem at first sight, T. I.'s association is feeble and diffuse. There may be animalcula in the water in a wash-tub, but water there does not suggest animalcula, rather soaps and animalcula are an important connecting li between the instrument and the wash-tub. In l manner you must mentally picture the many ga in St. Paul's Churchyard. If I am allowed I sho like to carry this subject further, to give hints as the best method of quickly forming mental pictu for recollection of reading, spelling, names, general subjects. I can only say in conclusion, t I think the value of the study of mnemonics grea underrated; it has opened almost a new life myself, and I should much like to lead others to l into the subject and benefit by it.—G. G. P.

[32386.]—**Centre-board Boat.**—The *Field* this year contains a number of working drawing various kinds, and in the number for Jan. 1 think your correspondent will find full details of such a boat as he wants. I understand that papers are published in book form; consequen "all rights are reserved," or I might have give réchauffé of the particular paper referred to. drawings are of a good size and dimensioned.—S.

[32679.]—**American Organ.**—I think, if " Amateur" will again read "Eleve's" letter p. 92, he will, by thinking over the matter, disc that the tremolo can be applied either to a wind suction instrument—the only difference is the m ner of applying. If, referring to the sketch herewith—which, so far as Fig. 1 is concerned, section of the right-hand back corner of the w chest—he will consider S the soundboard, and M bottom board attached to bellows, there shoul no difficulty in understanding with the hel Fig. 2. The latter sketch represents a plan of holes made through board, M, into the bellow only it is complete in itself, although of small s whereas Fig. 1 is only a bit of the soundboard. six holes shown are covered by a valve, show dotted lines, and the two-holes run-into-one either a ring of wood or else a square, B, buil around them exactly the same height as the rim of the wind-chest is deep. This constructio clothed with leather, so as to be fairly air-tight the two parts are screwed together. Now, it be obvious that if the holes—which, under ordi circumstances, place the reeds in direct commun tion with the bellows—are closed by the valve sh in dotted lines, the wind must pass up through hole W (Fig. 1), push aside the rubber ball, reach the bellows through passage B. The ball constantly endeavour to return, and so there have the tremolo. The arrows show direction wind. As to the means of closing the valve. I pose it would not be difficult to devise half a ways. The valve may either have a spring to it open, a spring to keep it shut, or no spring at In the first case the "tremolo" stop must be to close it, by pushing it down, when the effect required, by means of a plunger rod; in the seco the valve is so worked by the stop rod that it is p up when the stop is pushed in; and in the th case it is obviously only necessary to so connect valve to the stop rod that it cannot close when stop is home. If the valve is properly covered, pressure of the air (suction of bellows) will kee closed when this stop is out. A wire passing thr a stuffed hole in soundboard, with screw and top, is perhaps as simple a connection as anyt and a lever or crank actuated by the stop r work it whichever way the maker pleases. the look of the new tremolo very much, bu afraid I shall not have an opportunity of tryi for some time to come. I forgot to mention is held down by little lugs or hooks, which to screws as shown. I have sketched it as if longitudinally with the soundboard; it placed transversely—probably with a litt tage, for all I can say.—ORGANON.

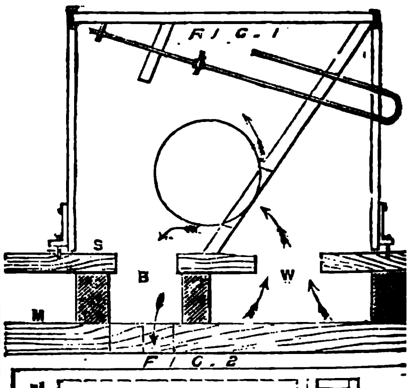
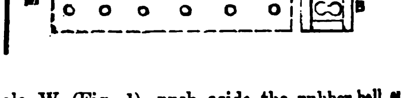


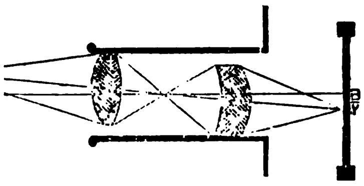
FIG. 1

FIG. 2



[32707.]—**Spectrum Analysis.**—I shou "Cyanogen" would find Mr. Rand Capro useful. It gives 136 photograps of metallic, and other spectra, with description, and extra plate of the solar spectrum, showing lines compared with the air spectrum. Spo lisher.—BRICKWALL.

—Photo Lenses.—It could not affect tion. The only effect would be to make l ray pass obliquely through the tube. I igure will explain this. Instead of seeing



as you would expect, and that in the direc- , you would see object X, and that in X Y. But you would never be able to 7 difference in your camera.—Perdu.

— **Map Printing.** — "Schoolmaster" pe to produce maps in anything like the of those he can buy cheaply. The small self-inking or otherwise, do printing sfies some people, but maps are usually ied or zincographed and coloured by hand, ur is put on by means of a series of stones, or blocks, and a number of impressions to the tints required. The process is, I ', quite beyond the scope of even a pains- ateur, unless he is about to enter upon the s a commercial speculation.—Essar.

—Sulphur Refining.—See Ure's "Dic- Wagner's "Technology," and Payen's l Industries." Information as to working nd cost of plant you can only obtain from ged in the business, and they will not tell it *quid pro quo*.—J. S. M.

—Glass Door for Hall.—Plate glass if the garden is fit to look at.—Hortus.

—Cyclometer.—Almost any train of l do for a cyclometer, understanding by a distance, not merely a cycle or wheel. It is fixed to the axle in such a manner inion or wheel moves one tooth for each . Wheels gear into that pinion and into er, and by counting the number of teeth s in the pinions you can ascertain how lutions they will make in a certain dis- then comparing the number of revolu- dicated with a scale prepared from your of the circumference of your wheel, it is culate the distance actually travelled. Of wheels themselves may be stamped with owing the actual distance in yards or e places for stamping being found by g the revolutions of the wheels and the overed by the wheel of the bicycle in one .—Geotromus.

—Cut on Forehead.—Yes, a surgeon sibly eradicate the mark in *time*, but in a child of 10) time will probably effect as t alone.—M. J. L.

—Right to Fish in Rivers.—If you can ; you have fished a river for 40 years with- id that river has not since become the pro- private person, you can fish it now, but keep in the river, not trespass on its banks.

—Painting Light Carts.—Practice and re varnish in the colour is what "A Young ght" wants.—A Mere Brushman.

—Marks on Coins.—Probably the dis- g marks of the dies.—J. M. G.

—Water Finding.—Allow me to say that lins, the water-finder, is an inhabitant of iear Chippenham, of which village I am the ie power possessed by this man first excited ity and then my surprise—surprise that omenon had never been investigated by men, and its proper sphere assigned to it ions of science. The facts of the case are iere are some people who possess the faculty ill it what you may, of having excited in rtain action by the flow of a stream of A forked branch of a tree or shrub is taken, held loosely between the fingers of each e fork pointing downwards towards the Holding the stick in this manner, the alks over the ground. Immediately upon ver a spring or stream, the fork begins to d no force can prevent its doing so, and ht round till it points directly upwards to- sky. I say nothing can prevent its doing held by a second party, it will twist itself id continue moving while held by even a he bark. Without at present going into e above are the plain facts. If any of your sire it, I will go into greater detail. The ossessed by many whom I have come across, by ladies, whose characters are above sus- There are multitudes, no doubt, among ers who would be surprised to find their ost willingly would I give every assistance who is able and willing to investigate the on, and to enter into details respecting the tests to which he has been subjected, and her particular.

ert this reply for what it is worth. It is ticated by name or address.—Ed.]

[32800.] — **Grating Noise in Telephone.** — The grating noise you speak of is most likely due to the imperfection in the flexible cords. You will find this out by shaking them, and when you have found out which particular one it is, replace it. If the ends of the wires are loosely connected to their tips, they will give this sound, although when the cord is tested on the galvanometer, it appears all right. If you have a resistance box in circuit, and you turn one of the plugs round in its hole, you will get the same sound, although you do not break the circuit. —Asor.

[32821.]—**Pygidium of Lacewing Fly (U.Q.).** —I should not expect to find a pygidium in a Chrysoperla. I believe this breathing apparatus is confined to the flea tribe, but search at the sides for spiracles. I have caught many lacewing flies, but none were free from the horrid smell. Although uncertain, should hardly think it was confined to one sex.—Theo Izod.

[32863.]—**Electro Magnet.**—Use No. 26 silk-covered wire, and a battery of 3 Daniell's cells, to be had of any seller of scientific apparatus at about 6s. per cell. You can make them yourself at so many pence. Take 3 ordinary jam pots, and fix them in a wooden box. Buy a pound of sheet zinc at 3½d., ½lb of sheet copper, and 3 porous cells 3½in. high, at 4d. each. Cut 3 pieces of zinc, 3½in. by 10in., and roll each to a cylinder 3in. wide, which you put inside the jam pot. Next cut 3 pieces of copper, each 3½in. by 1½in., and roll it up round a pencil, so that the diameter is a little over ½in. Put the porous cell inside the zinc cylinder, and make three wooden lids for porous pots with a central hole, in which you fix the coppers, so that they are suspended, and do not touch the porous cells. It is good to soak top and bottom of the porous cells for ½in. in melted paraffin. The metals are to be joined in this way. With a nail-punch make three holes in each copper

FIG. 1

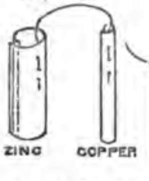
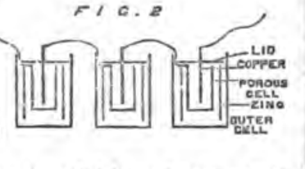


FIG. 2



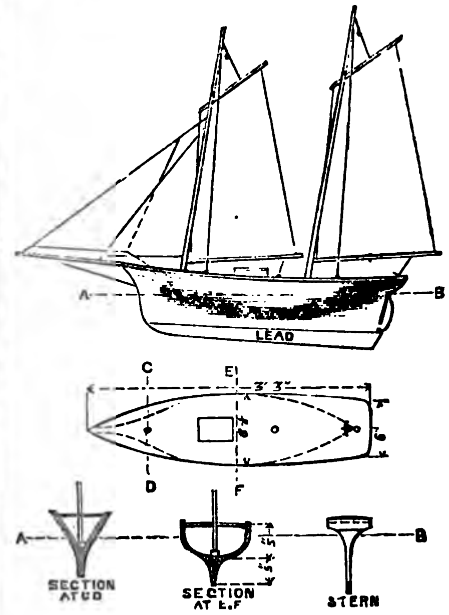
and each zinc (Fig. 1), and join each copper to the next zinc by hammering the ends of a copper wire in each metal; join them as indicated in Fig. 2. Put water and a few drops of oil of vitriol in the outer cell, and a concentrated solution of copper sulphate in the inner or porous cell, and join the first copper and last zinc to the terminals of your line. Add occasionally a few crystals of sulphate of copper to inner cell, and a little water to the outer.—Wiesendanger.

[32881.]—**Gas Holder.**—I have not made quite as many mistakes as F. R. Waite seems to imagine. I do not recollect that the querist said anything about muriatic acid gas, and for general purposes a zinc gas holder would be preferable, and I have seen many so made. Tin plate is about the worst material for anything in which water is to be constantly kept, and at most it will only last a few months. Zinc will last for years. If a continuous supply of the gas is required, of course two pipes will be necessary, but if the gas is merely to be collected in the cylinder and then used without any further addition, one pipe will answer the purpose, and be cheaper. Two pillars will be found quite sufficient. I have seen a fifty-gallon gas-holder with two pillars. A good material for the pillars is iron gas-pipe, fitting into sockets on the outside cylinder. With regard to acids, &c., which Mr. Waite says are produced in the manufacture of all gases, these and other impurities should be removed before the gas enters the holder. Some holders are made with cores, and so require a very small quantity of water, but this adds to the expense. In experimenting with any gas which would act on the metal I should contrive a glass holder, as very large glass vessels can now be obtained. But I do not think the querist requires a gas-holder of this description. I think he stated that he did not require pressure, but that he wanted a good and constant supply. If he speaks of illuminating gas a large closed cylinder or vessel between the main and place of consumption would equalise the pressure, and give him a good supply of gas. I have known gas-fitters to join a short length of large pipe to a small one in order to obtain a better supply.—Os.

[32885.]—**Canoe.**—I prefer to have a small line with a cork float which can be made fast to the anchor, and by which it can be weighed. Should the cable part, or become unfastened, you do not lose your anchor. My own is marked as a lead-line at the end opposite to the float, and is also used as a tricing line for the drogue.—Tressilian.

[32911.] — **Fuller's Battery.** — Thanks to "Sigma" for reply. May I trouble him once more to say how long this battery will remain in order for bell-ringing if used for signalling once daily? And as he speaks of a large negative surface, should the outside pot be partly filled with broken pieces of carbon? Also how many cells would be required, pint size, to work bell through 50 yards, No. 16 wire? —Amateur.

[32913.]—**Model Cutter.**—If "Poor Joe" wishes to make a model cutter or schooner 3ft. long to sail on a small lake or pond (such as can be seen at Clapham-common or Victoria-park), he had better



cut it out of a solid block of pine or yellow deal. I advise him to make a schooner with two masts. The sketch will help him. A B is the water line.—E. L. P.

[32930.]—**Pipe Angles.**—Dip the ends of the pipes in water at the angle required, and cut to mark. This is how I have seen it done. When several elbows had to be made, hot-water with whiting in it left a good mark. The "Sheet Metal Worker's Instructor," by Warn, oftentimes advertised in "ours," is very useful, but 10s. is not easily spared by many. If "John" wants to know how to do it by lines I will endeavour to make myself understood on the subject.—G. B.

[32933.]—**Legal Question.—Tithes.**—The tithe is placed in arrear by non-payment, although no demand may have been made for it. The notice, however, which the owner of the tithe is required to give, previous to taking a distress for its recovery is of the nature of a demand, and having given this notice, his broker may, after the lapse of ten days from the service thereof, proceed with the levy without further demand, and the expenses of such action fall on the tithe-payer. Under these circumstances, it is evident that if the tithe owner appoint a convenient time and place for receiving the tithe, the payer is not only morally but legally bound to attend, either in person or by an agent, to pay the tithe at the appointed time and place, or in default suffer the inconvenience and expense of a distraint upon his goods. The eatage of a churchyard is under the control of and belongs to the rector of the parish.—J. Luckyn.

[32942.]—**Interest.**—It is thus: If he pays £10 for the loan of £40 for 10 weeks, what will he pay for the loan of £100 for 52 weeks? That is:—

40 : 100 :: 10
10 : 52

Answer:—130 per cent.

Again—If he pays £337 1s. for the loan of £175 for 21 years, what does he pay for the loan of £100 for one year? That is:—

175 : 100 :: 337 1s.
21 : 1

Answer:—9¼ per cent.

—C. P. Bolton.

[32942.]—**Interest.**—None of the answers to this query on page 275 can be regarded as satisfactory, for your correspondents have one and all treated the problem as one involving simple interest, whereas it is clear that a borrower who pays periodical instalments of interest is, as a matter of fact, paying compound interest, as he loses the use of the money which represents the interest paid, and the lender has the opportunity of making interest on this interest. A little consideration will show that there is no such thing as simple interest so long as the instalments are paid when due, and that simple interest can only enter into the question when, an instalment of interest being in arrear, the borrower is allowed to pay it up at some future date without interest being charged upon it. The correct way of dealing with such questions as the present is to regard the lender as investing his money in the purchase of an annuity certain for a specified term, the payments of the annuity—so calculated as to repay the principal and interest at an agreed rate—being made by the borrower as they fall due. Thus in the first case the lender invests £40 in the purchase of an annuity of £5 a week for 10 weeks. This is equivalent to paying £8 for an annuity of £1 for 10 weeks. It is immaterial whether the terms are weeks, months, or years, as the rate per cent. will come out proportionately. It will, therefore, not affect the result if we regard the payments as made yearly instead of weekly. From Lieutenant Colonel Oakes' recently published "Tables of Compound Interest" (which give the "present value of 1" and the "present value of 1 per annum" for any number of years not exceeding 100 at rates increasing by ⅛th per cent. from ¾ per cent. to 10 per cent.) we find that the present value of 1 per annum for 10 years is at 4¼ per cent. = 8·011 and at 4⅜ per cent. = 7·962, from which we deduce a more exact rate of 4·278 per cent. per annum as that required. But in the present case we are dealing with weeks; the yearly rate is, therefore, 4·278 × 52 = 222·46, or £222 9s. 2d. per cent. per annum. The following table shows the subdivision of each weekly payment into interest and repayment of principal, and is at the same time a proof of the accuracy of the above solution:—

Order of Instalment.	Amount of Principal Unpaid. £	s.	d.	Amount of Interest Paid. £	s.	d.	Amount of Principal Repaid. £	s.	d.
1	40	0	0	1	14	2	3	5	10
2	36	14	2	1	11	5	3	8	7
3	33	5	8	1	8	6	3	11	6
4	29	14	1	1	5	5	3	14	7
5	25	19	6	1	2	2	3	17	10
6	22	1	9	0	18	11	4	1	1
7	18	0	8	0	15	5	4	4	7
8	13	16	1	0	11	10	4	8	2
9	9	7	11	0	8	1	4	11	11
10	4	15	11	0	4	1	4	15	11
				10	0	0	40	0	0

The second column shows the amount of principal remaining unpaid at successive payments; the third column contains interest calculated at 4·278 per cent. on the amount in column 2, and the fourth column shows the amount of principal repaid with each payment obtained by deducting the amount in column 3 from £5. The values in column 2 are successively decreased by those in column 4. It will be seen that the amount of principal repaid with the tenth payment in column 4 exactly covers the amount previously outstanding in column 2, and also that the totals of columns 3 and 4 give respectively £10 the interest paid and £40 the original sum borrowed. The second question should be treated in the same way. Here we have £175 invested in an annuity certain of £1 6s. 9d. for 252 months (I suppose 12 of these months go to the year). As I know of no table extending to so many terms as this, I have preferred to consider the sum of £175 as purchasing an annuity of £4 0s. 3d. per quarter for 84 quarters. (This assumption will not affect the result for practical purposes.) Employing Oakes' tables as before, I find the rate to be 1·767 per cent. per quarter or £7 1s. 4d. per cent. per annum. These results, it will be seen, differ considerably from those given by your correspondents; but this, as I have said, arises from their treating the problem as one of simple interest. Your correspondent, "Os," has gone wrong in his second solution by deducing an average from a total of values, each of which has an unequal force upon the result. I notice also that "A Barrister" is not consistent in his two solutions. In the first case, in obtaining the average term he takes the number of weeks (8) during which the principal is repaid, while in the second case he deals with the full term of 252 months, during which both principal and interest are repaid. I think he probably intended to take 10 weeks and an average of 5½ in the first case. I must, in conclusion, protest against such expressions as "£40 × 4½ weeks" and "£175 × 10 years 6½ months." Of course 4½ weeks times £40 is meaningless, and one has doubts whether the result is £180 or 180 weeks. The late Professor de Morgan has dealt trenchantly with this practice in his "Budget of Paradoxes," but indeed such a windmill was not worthy so doughty a knight!—FELLOW OF THE INSTITUTE OF ACTUARIES.

[32945.]—**Reducing Aperture of ¼in. O.-G.**—I beg to thank "W. G. P." for his early reply to my query, but I think he has not grasped my meaning exactly. I am perfectly willing to sacrifice a portion of the resolving power of my ¼in. if by any arrangement of stops I am enabled to gain a perceptible advantage in penetration. I have long since known that objectives of large aperture and great resolving power are more or less deficient in penetration, although I have seen one or two glasses which combine these qualities in a very high degree, and consequently command a very high price. I do not possess a ⅛-in., and do not wish to purchase one at present. My stock of powers is limited to three—viz., 2in., 1in., and ¼in., all of English make, the latter having 100° of angular aperture and screw collar adjustment. Now, if I can by any means alter my ¼in. objective so as to gain more penetration, I would gladly submit to less resolving power, of which it seems to have more than sufficient. I have read with considerable interest the microscopical matter in these columns from time to time, and I remember one of our correspondents stated that with a series of stops he could alter at pleasure one of Ross's ¼in. glasses so as to gain penetration at a loss of resolution, and *vice versâ*. I should very much like to know how the stops were arranged to get that effect, as in my case I cannot arrive at any satisfactory result. With the ordinary back-stop of various sizes, and placed in various positions, I lose light and angle, and apparently gain nothing to compensate for it. Any hints from our numerous correspondents will greatly oblige me. Perhaps I may venture to trespass on Mr. Wenham's kindness. If he has the time I know he has the willingness. Also, any remarks from him on the appearance of the mercury globule when testing high powers would, I am sure, be read with more than ordinary interest by many others than myself.—H. R. HERBERT.

[32947.]—**Blacking.**—Due regard is not paid to method or manipulation when receipes are given. The following I give for the making of blacking:—Take ivory or bone black, any quantity, and to every pound put 1½oz. measure of sulphuric acid, and well triturate it. It will become damp, like snuff. Next add cod oil, 2oz. to the pound. If liquid add treacle, 3oz. to the pound, and small beer to mix, or stale beer if for paste, enough to make up into a paste. Foots sugar is preferable to treacle, and a better black by the addition of ¼oz. to the pound of Prussian blue. It is improved if laid up light for a day or two after the first manipulation, and again after the second, as a decomposition takes place which improves it very much.—BEAVER.

[32964.]—**Science and Art Examination.**—If "Learner" intends to "work up for Honours," 7th Stage Mathematics, he will find the following works very suitable:—Boole's "Differential Equations," also his treatise on "Finite Differences;" Todhunter's "Differential and Integral Calculus;" Dr. Salmon's "Analytic Geometry of Three Dimensions," also his "Higher Plane Curves" and "Higher Algebra."—BERNARD M'GUIRE, Liverpool.

[32964.]—**Science and Art Examination.**—Todhunter's "Differential and Integral Calculus," Boole's "Finite Differences," Boole's "Differential Equations." Woolhouse's "Elements of the Differential Calculus" is also a capital book on commencing the subject. For each and all of these a thorough knowledge of algebra is necessary as a preliminary.—FELLOW OF THE INSTITUTE OF ACTUARIES.

[32966.]—**Solution of Caustic Soda.**—Weigh out 24·99 grains of pure fused caustic soda, and dissolve in 10,000 grains of water. The resulting solution will then be of the required strength.—J. M. W., Manchester.

[32968.]—**Steam.**—You will not be able to get a steam engine to propel a small boat as fast as four oars can. Probably your 20ft. yawl can be driven with oars 8 miles per hour; with screw or paddle you will scarcely get half this speed.—E. B. F.

[32970.]—**Solid Stencil Ink.**—Lamp-black and curd soap.—BEAVER.

[32073.]—**Screw Cutting.**—Taking your leading screw to be four threads to the inch, your wheels will be mandrel 100, stud 50 inside, 100 outside, 20 upon leading screw. Make a mark upon your 50 wheel in one space. Divide your top 100 into five, by teeth; when you have cut one, turn until one of your teeth comes into space of 50. Slip out, and turning mandrel round to No. 2, slip into same space again, and repeat No. 3, &c., and you will have the five threads. You will need your slowest motion on back gear.—BEAVER.

[32974.]—**Sheet Steel.**—The scale can be removed by flogging upon a wood block end way of grain and wood. Maul with sand.—BEAVER.

[32975.]—**Carbon.**—You cannot make good carbons for the electric lamp. Better by far cut them out of good gas carbon. Get the carbon with closest texture, and saw with emery and water.—W. J. LANCASTER.

[32979.]—**Eyepiece for Telescope.**—To MR. LANCASTER.—If you wish to get the nearest power to 100 per inch, by using the ¼in. lens, you must use with it a plano-convex lens, ½in. focus, as an eye-lens, and mount the two lenses ⅓in. apart, above the eye-lens; have a small diaphragm, with a pin-hole aperture. You must also have a diaphragm in the focus of eye-lens, and having a diameter about the same as a small pin's head. If you want to get a power of 100 to the inch, you must use the following lenses:—Eye-lens, plano-convex (⅛in. focus), field-lens, plano-convex (⅓in. focus), the two being ⅛in. apart, with pin-hole diaphragm in focus of eye-lens.—W. J. LANCASTER.

[32982.]—**Sleeping on the Back.**—Having cured myself of the same, I have much pleasure in telling you how I did so. Before getting into bed I made an impression in the bed, so that I lay partly on my back and partly on my side—*i.e.*, between the two. It is not a good plan to lie right on the side at once. If "Bachelor" adopts this plan, and perseveres in it, he will soon be as adverse to lying on his back as he is now to lying on his side—at least, such is the case with me. Of course this will not prevent the adoption of some mechanical contrivance, should it be preferred.—W. R. S.

[32982.]—**Sleeping on the Back.**—"A Bachelor" had better wear when in bed, a broad band or belt round his waist, but rather high up, and to this band at the back fix several empty cotton-reels, so that if he was to turn on his back in his sleep, he would find the reels too uncomfortable to allow him to remain long in that position. Or another way would be to fix instead of the reels, a small board about 6in. square, and to the centre of and perpendicular to which is fixed a kind of leg 4in. or 5in. long. If he was to try to sleep on his back when lying on this one legged stool, I think he would find, as soon as he dropped off to sleep, that he would fall on one side or the other. He might also try tying himself in bed, so that it would be impossible to lie on his back. Supposing, for instance, he wished to lie on his left side, he could easily manage it by fixing to his right arm, as high up as possible, a strap, the other end being fixed to the left side of the bed, and on his left arm tie one which was fixed to the right side of the bed, with straps being just slack when he was lying on his side. In this way he could sleep comfortably on his side, but as soon as he turned to lie upon his back the straps would tighten, and not allow him to do so.—A. A. WATKINS.

[32984.]—**Anhydrides.**—Benzo-cinnamic anhydride occurs in certain balsams, and is prepared from dry sodium cinnamate and benzoyl chloride. Thus:—

$$\mathrm{C_8H_7CONaO + C_6H_5COCl = NaCl} + \left.\begin{matrix}\mathrm{C_8H_7CO}\\ \mathrm{C_6H_5CO}\end{matrix}\right\}\mathrm{O}.$$

After washing it is left pure, and is dissolved by alcohol, from which it crystallises in small lustrous prisms, having an agreeable smell. Aceto-benzoic anhydride is prepared by heating dried sodium benzoate with acetyl chloride. Thus:—

$$\mathrm{C_6H_5CONaO + CH_3COCl = NaCl} + \left.\begin{matrix}\mathrm{C_6H_5CO}\\ \mathrm{CH_3CO}\end{matrix}\right\}\mathrm{O}.$$

Or by acting on fused sodium acetate by benzoyl chloride. Thus:—

$$\mathrm{CH_3CONaO + C_6H_5COCl = NaCl} + \left.\begin{matrix}\mathrm{CH_3CO}\\ \mathrm{C_6H_5CO}\end{matrix}\right\}\mathrm{O}.$$

Potassium acetate may be substituted for sodium acetate in this reaction. In the above reaction the group $\mathrm{C_6H_5Co}$ takes the place of the Na in $\mathrm{CH_3CoNao}$ to form this mixed or double anhydride. Other anhydrides are formed by similar substitution. When distilled it is resolved into acetic and benzoic oxides or anhydrides. Thus:—

$$\left.\begin{matrix}\mathrm{CH_3CO}\\ \mathrm{C_6H_5CO}\end{matrix}\right\}\mathrm{O} + \left.\begin{matrix}\mathrm{C_6H_5CO}\\ \mathrm{CH_3CO}\end{matrix}\right\}\mathrm{O} = (\mathrm{C_6H_5CO})_2\mathrm{O} + \begin{matrix}(\mathrm{CH_3CO})\\ \mathrm{O_2}.\end{matrix}$$

In the distillation, the acetic anhydride passes off first, while the other crystallises on cooling in the retort. It is decomposed by water at 100° into the constituent acids. This anhydride is a colourless neutral oily liquid, obtained by washing from the NaCl formed in the above reactions.—HUGH CLEMENTS.

[32986.]—**Headache in the Water.**—I used to suffer from headache immediately after bathing, though not, like "J. N. B.," while in the water. I found that the best plan was to dry the head first, and immediately to put my hat on, and then finish drying the rest of the body. The hat seemed to make all the difference.—GLATTON.

[32986.]—**Headache in Water.**—Headache may arise from several causes. As, entering the water immediately after a hearty meal; or, when very much fatigued and exhausted; or, sometimes bathers suffer from inflating their lungs excessively, under the impression that it is necessary. The precaution of first wetting the head should be taken, if he do not enter head first, which is far better if practicable. Above all, the bather should not stay in the water too long; ten to twenty minutes is quite sufficient, unless in constant practice.—NOVUS HOMO.

[32986.]—**Headache.**—Perhaps you could prevent this by spilling a bucket of water on your head before entering the sea; at least, I have found this give relief.—E. B. F.

[32987.]—**Water Colour Bones.**—Make a slip of either zinc white or white lead with one of japanner's gold size to four of turps, and dip the article in. For the finishing add one part of best copal varnish. The turps must be clean and good.—BEAVER.

[32988.]—**Books on Botany.**—If "E. M. M." wants a cheap book which will give him a really scientific introduction to botany (not a mere list of the names of British plants) he cannot do better than procure Rossiter's "First Book of Botany," 1s. 6d., T. J. Alman, Oxford-street, London. An excellent companion to this, or any other scientific book on botany, is Professor Henslow's "Dictionary of Botanical Terms:" Groombridge and Sons, Paternoster-row.—W. WILSON, LL.D.

[32988.]—**Books on Botany.**—Cooke's "Structural Botany," 1s., Cooke's "Botanic Terms," 2s. 6d. (Hardwicke), and Hayward's "Botanist's Pocket-Book," 4s. 6d. (Bell and Daldy), will be found exceedingly useful. My London bookseller informed me last week that Hooker's "Flora" is "reprinting;" so I hope to have a copy shortly.—J. N. D., Tuxford.

[32989.]—**Dimensions of Tank.**—The amount of taper of the sides of the frustrum of the cone being 5 feet in a depth of 6 feet, the amount of taper for each foot will be ⅚ths of a foot, or 10 inches. Thus the diameter at 1 foot in depth will be 19ft. 2in.; at 2ft., 18ft. 4in.; at 3ft., 17ft. 6in.; at 4ft., 16ft. 8in.; at 5ft., 15ft. 10in.; at 6ft., 15ft.—H. E. H.

[32989.]—**Dimensions of Tank.**—By looking at the shape of the section of the tank "Gauge" will see that the figure can be divided into a parallelogram and two right angles. The parallelogram will be the width of the smallest diameter of the frustum. The diameters at different vertices will vary in direct proportion as twice the length of lines parallel to the base of one of the triangles. The diameters will be, therefore, 19ft. 2in., 18ft. 4in., 17ft. 6in., 16ft. 8in., and 15ft. 5in., for each foot in depth respectively.—G. F. H.

[32990.]—**Polishing Alabaster.**—If your slab is very rough rub it with a piece of hard stone and fine water. Follow up with (1) Bilston or (2) Congleton; and (3) Snake stone, using water. Polish with a piece of old linen ick felt, sprinkled with putty powder, and with water. Should your slab be small l do for the polisher; if it is large nail the laned wood block the size of a brick. But, se, do not employ rag unless you put it elt. Avoid grit when you have finished and.—W. K.

—**Gold Leaf.**—If "J. A." transfers the ie will not have any waste. Cut tissue paper ger than the leaf of gold, and wax on one ce the waxed tissue paper on the book of ed side to the gold leaf. Do this to as ves as you require to use; then put the r a heavy weight for a few minutes. The adhere to the tissue, which can be cut to a pair of scissors. Lay the gold where re- ess on with wadding, and peel the paper 'J. A." can use writing pencil he will find ay is to get some bronze powder from a hop, dissolve some gum arabic in water, ncil in the gum water, and then in the ien he can paint whatever he requires on ed linings of the books. To rub off super- d use a fitch or No. 1 sash tool.—Tu

—**Gold Leaf.**—What you require is a shion and knife. Ornamental work on nerally printed either in varnish or size, ith bronze powder and a hare's foot. Don't l skewer off.—Beaver.

—**Musical Box.**—I am much obliged to s for his reply to the above query, which ory as far as it goes, but hardly promises cure for the evil. Am I to understand rring arises from an excessive vibration ues? And, if this is the case, could it not d by restoring in some way the original the comb?—Discord.

-**£5 Telescope.**—Mark a circle 3in. in n thick paper, and cut it out with scissors. too true, but make a many-sided polygon. the outside of the O.-G.; now, on re- eyepiece, and looking through the tube, r ring of light should be seen round the re the paper does not touch the brass). nses out of the brass band of the highest screw the band into the eye-tube. On rough the small hole in the band, the e diaphragms should just cut the line of the O.-G. The small hole should be in cus of the O.-G.—Texan.

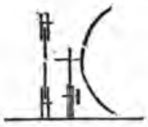
-**£5 Telescope.**—Are you sure you have lens in the cell rightly placed? This often ts where none ought to exist. The lenses losely together, like a boy's sucker, and laced in cell with convex surface down- rards object looked at), then the flint wn upon the crown convex. Having them nner, next screw in, and try effect. If ght, I would recommend you to make iragms in the following manner:—Cut of cardboard about 11in. long by 1in. in unroll one of them in the tube, and glue ping portions together, so as to make a of tubing; then line it with a second rdboard. Having finished one, make two then paste upon them three diaphragms ardboard of the following dimensions:— ., 2¼in. Having done this, remove cell e, and take a piece of string and fasten to eyepiece tube. Now, place the three s in such a position that they each push p a little towards centre of tube. You black them before fixing in tube. Having gain try the telescope upon some distant if still bad, don't throw it away, but e of Wray's object-lenses, same size, and d to the telescope. You may get some or lens now in.—W. J. Lancaster.

-**Telescope.**—If your eyepieces are too e size of your O.-G. you will be troubled ess in the image; so, too, you will if they erful.—E. B. F.

-**Enamelling Tin.**—Paint the tin four s with the best white paint, mixed up h instead of oil, and place it in an oven to Doces.

-**Bleaching with Sulphur Fumes.**— e in what we call stoves, which are made of brick, and of any size you need. Those sed are about 2 yards wide, 4 yards long, h. They are provided with rails on each stove), into which pegs are stuck on ng the goods to be bleached. The sulphur ron dishes, a hot iron is passed over the ight it, the door is then closed, and the wed to burn itself out. These kinds of ot act very well, as large quantities of pe through the mortar in the walls. would do a great deal better if made of one-third of the sulphur now used would ould also prevent such large quantities o the air, and doing so much damage to und.—Chemical Student.

Phonograph.—You should have 14 the inch instead of eight, and square you would find no difficulty in getting urface with your tinfoil by means of a Your foil has too much play in the grooves. One diaphragm is quite enough for successful reproduction of sound. It ought to act, not directly, but by means of a steel spring. The



diaphragm has not enough elasticity by itself. Fix the point and spring as shown in sketch.—Wiesendanger.

[32999.]—**Curious Apparatus.**—The glass tube with the two bulbs is very old, and was originally called a pulse-glass, as the good old people imagined it gave a visible record of the pulse. This, however, it does not do. The liquid contained in it is spirits of wine, just tinted to make it more visible. Then, before being sealed, it is gently boiled, so that nearly all the air escapes. As there is, however, a small bubble of air, this when heated expands, as does also the spirit vapour, thus giving rise to an apparent ebullition.—W. J. Lancaster.

[33002.]—**Safe Working Load of Timber.**—"L. D." will find the following formula to be tolerably accurate:—Let B = breaking weight in lb., L = length of timber in inches, W = width in inches, D = depth in inches, and M = 900. Then $B = \frac{D^2 \times W \times 4 \times M}{L}$. For the safe working load take ⅓ off the breaking weight.—T. E. J.

[33002.]—**Safe Working Load of Timber.**—The rule that "L. D." requires is as follows:—Multiply 4 times a constant value (say, K) by the breadth, and then by the square of the depth. Divide this sum by the length between supports, the quotient will be the breaking weight in cwts. This divided by 5 or 6, as the timber is exposed or not, will give the safe working load when applied centrally. But if the load is equally distributed it will bear twice the amount. The value of K for Scotch fir is 12cwt., so that $\frac{4 \times 12 \times 8 \times 64}{96 \times 6} =$ safe central load in an exposed situation, about 2 tons 2 cwt.—G. F. H.

[33004.]—**Photography.**—The lens you have would not produce good photos; better have a good combination made of the usual form, if you wish to have good pictures. Still, you may obtain a good view with a meniscus convex lens of, say 6in. focus. This will produce a fair quarter-plate view by using a stop 1in. in front of lens and 3-16in. diameter.—W. J. Lancaster.

[33007.]—**Violins.**—Three of the makers named had no great reputation. The one by Jacobus Staines may be a Steiner; if so it would be considered valuable by some people, but, in the writer's opinion, the tone is as ugly as the model. The finest quality and quantity of tone is invariably met with in violins of the Straduarius flat model school; the high models have a thin penetrating tone. I bought an old violin the other day which had not seen daylight for 60 years. The label is not quite legible, but reads thus: "Signor Blumby, Naples, Fecit 1708. Repaired by Standby, 1789." This violin is of flat model, and now it is repaired has a most magnificent tone, firm, round, bold, and mellow. Can any one tell me anything of this maker?—S. Taylor.

[33010.]—**Riding.**—Lean well forward when riding for a time—this will give you the balance. You may then gain what you wish by degrees, though there is always an inclination to lean slightly, which is an advantage.—One who has Ridden a Great Deal.

[33010.]—**Riding.**—Wear stays.—E. B. F.

[33015.]—**Mining.**—1. Horizontal double-cylinder engines are the most suitable for mines of great depth, and where large outputs are required. The engines should be fitted up on the most approved style, having all the modern improvements for the employment of the least possible quantity of steam for the greatest possible amount of work. These improvements are to be seen quoted in any specification or tender from any of the large engineering firms. 2. Round steel wire ropes are the safest and most economical to use; they combine greater strength with less weight and space than either flat steel or hemp ropes. They are used now on all new erections, and have in many cases been fitted on old machines. 3. The pulleys should be of cast steel, of as large a diameter as possible, consistent with strength and regard to the diameter of its shaft. The drum should also be of as large a diameter as possible. I have never seen pulleys of less than 6ft., and drums 10ft., for round wire ropes. There are only two kinds of drums for round wire ropes—the cylindrical and the conical, the latter acts as a kind of counterbalance; but the ropes are apt to slip, so that I am of opinion that, with a sufficiently powerful engine, the cylindrical drum is the best. 4. There have been several safety-hooks and arrangements for the prevention of accidents due to overwinding invented; but, I believe, King's and Walker's detaching hooks are the best. "Practice" can see them illustrated in any paper where they are advertised, and can obtain particulars from the makers. I do not remember the name of any safety-cage (to prevent accidents from the breakage of ropes) except that of Aytoun. There are numerous varieties patented, but all act by grasping the guide or "skeats" with arms released by springs on the breaking of the rope. But they are all more or less objectionable on account of the spring acting without the rope breaking from some acceleration or jerk in the winding, and this causes a delay. If "Practice," therefore, could exercise his ingenuity and invent something to obviate this difficulty, he would confer a boon on the mining community.—T. E. J.

[33018.]—**Excavating.**—The number of cubic feet in the excavation is 2,477,386, which number is obtained by either of the following rules: "To the product of the diameters of the two ends add the sum of their squares, multiply this sum by the perpendicular height, and by ·2618 the product is the solid content;" or, what amounts to the same thing, "To the product of the radii add the square of the radius of each end, multiply the sum by the height, and this product by 3·1416, ⅓ of the result will be the volume." As to the payments, "Excavator" will find that the number of cubic feet lessens for each foot in depth (see reply to Dimensions of Tank), therefore the payments ought to be on a scale to suit the variations.—G. F. H.

[33018.]—**Excavating.**—This is a question of the content of the frustum of a cone, diameters 456ft. and 405ft., depth 17ft. The squares of the diameters of the two ends of the frustum of a cone, added to the product of the two diameters, and that sum multiplied by its height and by 0·2618, equals its solidity. In this instance $(456^2 + 405^2 + 184{,}680)$ $17 \times 0{\cdot}2618 = 2{,}477{,}386$ cubic feet or 91,755 cubic yards in the whole work, assuming the surface of the ground to be level, as nothing is stated to the contrary. The quantities in each foot in depth should be taken in the same way, and are so taken in the table subjoined, or they may be taken in a less tedious mode and sufficiently accurate for earthwork in the case of such thin layers by taking an average diameter for each layer of a foot thick, squaring it and multiplying by ·7854. The excavation being 51ft. narrower in 17ft. of depth (*i.e.*, slopes 1½ to 1) at each foot down there will be a decrease in diameter of 3ft. Thus the two diameters for the first layer of a foot deep will be 456 and 453, and its average diameter 454·5, and so on for the remaining layers. The following are the contents of each foot in depth:—

ft.	Cubic feet.
1st	162,241
2nd	160,106
3rd	157,986
4th	155,879
5th	153,787
6th	151,709
7th	149,645
8th	146,595
9th	145,559
10th	143,537
11th	141,530
12th	139,536
13th	137,557
14th	135,592
15th	133,641
16th	131,704
17th	129,782
Total	2,477,386

The completion of a perpendicular foot will only take place 17 times, so I presume your 18th payment is at a certain date after completion of the work.—H. E. H.

[33020.]—**Lacquer.**—You will find a lot of good recipes in back numbers for capital lacquers, and the best methods of applying them.—W. J. Lancaster.

[33021.]—**Piano.**—"A. T. C." does not say what class of piano he intends making, but I suppose it may be taken for granted to be a cottage. If so the first thing he must turn his attention to is the back, and this, I would advise, should be of iron. The cost of a reliable one ready pinned will be from 50s. to 80s., but if he does not care to venture so much he had better procure six 4ft. lengths of 3in. × 4½in., and 13ft. of 1½in. × 4½in. dry sound spruce, as also a beech wrest plank and bent side. The two latter can be obtained at Brooks', Cumberland Market, N.W., ready seasoned, and cut with the flowery side out. The cost of these, together with a metal plate and resisting irons, will be about 17s. If "A. T. C." will state which way he decides I shall be pleased to give him measurements and directions. In the mean time, to encourage him, I may mention that out of a large number of similar plucky attempts that have come under my notice I have not known a single failure; while the results in not a few would shame many practical hands.—W. H. Davies.

[33023.]—**Barometer.**—In the first place you must know the elevation above sea level of the position of barometer, and then you must add one-tenth of an inch for every 110ft. above sea level; then for temperature you must correct according to the corrections on the certificate for the especial barometer.—W. J. Lancaster.

[33026.]—**Heat Question.**—The question refers to a very simple experiment easily performed—viz., to have a glass jar, and gradually breathe into it the air as it leaves the lungs, of course, being cool;

now the air expired differs from the air inspired in that it not only gains roundly 5 per cent. CO_2, but that it has lost 5 per cent. O. Hence, when the expired air has pushed the ordinary air out of the jar, it will be found that a taper will be extinguished on account of oxygen starvation, and not so much on account of the excess of CO_2.—W. J. LANCASTER.

[33028.]—**Siphon.**—You cannot depend upon your siphon working more than 30ft. in depth; so that, if you can arrange that the outer leg falls 40ft., or even 35ft., you will easily get rid of the water. But as you want to empty a well 40 yards deep, you will at once know that a siphon is useless. Better get a pump at once; that is the only effectual way of doing the work.—W. J. LANCASTER.

[33029.]—**Gilding on 15 and 18 Carat Gold.**—You will find a good deal of instruction on this matter in the back numbers. I do not altogether see what is meant by "gilding on 15 or 18 carat gold." Pure gold should be used in order to get as good a colour as possible, and good gilding should resemble "coloured gold." 15 and 18 carat gold cannot be distinguished (by sight) when properly coloured.—Os.

[33040.]—**Condensers.**—If your photos are circular ones 3in. diameter, then the 3½in. condenser is plenty large enough to show the whole of the photo; but if they are square photos then a 4in. condenser would be necessary. The quarter plate lens ought to give a sharp disc from centre to margin; and it may be that the dimness around edge is due to wrong position of lamp. Try lamp half an inch nearer lens.—W. J. LANCASTER.

[33042.]—**Polariscope.**—A polariscope as applied to the microscope should, if possible, be made of two Nicol prisms. The prisms are so much better than any other arrangement that the outlay of 10s. for a pair is not much even to an enthusiast short of "cash." However, you may try to make a pair of thin glass polarisers, and if you follow the instructions below you will succeed in obtaining fair results, although a mere fog compared with the brilliancy of the prisms. Get about 15 pieces of thin microscopic glass cut in a long oval form, so that you can place them nearly upright in a small tube above object lenses. Having the pieces ready, fasten them into the tube at an angle of 27 degrees with a line drawn through the centre of the microscope—that is, the plates will be just inclined 27 degs. out of the perpendicular. This, then, the analyser has to be mounted above the object lens; and for the polariser get a piece of patent plate, 3in. by 2in., mounted in the gimbals, which ordinarily carry the mirror, and incline the microscope, so that the glass shall make an angle of 58 degrees with the source of illumination. The under surface of plate must be blacked with a dead black, and then the instrument will be complete.—W. J. LANCASTER.

[33047.]—**Chromatic O.-G.**—You cannot do anything with it if it is so bad as you say. The better way will be to part with it and get a good lens. Before doing so, however, test it with the two lenses in all positions until you may hit upon one position in which it may work well; then make a pencil mark across the two edges, so that you will know the best working position.—W. J. LANCASTER.

[33048.]—**Microscopical.**—You do not really mean to say that the "opticians" (dealers in spectacles, I must suppose you to mean) have refused to clean the lenses, remove the black, and reblack with a dead firm black, your objective? Really this is astonishing! However, why don't you do it yourself? Not that I should at all recommend amateurs to take high-priced objectives to pieces on any consideration—better by far send them to a good man to clean for you. However, as your lens is probably not a very expensive one, proceed in the following manner:—Before removing the anterior lens, notice whether there are any marks denoting position of the two parts of brasswork. If not, before removing make a mark either with pencil, pen, or minute scratch with knife, so that you can screw up to precisely same positions. Proceed in this manner with every lens until the whole are out, then, with a fine camel-hair and some hot alcohol, clean out the whole of the black left in the tubes. Having done so, mix up into a thin paste a small quantity of the best ivory black with two parts of French varnish and one of alcohol; then paint the inside of tubes with this composition. Then clean the lenses with a tuft of perfectly clean cotton wool on the end of a quill or stick. Having cleaned largest lens first, screw into position, and clean others in same manner, using a new piece of cotton wool each time. With a little time, and a great amount of care, you will be able to clean the lens as nicely as it would be done in London.—W. J. LANCASTER.

[33048.]—**Microscopical.**—I should advise "Kaph" to place his objective in the hands of the makers, and of no one else. But I do not believe any maker in London will charge him one farthing even for removing the black particles, if they are from the cause he names, and are not produced by his own want of care in handling. I never saw any black come off in this way, and I do not use mine very carefully either.—ESSEX.

[33049.]—**Boring Sticks.**—Take a piece of steel rod (a bit of umbrella frame will do), bring to a cherry red heat at the tip, and hammer flat, grind to a spear point, harden, and temper. Fix it upright in the vice, with a couple of inches projecting, set the stick on it with its pith on the drill point, twirl it between the palms till the stick has descended to the vice, then give an inch or two more feed, and so on. I took the idea from reading a traveller's account of the Arab method of boring cherry sticks for pipes, and found it answer for sticks two or three feet long; and with care, I think, I could have bored longer ones. Of course, I am speaking of what I may call natural sticks, with pith or rudiments of pith in them. It would not answer for sticks cut out of solid wood; they could be drilled only in the lathe, I should think.—ARGENT SABLE.

[33049.]—**Boring a "Cherry Stick."**—In an article contributed to this journal a few years back, under the title of "Artisans of the East," I fully described the method of boring the sticks for Turkish-pipe stems, some of which are more than 6ft. in length, in order to reach from the sitter on a divan to a tray placed on the floor for the reception of sparks or ashes. The process of truly drilling up the sticks, though seemingly rude, is both expeditious and accurate. It is this: the stem must be perfectly straight; if not it must be made so by steaming or bending the crooked parts under fire heat. The drills are made of soft iron wire, as these may be very easily kept sharp by a file. The cutting end of the drill is flattened out, so as to make a hole about one-fourth larger in diameter than the hole to be bored. Attached to the other end of the wire is a wooden pulley, exactly like an ordinary cotton reel. The wire stem of the drill is driven only about a fourth way down the hole in the reel. In a wooden block fastened to the floor is driven a wire spike that fits the hole in the reel. Drills of several lengths are used in boring a pipe-stem, beginning with a short one. The workman sits on the floor, marks an entering or centre hole in a stick, places a short drill to begin with upright on the spike, and works the drill to and fro with a bow, consisting of a cane and leather thong. The borings fall down without the necessity of removing the drill, which is changed for a longer one as the work progresses. Some little knack has to be acquired. This principally consists in allowing the stick to slip round slowly in the hand, otherwise a straight bore cannot be maintained. The stick is grasped with the left hand about a foot above the work.—F. H. WENHAM.

[33053.]—**Colouring Water.**—Try one of the aniline dyes.—NOVUS HOMO.

[33053.]—**Colouring Water.**—This is another of those vague queries that give much needless trouble in answering, and bring, I should think, but little satisfaction to the querist. (See my answer, 32943, p. 275). Brazil wood boiled in water, with a little sodium carbonate, will give various shades of red according to time and strength. So will cochineal, madder, &c. Litmus colours water blue, but on addition of an acid it changes to bright red.—DAGHBERT.

[33053.]—**Colouring Water.**—Make an infusion of red cabbage, and add sulphuric acid till the colour becomes bright red. This forms a precipitate after some time, but it can then be filtered, and will remain clear. It will require plenty of acid. Dissolve carmine in a strong solution of ammonia, and add water sufficient. The depth of colour in both these preparations of course depends on the quantity of water in proportion to other ingredients.—Os.

[33054.]—**Sulphuretted Hydrogen.**—You may obtain this gas by pouring dilute hydrochloric acid upon a metallic sulphuret, such as that called crude antimony. It will keep a short time over water, is colourless, transparent, inflammable, and quite irrespirable.—FRED W. MUNCEY.

[33054.]—**Sulphuretted Hydrogen.**—This is prepared by heating sulphur and iron filings together in a crucible, or by bringing a stick of roll sulphur and a piece of white hot iron into close contact one with the other. Either way a compound is formed of one equivalent of iron and one of sulphur, which yields sulphuretted hydrogen on being dissolved in diluted sulphuric acid.—J. HARRIS.

[33054.]—**Sulphuretted Hydrogen.**—If "Kappa" is a student of chemistry, surely his textbook tells him how to prepare this; and, if he is not, it is hardly advisable for him to meddle with so poisonous a gas. Take 88 parts (grains, drachms, &c., according to quantity wanted) of ferrous sulphide, and 100 parts (by weight) of sulphuric acid. Fit a flask with a good cork (caoutchouc is better) and bent tube. If wanted in the state of gas, collect it at pneumatic trough (not a lead-painted one) over warm water, or by downward displacement—i.e., by passing the gas to the bottom of receiving bottle. If a solution is required, pass the gas into one or more bottles full of water, which absorbs about three times its volume of the H_2S. The books recommend you to add the acid in small portions through an acid funnel; but it is best to add it all at once, diluted with two or three volumes of water, and immediately fit in the cork and tube. No heat is required, and all this should be done in the open air, where the wind may quickly carry away any gas that escapes. 528 grains FeS + 600 grains H_2SO_4 will yield 204 grains H_2S, or about two gallons, enough to saturate six pints of water; and also 1,668 grains $FeSO_4$ when crystallised. There are many other ways of making the gas.—DAGHBERT.

[33055.]—**Sticking Paper Labels to Cloth.**—Take button shellac and methylated spirit, adding the spirit till it covers the shellac, placing in a tin pot, and stirring over a gas stove. When liquid, lay on evenly with a brush, and lay out to dry. V using, a hot iron placed on the back of the clo all that is needed.—PAPER CUTTER.

[33055.]—**Sticking Paper Labels to Clo** Has the querist tried litharge boiled in oil? Tl the adhesive matter used in the sticking-plas the surgeon, and I should imagine it would an the purpose in this case, as it certainly would ac on the application of heat. Any chemist c supply the litharge, but if "Peardon" is desire making it himself I will instruct him how to d —J. HARRIS.

[33056.]—**Telescope.**—The best thing to do the 5in. is to mount a 2in. focus concave for piece. This will give you a fair working teles and would, in fact, be the best thing you can do it.—W. J. LANCASTER.

[33057.]—**Henry Andrews, Almanac Mak** — The engraved portrait in the possessio "E. C. H.," was probably issued with "Mo Almanac" of the same date, 1788. "Francis M Physician," was not a fictitious personage, it h on record that he "was the original compiler o well-known almanac bearing his name, and th died in London in 1724." After his death we told that the work "was wrote and continued by John Wing, and afterwards by his son Tycho, l of Pickworth, in the county of Rutland. Mr. Ty Wing died in 1750, after which it was "written compiled by Mr. Wm. Harvey, of Knipton, n Grantham, for Mr. Vincent Wing, who contin and wrote it for him till about the year 1762, af whose death Thomas Wright, of Eaton, near Mel Mowbray, was employed." The latter individ "had the audacity to assert that he had been t only compiler of 'Moore's Almanac' for nearly fourth of a century from papers and informa communicated to him by Mr. Moore." Mr. He Andrews, stationer, of Royston, who died in 1 aged 76, had during the 40 years previous man factured "Moore's Almanac" for the Station Company, and it was in the issue for 1788 that co tained on the last page a "Rebuke to Thom Wright," respecting the assertions he had made, a denying that this "pretended astronomer ever calc lated the eclipses, &c., for the 'Almanac,' be incapable of doing them, so that any alma published under the name of such an impostor m be false and counterfeit." To make the reb additionally warm for Thomas Wright, and at t same time gratify a slight weakness of his ow Andrews appears to have issued his portrait wi the "Almanac" for that year.—GEMINI.

[33062.]—**Zincography.**—There are two p cesses—one called zincography, the other anastat But zincography is used mainly for letterpress pri ing, while anastaty is a substitute for lithograp For zincography the plate is grained according the fineness of the work to be done, the drawing then drawn on with lithographic crayons, and rol up with lithographic ink with which bronze has b ground. When rolled up sufficiently it is dus over with resin powder, and etched, rolling a every etching till the lines stand boldly in rel The light parts are then cut away with gouge a chisel, as in stereotype, and the plate mounted ty high, then put on machine, and worked. In t anastatic the plate is polished, and, the drawi having been done with anastatic ink, the paper damped with pure acid, and laid between blotti paper—it is better to damp two or three times—th transferred between steel rollers, with heavy pr sure, the drawing then pulled up, and plate wip with water sponge, all marks and dots taken o with stick of slate-pencil and sand-paper: th rolled up with litho ink, etched, gummed up, a let stand for an hour or two, to let work settle, a printed in litho press in ordinary litho man When going to print in colour, wash out with tu pentine, and roll up in the coloured ink. For la numbers transfer on stone, as it is much easier. A other information I shall be happy to give.—PAP CUTTER.

[33062.]—**Zincography.**—Did "G. A. P." tr the precaution of applying gum to his plate bef "rolling up?" Thin varnish should be prefer to olive oil for rubbing down ink. For the sake "G. A. P.," myself, and other amateur zincograph I should be glad to know of a treatise on this subj —D'EVLYNN.

[33064.]—**Oroide Gold.**—A very good imita gold may be made by adding 10 parts of alumini to 90 parts of copper, but all these alloys requir be (and generally are) gilt.—Os.

[33070.]—**Protecting Iron from Nitric Ac** —If you can, dip the article into the strong ac this seems to induce a passive state in the i which may then be placed in a weaker acid with change. Nitric acid of specific gravity, 1·38, has action upon iron at a temperature of 31° C.; ordi strong acid at 1·42 has no effect at 55° C. (Ther —DAGHBERT.

[33074.]—**Chemical Examination.**—You enter yourself for the examinations of the Sci and Art Department, South Kensington. For formation apply to the secretary. The best b would be Galloway's "Chemistry," first and sec steps. These will give you a good practical kn ledge of analysis, together with all the requ calculations.—Os.

[33074.]—**Chemical Examination.**—You qualify yourself for following the profession becoming a member of the "Institute of y," a society of professional chemists. To ed, you will have to pass a most rigorous ion, by which, if you succeed, you establish elf the right of practising as a professional Although the society is, it is feared, at r from perfect, yet it might not be inad- r you to join it, for despite its failings, y and serious, it is undoubtedly a move in direction—viz., organisation amongst You cannot have a book better suited to irements or one of such great reliability al usefulness as Fresenius' "Quantitative Analysis," which is written in the most comprehensive manner, and is, I think, nably the standard work on the subject.— T.

NSWERED QUERIES.

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bers and titles of queries which remain unan- five weeks are inserted in this list, and if still are repeated four weeks afterwards. We trust will look over the list, and send what information the benefit of their fellow-contributors.

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QUERIES.

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Removing Mildew from Paper.— emove mildew from paper without damaging w.

Arithmetical Rule Wanted.—Will correspondents give me a rule in arithmetic the following? A locomotive with driving liameter, crank 1ft., what distance does the travel in one revolution?—J. W. B.

Raising Water.—I should be thankful if aders would inform me what engine power uired to raise 250 gallons of water per minute eight, and by what means the said power pplied, but not by a pulsometer?—L. Gil-

Telescope.—I have a 2¾ achromatic object- n. focal length; also an eyepiece complete, our lenses, varying from ⅝in. to ¼in. in dia- n. in length. I have also another eyepiece gth; the lenses are 1⅛in. diameter, but un- he lens next to the eye is gone. The glasses t tube are more convex than in the other, and ound the edge with a blue colour. I have scopic object-glass about ⅜in. diameter and gth. Can I manage with these to see bullet 00 yards? If some one will kindly tell me require to make the large eyetube complete ich obliged, as at present the centre of the out of focus (through convexity, I suppose). ject-glass has the name of "T. Doublet" l it.—Tu Docrs.

Filling in Letters on Metal Plates. ne be good enough to supply "L. I." with a tion for filling in black letters on a worn-out ting under windows?—L. I.

Cleaning Bicycles.—Can any correspon- e best powder, &c., for cleaning and polish- ithout injuring the surface of the steel?— Jun.

Eyepiece.—Many thanks to "F.R.A.S." my question concerning the power available bject-glass, but I should be still more obliged will tell me how to purchase an eyeglass of, r. Must I write to an optician that I want an eyepiece to magnify 200 times, or must I send him (the optician) particulars about my object-glass, &c., as I have read that the magnifying powers are different on different object-glasses? I suppose that I shall have to send my eyetube to have the glass fitted, for it would be very inconvenient to send the whole instrument.—A Poor Student.

[33096.]—**Cylinder for Phonograph.**—Would Mr. Shelford Bidwell kindly tell me whether it is necessary to have the cylinder made of brass, and whether a good hard wooden one would not do as well, the latter being much cheaper? I have nearly finished making a phonograph according to his very clear description, but in cutting the thread on the cylinder the brass broke away in patches. The brass was cast and not wrought. I suppose it ought to have been the latter. I found my ferrotype plate bulge a little when fixing the point upon it. Will this materially injure the vibration? I can only get my paper drum tolerably tight. It gives a little to the touch. Will it not any the worse for that? When it is connected with the spring, however, it is quite tight. Does it make much difference what the thickness of the tinfoil is? I procured some at 15 sq. ft. per pound according to his direction, but have a quantity of half that thickness by me. Will not the latter answer?—Stulrus.

[33097.]—**Indiarubber Binding for Books.**—Will any one oblige me with the manner of doing this and particulars of the solution? Where is this last procurable? Does the binding spoil with time like most rubber goods?—Stitch.

[33098.]—**Telemeters or Range Finders.**—Can any one tell me if Nolan's method is that adopted now in the service? How can I obtain descriptions of Adye's and Berdon's methods?—J. M. B.

[33099.]—**The Dipping Needle.**—Will some one be kind enough to tell me what kind of dipping needle is used for observations of the Aurora, and give me an idea of the price of a good one?—X.

[33100.]—**Permanent Green Writing Ink.**—I am anxious to obtain a permanent emerald-green ink. Can any one tell me how to make it? I have liquid verdigris, which is exactly what I want so far as colour goes, but I find it too faint to write with, and it soon fades.—X.

[33101.]—**Injector Condenser.**—I should be greatly obliged if some reader would give a slight sketch of a good injector condenser and air pump suitable for a 20 h.-p. single cylinder oscillating engine?—George Rodaway.

[33102.]—**Wire Joints.**—To Solder and Insulate.—Will some one give an amateur the details of the best method of soldering copper wire joints for electric bell and telephone purposes, and of insulating them? What is the best kind of solder and the way of using it?—T. J. M.

[33103.]—**Wheelmaking.**—Will some of our Arsenal wheelers be kind enough to inform me what is the method adopted for making the iron-nave wheels that are in general use for gun carriages, &c.? Are spoke feet oiled or painted before putting them together? If so, what is the benefit derived? Any further information that will aid me in making them by hand will oblige—Practical Wheeler.

[33104.]—**Bicycle Query.**—I have a 54in. Premier, which is not in the least too high for me when once I am mounted. My difficulty is to mount. Could a spring be fitted with a runner on the backbone, as springs of this description are lower than the Premier ones? I have tried fixing an inch block to the step to increase the height, but even with its assistance I am unable to get into the saddle without a jerk, which is very liable to tilt the fork forward, and so to land me on the ground. Any hints will be acceptable to—Alpha Beta.

[33105.]—**Phonograph.**—I have made a phonograph, but on adjusting the reproducer the style makes such a scratching that it effectually drowns the words. I have wrapped indiarubber round the spring before screwing it down, and put an indiarubber ring to press lightly on the spring, but to no purpose. Can any one tell me how to remedy the nuisance?—N. G. H.

[33106.]—**Coal Waggons.**—I should be obliged if some of our readers would give me the names of the principal railway companies who carry coal in their waggons for merchants. The best size of waggons, 6, 8, or 10 tons, spring or dead buffers?—E. A. Watkins.

[33107.]—**Phonograph.**—Mr. Shelford Bidwell's generosity in offering his assistance for the benefit of those desirous of making an instrument for themselves prompts me to seek a little further information. I have lately finished an instrument from his description, but the results are not satisfactory. I can perceive the effects of the iron diaphragm and point on the tinfoil when I speak in a very high tone, but is there not a great difficulty in setting the second point to the exact depth requisite to insure a repetition, and at the same time to avoid the noise produced by the constant rubbing of the tinfoil against the point, which must interfere with the articulation? The only differences of which I am aware existing between my instrument and the one he describes are:—1. My mouthpiece is of gutta-percha—size of hole in same is ¼in. at the outlet. 2. I have made my second diaphragm of will parchment. 3. Instead of having a spout or rim to carry the paper resonator, I have used four bent slips of brass, which are held by the brass flange.—Zeichner.

[33108.]—**Anastatic Printing.**—From the "Brief Description of Anastatic Printing," published by Mr. Cowell, of Ipswich, I perceive that the so-called anastatic printing of the present day is nothing more nor less than zincography. Mr. Cowell says that in the beginning it was conceived that this art could be applied to the reproduction of old books, and we have a specimen of this in the Art Union of 1845. But it appears that the revivification of old prints was to be obtained only by such complicated chemical processes (secrets now lost to the world) that it is now altogether abandoned. A friend of mine, a Frenchman, tells me that he believes that the anastatic process is used in some places in France. Can any one of "ours" inform me if he knows of this process being now used anywhere, or if it is utterly defunct?—D'Evlynn.

[33109.]—**Soldering Wires of Electrical Apparatus.**—I find in Douglas's "Manual of Telegraph Construction," p. 250: "The copper wire used for electrical purposes is jointed usually with a twisted joint, soldered where practicable with silver, as the metal is readily attacked or gnawed by solder." I have often noticed the ends of wires, soldered, quite rotten, and shall be glad if some of your readers will kindly explain.—Reader.

[33110.]—**Steam in Small Boats.**—I read with pleasure query 32968, by "Aquarius," in last number of English Mechanic, relative to the use of steam in small boats. I for one would be most anxious to use steam in my small pleasure-boat, but the principal drawback is not knowing how to set about doing so; that is, how to know the power of engine, size of boiler, cylinders, &c., and how to apply the power, whether it should be a screw or paddle. Perhaps "Aquarius" would kindly throw some light on the subject for me. My boat is 17ft. by 4ft. 2in. beam, light built. I would also like to know what might the fittings cost me, as I think I could put them together myself, being a bit of a mechanic. If there were some working drawings given through our most instructive and valued paper of small engines, &c., suitable for the above purpose, I have no doubt but that they would be appreciated by many like myself that have a pleasure boat.—Mount Trenchard.

[33111.]—**The Spider and the Fly.**—I have a little fact for our natural history readers. While sitting "listlessly" in the garden the other day I saw a spider, and within an inch from it a little fly about ¼in. long, so I waited, as King Bruce did, "to see what the spider would do." The little fly walked boldly up to his majesty and touched one of his legs, and, strange to say, the spider drew back affrighted. Would this indicate that the spider is not so bold except when he has his victim under lock and key? The spider was a short-legged one.—Perdu.

[33112.]—**Dialling.**—Will "F.R.A.S." kindly give me a formula or construction for finding what latitude a given horizontal dial is meant for? The gnomon is wanting, and the hour-angles, as near as I can measure, are 12°, 25°, 38°, 53½°, 72°, 90°. By a formula given in E. M., Vol. XVIII., page 72, and a table of logsines in "Moore's Navigation," I have found the hour-angles for lat. 55°, which are not those of the dial. The reverse problem I cannot solve for want of a table of log-tans. I have with a fine fretsaw sawn the dial through the meridian line, intending to set the two halves the thickness of the gnomon apart, which had not been done, and must surely have affected the correctness of the indications.—Argent Sable.

[33113.]—**Phonograph.**—To Mr. Shelford Bidwell.—I have constructed a phonograph as described by you, except that my cylinder is 3in. diameter, and 12 threads to inch, but fail to get it to speak. I have got what I thought to be the marks on the tinfoil, but on passing it before the point attached to the spring I got nothing but a rubbing sound, and when done quickly sometimes a low musical note, and if I passed part of the foil which had not been indented it produced much the same sound. When speaking into the paper diaphragm I could get very good marks on the foil, but on repassing it over the point I also met with the above result. I sent for tinfoil of weight you mentioned, and it is rather thicker than the paper of the English Mechanic, and has a rough appearance. Should the points be exactly on a line with centre of cylinder? If you could give me any hints which you think would set me right I would be greatly obliged.—R. E. Sprott, Dromore, Co. Down.

[33114.]—**Electric Bells.**—I have an electric bell, the bar magnets of which seem to be very weak. What shall I do, and how? Also how long do they last—*i.e.*, good ones, as I believe mine are? This one has been in use nearly a year.—W. R. S.

[33115.]—**Black Board.**—Having a black board, and desiring to repaint it, would any correspondent give me any information as to what sort of print or enamel is used in order to get a smooth surface suitable to write on with chalk?—Nero.

[33116.]—**Equatorial and Lightning.**—I should be glad if "Sigma," or some one else competent to advise, would tell me whether there is any danger of the high iron pillar of an equatorial being struck by lightening, especially when the observatory is a little height from the ground?—Brickwall.

[33117.]—**Chamber Organ.**—I am about to build a chamber organ of 4½ octaves (CC to f^3), to contain the following stops:—

(1) St. Diapason (wood)	CC to B	8ft.
(2) Open Diapason (metal)	tenor C to f^3	8ft.
(3) Lieblich Gedact (wood)	tenor C to f^3	8ft.
(4) Flute (wood, lower octave stopt)	CC to f^3	4ft.
(5) Spare slide	tenor C f^3	8ft.

Will any correspondent versed in these matters kindly tell me how small I can make the sound-board? Can I get it into 4ft. 6in., or even 4ft. in length? I am not so particular as to depth, but I should prefer it not to be more than 2ft.; 3, 4, and 5, to be enclosed in swell box, the louvres of which are to be at the sides of organ. I am thinking also of adding two octaves of pedal pipes (Pyramidon CCC, 2ft. 9in. long, 7in. wide at top, 2in. wide at mouth), the sound-board of which is to form roof of swell box. I am not restricted as to height. Would pedal pipes be of much use in so small an organ? Can any one recommend a method of blowing this organ by foot as I cannot always be getting some one to blow when I wish to play, and as far as I can see there will be no room for both pedals and the ordinary bellows pedal? The action is to be electric to save complication of mechanism, as I wish to introduce an octave coupler on the manual; and, lastly, what would be the best flute to employ, and what is the scale? The open diapason pipes I have are voiced on 2½ inches of wind. I am afraid of making the sound-board too small lest there should not be enough wind in it.—Gothic.

[33118.]—**A Universal Telegraph.**—Under this heading, on page 350 of Vol. X., a telegraph invented by Mr. W. T. Tobin, of the Polytechnic, is mentioned, and the statement made that no battery or complicated machinery was needed to actuate the indices on the dials. It was of the A B C type, and by simply depressing a semaphore or handle in front of the instrument the indices moved round until arrested by a second movement of the handle. By a third movement both indices were brought back to zero. Will some one complete the description of this wonderful instrument and describe the mechanism?—Glatton.

[33119.]—**Brewing.**—I have to thank Mr. Harris already for kindly replying to previous queries, and trust he will not think me troublesome in addressing myself to him for further advice. In a small brew-house (2 qr. plant) I should like to know if the advantages of brewing by steam are sufficient to make it desirable to fix up a boiler, and, if so, what size boiler, and what make would be advisable? Mr. Harris may remember that he suggested an iron tank for boiling the liquor, but, as I pride myself on a pale golden ale, would it not be liable to discolouration through rust?—Home Brewed.

[33120.]—**Rendering Woodwork of Boiler-Room Fireproof.**—Could any one inform me of the best means for rendering the woodwork of a boiler-room as much fireproof as possible? Is there any good fire-resisting paint?—L. S. Y.

[33121.]—**Violin Varnish.**—Would some correspondent give me the name of the best kind to use for this purpose, with the mode of laying it on? I want to revarnish a violin, which I scraped the varnish from with a piece of glass, for the reason that the sap had never thoroughly dried. It must have been varnished before the sap had properly dried out of the wood, because the tone is very harsh even after all the "rasping" it has received.—Bamstaal.

[33122.]—**Mineralogy.**—Would some one kindly give me some information about any or all of the following minerals, telling me where they are found, what they are composed of and the uses (if any) of each—roselite, euchroite, erinite, margyrite, minium, fayalite, fluellite?—A Would-be Mineralist.

[33123.]—**Brown Coal.**—Is there such a thing as brown coal? if so, is it ever used as fuel? how does it differ from common coal? where is it found? what are its properties?—A Would-be Mineralist.

[33124.]—**Screw Boat.**—Would some correspondent kindly describe how to build a small boat to carry two persons and a dog, with small draught of water, suitable for shooting purposes, screw to be worked by hand? Also where screw and fittings could be purchased? or description as regards size &c., as they can be cast specially, if not procurable otherwise?—Sportsman.

[33125.]—**Painting on Silk.**—Will any one kindly tell me what preparation to use, so as to make water-colour painting on silk permanent? I have been painting on silk and satin, flowers and foliage with moist colours, but find they rub off in a very short time. I have tried gum and that fails.—Anon.

[33126.]—**Microphone Construction.**—Will some reader of the English Mechanic who has had success in microphone-making, kindly help one who has been favoured with less of good fortune's bounty? The best microphone that I have made has the vertical piece of carbon, about 1¾in. long, with a section of $\frac{1}{16}$in. × ¼in. The blocks which it touches at each end, are rather less than a cubic inch in size, and all the three pieces are of gas-carbon. With this instrument—and this is my best—I have not been able to hear speech articulately enough to carry on conversation, and the words are almost drowned with an unpleasant click click. The telephone I use has an ordinary bar magnet ⅝in. × 4in., with a coil of No. 36 wire, and a ferrotype disc. I have tried a soft iron bar in place of the magnet, but with no better result. And I have used battery power, varying the strength from one cell to size of a Smee's battery. What is the matter? Is my microphone, telephone, or battery at fault?—A. A. Watkins.

[33127.]—**Eye Cups for Short Sight.**—Can any one tell me if these are efficacious? Also what is the principle of their use? Can I make them myself, or contrive a means on the same principle? I see glowing testimonials in their favour, but cannot afford the advertised eye cups, unless by long pinching.—Blindworm.

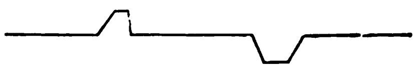
[33128.]—**Photographic.**—I send the enclosed cutting from a newspaper; perhaps some of your numerous readers might be able to give additional particulars as to the new process. It would be very desirable to be able to take advantage of it during the present season:—"*A New Invention in Photography.*—An invention which simplifies the out of door practice of the art of photography may be said to have claims to the attention of tourists and travellers, as welll as that of the professional operator. To carry the bottles, liquids, and other appliances at present required necessitates troublesome baggage, but much of that inconvenience can be avoided by the use of what is called dry bromide of silver emulsion, an invention of M Chardon, of Paris. That preparation, a mixture of collodion and the silver salt, will keep an indefinite time in bottles excluded from the light, and does not suffer from varying temperature. When required for use, the bromide is mixed in certain proportions, with ether and alcohol, the plates are coated with the solution, and, as soon as dry, are ready for use. They require no further preparation, and retain their sensitiveness through many months, but, of course, must be carefully kept from the light until employed. The image may be developed immediately or after the lapse of weeks, according to circumstances."—Photo.

[33129.]—**Aeronautics.**—This subject has been unstirred by would-be flyers for another period. I will give it another start if you oblige me and insert this query. It is my favourite study, and I have experimented for a solution during the course of the last twelve years; and I made a machine three months ago which gave me satisfaction in its performance, and convinced me that it is quite possible for man to rise off the ground and propel himself through the air by means of machinery, and have as much control over the machine as to go in any direction like a humble bee. In that insect's flight, speed makes up for surface, so I made speed make up for surface in this model, half a square foot lifted two pounds and a half four feet perpendicularly in one second. All the experiments I made, prove that revolving inclined planes are to be the propellers of the future aërial locomotive. The machine is driven by two springs of equal power, working separately in opposite directions; their strength is about equal to ten pounds each, and will lift at any rate ¼lb. each by the vanes, but with a nicer constructed model they will lift more. May I now ask Mr. Brearey, am I farther advanced than he?—Robert Milne, Milnfield, Elgin, N.B.

[33130.]—**Lightning Conductors.**—Would some of our readers kindly give me some information on fixing lightning conductors on chimney shafts, and oblige—T. W.

[33131.]—**Newtonian Reflector.**—I should be *much obliged if some* of our correspondents would answer the following queries respecting above instrument. 1. I suppose that the flat mirror is first ground and polished truly plane, and then is cut or ground to an ellipse of the required size. Now will some of our readers tell me how this cutting or grinding is most easily and accurately effected, without in any way injuring the polish and figure of the flat? 2. Give some good tests, easy of application, by which I may find whether the figure of flat mirror is a true plane or otherwise. These tests to be applicable without the flat being placed in a position in the telescope. 3. What would be the most suitable negative focal length for a Barlow lens to be applied to a Newtonian, the speculum of which is 6¾in. diameter and 6ft. focus? 4. What is the construction of the achromatic eyepiece used with reflecting telescopes: are they identical with the Berthon achromatic eyepiece? 5. What would be the most suitable size of finder for a telescope of the size mentioned in query 3? State diameter and focal length of object-glasses, and best kind of eyepiece with focal lengths of component lenses? 6. (And Mr. W. J. Lancaster can perhaps best answer this), what is the standard internal diameter of eye tube—that is, the tube into which the eyepiece slides? I suppose there must be some standard size for the above, or else I should not be able to apply one maker's eyepieces to the tube which those of another maker fitted.—Perfect Flat.

[33132.]—**Lathe.**—Will some reader say whether it is possible to make a small wood-turning lathe that could be worked with both feet sitting? Please give size of frame. Would a 2in. crank do, and should it be as per following sketch? Should the treadles be hung in front instead of back as in ordinary lathes? I have some idea how to make it, but am not sure whether I should have power enough sitting to work it. If some of our readers would kindly answer this question they will doubtless interest many who, like myself, are standing all day and would like to sit to work in the evening.—P. R. V.



[33133.]—**Bicycling.**—I would be much obliged if one of our bicycling friends who has had some experience (a secretary of an amateur club, for instance) would give me a little advice on this subject. I am about to buy a bicycle, and, knowing nothing about the cardinal virtues of a good one, am consequently greatly perplexed among the many varieties offered for sale. 1. Is it possible to get decent second-hand bicycles? 2. How is it that some makers advertise full size (52in.) bicycles at very low prices—*e.g.*, the "Mercury" bicycle and the "Desideratum" bicycle—compared with most of the Coventry makers? 3. What are the parts to examine when selecting a bicycle? 4. Is it possible to learn to ride on a spider, or must one first mount a "body-jolter?"—Pegasus.

[33134.]—**Nickel Plating.**—Would any reader kindly inform me how to nickel plate brass, steel, &c.?—Ignoramus.

[33135.]—**Ph. D.**—Will any reader of the English Mechanic be kind enough to inform me what are the necessary qualifications for becoming a Ph. D.? What subjects is it necessary to undertake, and of what difficulty is the examination? Any information on the subject will oblige—Chemist.

[33136.]—**Siphon.**—I shall be very much obliged if any of our readers will answer the following:—I am fixing some piping from some large tanks of water to a fern case, and am intending to make a fountain at the end of piping. Now what I wish to know is whether I shall gain any pressure by taking the pipe to the top of a high wall and down again so as to form a siphon. There is only about 3ft. difference in the level of fern case and tanks.—Rehcraf.

[33137.]—**Glass Reeds for Harmonium.**—Could toughened glass be made into reeds for harmonium? What would be the probable result as to tone if it could be?—J. Forward.

[33138.]—**Testing 3in. O.G.**—Will "F.R.A.S." give a few stars for testing a 3in. Wray? I think all but one of those he gave in No. 666 are gone for the season. Is Lambda Ophiuchus a test of severity? It appears just on the point of division with about 170; the upper looks reddish and the lower steel blue, the latter considerably smaller. In accordance with his advice to "A Poor Student" I have just obtained "Proctor's School Atlas," I should think it is a marvel of cheapness.—Texan.

[33139.]—**Power of Astro Eyepiece.**—I shall be very glad if one of your very able correspondents would make it plain how to get the power of astro eyepiece. I see it stated 100 × 2¾ = 275. I am at a loss to know what the 100 is, or how to ascertain whether my glass is 40 to in. or 100. Mr. Webb's directions leave out the very point I want to know—how the ascertained divisions are multiplied. A simple answer would help me in making another—Eyepiece.

[33140.]—**Decimals.**—I wish to know how to find examples value correct to five places of decimals—

$$16 \times \left(\frac{1}{5} - \frac{1}{3 \times 5^3} + \frac{1}{5 \times 5^5} - \frac{1}{7 \times 5^7} + \&c.\right) - \frac{4}{239}.$$

Answer 3·14159.—Borb.

[33141.]—**Mathematical.**—Will some one kindly solve for me—

$$\left.\begin{aligned} \frac{x}{b+c} + \frac{y}{c-a} &= a+b \\ \frac{y}{c+a} + \frac{z}{a-b} &= b+c \\ \frac{z}{a+b} + \frac{x}{b-c} &= c+a \end{aligned}\right\}$$

Also simplify—

$$\left(\frac{a}{b} + \frac{b}{a}\right)^2 + \left(\frac{b}{c} + \frac{c}{b}\right)^2 + \left(\frac{c}{a} + \frac{a}{c}\right)^2$$

$$- \left(\frac{a}{b} + \frac{b}{a}\right)\left(\frac{b}{c} + \frac{c}{b}\right)\left(\frac{c}{a} + \frac{a}{c}\right)$$

Mr. Proctor was once good enough to solve a somewhat similar example, but we miss his contributions now.—Equation.

[33142.]—**Solid Ink.**—Could any brother-reader kindly inform me how to make solid ink, and how to cast the same for propelling in pencil case?—J. Forward.

[33143.]—**Wine.**—"No Name" has in No. 32756 kindly given two receipts for wines. Could he kindly give the modus operandi? Also how unfermented wines are manufactured?—J. Forward.

[33144.]—**Indiarubber.**—Is there any remedy for a "sticky" indiarubber coat, or for one which is in the opposite extreme and "cracks?"—Grateful.

[33145.]—**Marking Ink.**—What sort of ink is used with types for marking linen, &c.? Information as to the above is requested by—Grateful.

[33146.]—**Honeysuckle.**—Will some botanical reader supply information on the following? The honeysuckle is pentandria, monogynia—*i.e.*, has five stamens and one pistil. The azalea is, I believe, a species of honeysuckle, the yellow specimen of which (from which, I presume, the other varieties have been raised by superior culture), has accordingly five stamens and one pistil. The pink variety, however, has greatly enlarged petals, and eight stamens instead of five. As a general rule when the petals are increased in number it is at the expense of some of the stamens, which are accordingly diminished in number. Thus the common hawthorn is icosandria, monogynia, having 20 or more stamens, while the double hawthorn is only diandria, having only two stamens. Query: How does the pink variety, with greatly enlarged petals (though not double corolla), get an increase in the number of stamens?—Wm. Wilson, LL.D., Chester.

[33147.]—**Patent Leather.**—Can any of your readers describe the process of manufacturing patent leather? The question has been asked before but was not answered. By patent leather I mean polished leather such as is used for carriage dashboard, boots, &c.—A Constant Reader.

[33148.]—**S.E. and G.W.R. Train Service.**—Can any of your readers kindly inform me in what year the service of trains from Dover to Birkenhead (S.E. and G.W.R.) was instituted, and when and why it was discontinued? Also what were the times taken on the Reading Branch of S.E.R.?—F. C. F.

[33149.]—**Paint for Cart.**—I want to paint and varnish a tax-cart, and stripe it with white or vermilion. I will thank some friend to give me instructions how to do it. I have no experience in carriage painting, but can paint a picture in oil.—E. B. F.

[33150.]—**Eruptions and Earthquakes in 1877.**—Will the author of the article on this subject oblige by giving the number of *Naturforscher* in which M. Fuchs' paper occurs?—John J. Lake.

[33151.]—**Drying Oil.**—Can any of our chemical correspondents tell me the chemical action that takes place when red lead, litharge, copperas, manganese, sugar of lead, &c., are boiled with linseed oil, and which is the strongest or best drier?—Petro.

[33152.]—**Carbon-bisulphide Prism.**—I have found a difficulty in rendering a prism made of plate glass fluid-tight. It is intended to contain carbon bisulphide, and the slips are joined by cement composed of isinglass dissolved in acetic acid. Will any one oblige me by suggesting a better means of joining them?—Nemo.

[33153.]—**Hobby Horse for Crippled Child.**—Required for a little boy, two and half years old (who for 18 months has lost the entire use of both his legs from paralysis of the spinal cord) a kind of hobby horse, so that his feet just touch the floor, to induce him, if possible, to use the legs, if ever so little? I should like to know the simplest way to make such a thing.—Distress.

[33154.]—**Harmonium Reeds.**—I have commenced to build a large harmonium. Will some kind friend say which are the best reeds, and quickest to speak—viz., the broad, the bent, or the ordinary reed?—J. F.

[33155.]—**Bicycle Brake Cord.**—I would be obliged if any one would say what is the most durable brake cord for back wheel? The one sent with my machine, cut through in less than a week. Also a good recipe for preventing rust on bicycles would be useful to many besides myself.—Tangent Amateur.

[33156.]—**Cupola Plant.**—I am about to replace some old plant in a large foundry, making large marine castings at the rate of about 20 tons daily, and would feel obliged if, by the assistance of some of your many subscribers, I could ascertain which is the best kind of blower to use, and the best pressure to work it at? Also the best form and dimensions of cupola to melt, say, 6 tons an hour, giving full particulars of height above and below the tuyeres, &c.; and if there is any method in use for heating the blast? I have heard of such being done in the cupolas for Bessemer plant. I would also like to know the most economical system of working so as to reduce the coke consumption to a minimum. My chief reason for asking for this information is, there is no treatise published that I am aware of on cupola management to which I could refer.—Cupola.

[33157.]—**Locomotive.**—Will any reader tell me the way to mark off slide-valve of locomotive and eccentric sheaf?—W. B. G.

[33158.]—**Colouring Photos.**—Can any one inform me in your next issue the best means for preparing photographs for water-colour painting—*i.e.*, for removing the glazed surface without injury to the groundwork?—Old Sub.

There are nearly 2,500 flour-mills in the United States, affording employment to 60,000 men.

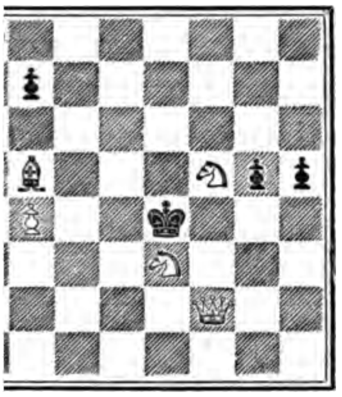
The Howson Puddling Furnace.—We are given to understand that the experiments lately conducted at the Erimus Ironworks, Middlesborough, with the Godfrey-Howson rotary puddling furnace have turned out successfully. The chemical success has been already ascertained some time ago, but these later experiments were directed to making it successful mechanically and economically. This, as we have said, has now been put beyond a doubt, so that those works, originally fitted with the Danks machine, will soon be started with the Godfrey-Howson instead. As a machine, this furnace is gaining on the favour of those more immediately interested, and promises to be the commercially efficient purifying puddler of Cleveland iron so long and so keenly sought for.

CHESS.

munications intended for this department lressed to J. PIERCE, Copthill House, Bedford.

EM CCCCXXVIII.—MOTTO "ANYTHING."
ish Chess Problem Association Tourney.)

Black.

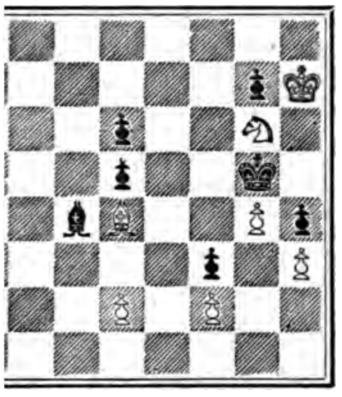


White.

hite to play and mate in three moves.

OBLEM CCCCXXIX.—BY J. PIERCE.

Black.



White.

hite to play and mate in three moves.

SOLUTION TO 425.

ite.	*Black.*
Q B 5.	1. B takes R (best).
K 4.	2. Anything.
o Q 7.	3. Anything.
es.	

SOLUTION TO 426.

Q B 7.	1. Anything.
es accordingly.	

NOTICES TO CORRESPONDENTS.

OLUTION to 423 by W. H. Ferry ("a very nice and required close attention."

ND T. J. AMERY.—Respecting 424 see notice to in last number. Solution to 426 correct. W. H. Ferry is correct.

OLUTIONS to 420 and 426 by Arcanum.

Y.—Why cannot your other three-mover be s:—1. $\frac{\text{Kt to Q 6}}{\text{P moves}}$. 2. $\frac{\text{R to K 6}}{\text{P moves}}$. 3. R takes P

olverhampton Corporation have made a heir sewage farm at Barnhurst for this ng with March of £1,200.

ood Splitting.—A new means of utilising wood of shipbuilding yards and railway epairing works has recently been brought essrs. Thos. Christy and Co., Fenchurch-o are introducing Rowley's firewood-split-ine. An experiment made this week with it ssed by several gentlemen, who were sur-se that the machine apparently cut up oak m sleeper ends as easily as it did those leepers. The success of the machine in p oak showed its value for use in ship-yards, especially those near large towns, ld consume the wood that could be cut up onvenient form now common in London d, at a nominal cost.

han 11,000 miles of telegraph cable have duplexed by one English firm of telegraph

SPHINX.

*** *All communications for the "Sphinx" should be addressed to* T. MITCHESON, B.A., *City of London School, Cheapside, E.C.*

Owing to the influx of mathematical correspondence a little time will be required for a satisfactory perusal and election for insertion, the space allotted for the "Sphinx" being necessarily restricted.

Questions.

761.—A B is a diameter of any circle, with centre B, and radius B A describe a second circle. From B draw any straight line cutting the larger circle in P and the smaller in Q; join A Q. Show that the area contained by P Q, arc A P, and chord A Q, is bisected by the arc A Q.—A STUDENT.

762.—Show that the number $P_0 + 10\,p_1 + 10^2\,p_2 + 10^n\,p_n$ is divisible by 101 if the following is—

$P_0 + 10\,p_1 - (P_2 + 10\,p_3) + (p_4 + 10\,p_5)$, &c.—E. S. C.

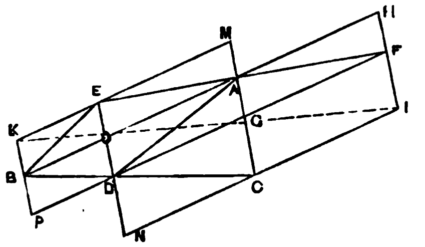
763.—Show that the sum of the *n*th roots of unity, and the sum of their reciprocals, are each equal to zero.

764.—Having given $x = y - y^3$, expand y in a series by ascending powers of x by means of indeterminate coefficients as far as x^5.

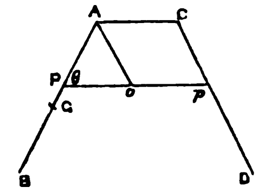
765.—A, B, C are fixed points in a right line which are joined to any fourth point, O. Prove that the ratios O A cosec. B O C : O B cosec. C O A : O C cosec. A O B, are independent of the position of O.

Solutions.

735.—Through A E B D construct a parallelogram, whose sides are respectively parallel to A C, A B, and a similar parallelogram through A F C D; then it is apparent that K O G I is the line of the diagonals of M K P G, and H I N E, O, G, being in D E. A C, respectively. It has been shown recently in the ENGLISH MECHANIC, by "Maggie," that the diagonals of the complements, E A O, B D, meet the diagonal, G K, at the same point; hence also F G, C D—*i.e.*, C B meet I O—*i.e.*, I K in the same point; hence G E, F G, converge to the same point; but, if they do this without being in the same straight, *they inclose a space*. Therefore, &c.—MAGGIE.



736.—(Maggie.)—Let A B, C D, be the rods; P p the pegs; A C the string. Let G be the centre of gravity of A B, the angle A P p = ϕ, A G = a; draw A O parallel to C D. W = weight at G. Three forces—namely, its own weight at G, the normal reaction at P, and the tension of the string at A—keep the rod, A B, in equilibrium. But, taking moments round A, we get



$$R \times A P - W \times a \cos.\theta = 0 \quad . \; . \; . \; (1)$$

$$\text{Again, } R \times \cos.\theta - W = 0 \quad . \; . \; . \; (2)$$

$$\text{Also } A P = \frac{a \sin.\theta}{\sin. 2\theta} \quad . \; . \; . \; . \; . \; . \; . \; (3).$$

Eliminating R and W between (1), (2), (3), we readily get

$$a \cos.^2\theta = \frac{a \sin.\theta}{\sin. 2\theta} = \frac{a \sin.\theta}{2 \sin.\theta \cos.\theta} = \frac{a}{2 \cos.\theta};$$

$$\text{or, } \cos.^3\theta = \tfrac{1}{2}, \therefore \cos.\theta = (\tfrac{1}{2})^{\frac{1}{3}}, \therefore \theta = \cos.^{-1} (\tfrac{1}{2})^{\frac{1}{3}}.$$

(See "Earnshaw's Statics Prob.," 26 pages, 202, 203, 204.) —J. F. W.

745.—Let the vertex be the origin of rectangular coordinates, the supporting axis the axis of x, and the line through the centre of the base when the cone is in equilibrium the axis of z. If radius of base = a, height = 1; then $x^2 + y^2 - a^2 z^2 = 0$ is the equation of the conical surface. Calling k the radius of gyration round the axis of x, we have

$$\frac{\pi a^2 k^2}{12} = \int_0^1 \int_0^{a z} \int_0^{\sqrt{a^2 z^2 - x^2}} (y^2 + z^2)\, dz\, dx\, dy.$$

Putting $x = r \cos.\theta$, $y = r \sin.\theta$, the triple integral is transformed to

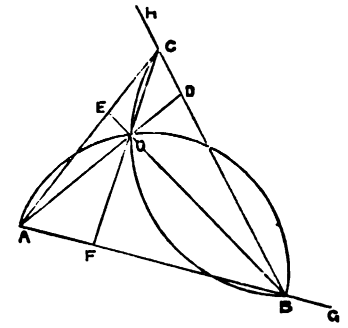
$$\int_0^1 \int_0^{a z} \int_0^{\frac{\pi}{2}} (r^3 \sin.^2\theta + r z^2)\, dz\, dr\, d\theta,$$

and its value easily found to be $\frac{\pi a^2}{80}(a^2 + 4)$. We have, therefore,

$$k^2 = \frac{3}{20}(a^2 + 4).$$

But we know from kinetics that $\frac{4}{3} k^2$ is the length of the isochronous simple pendulum, which, equated to unity, gives $k^2 = \frac{3}{4}$. Substituting this value in the last equation we get $a = 1$. Q. E. D.—LEIDHOLD.

746.—Produce the sides A B, B C, of the given triangle A B C, to G and H. On A B describe the segment of a circle containing an angle = angle C B G. On B C describe a segment of a circle containing an angle = angle A C H. The two segments will intersect in B and O. Through O draw the straight lines A D, B E, C F, meeting the sides of the triangle in the points D, E, F. Then angle A O B = angle C B G = angle A + angle C; angle B O C = angle A C H = angle A + angle B; and angle A O C =   = angle B + angle C. ∴ angle A O F = angle A = angle O C A + angle O A C; and angle A − angle O A C = angle O C A = angle O A B; also angle D O B = angle B = angle O A B + angle O B A; ∴ angle O A B = angle O B C; ∴ angle O A B = angle O B C = angle O C A.—L. S.



Ventilating Exhaust Cowls.—The report of the sub-committee (consisting of Captain Douglas Galton, C.B., F.R.S., Rogers Field, B.A., M.I.C.E., William Eassie, C.E.) appointed by the Sanitary Institute of Great Britain to practically test the ventilating exhaust cowls exhibited at Leamington in October, 1877, was presented recently, and is as follows:—"The sub-committee appointed at Leamington to test the ventilating exhaust cowls beg to report that they have given the matter their most careful attention, and carried out at the Royal Observatory, Kew, an elaborate series of about 100 experiments on seven different days, at different times of the day, and under different conditions of wind and temperature. After comparing the cowls very carefully with each other, and all of them with a plain open pipe, as the simplest, and, in fact, only available standard, the sub-committee find that none of the exhaust cowls cause a more rapid current of air than prevails in an open pipe under similar conditions, but without any cowl fitted on it. The only use of the cowls, therefore, appears to be to exclude rain from the ventilating pipes, and as this can be done equally, if not more efficiently, in other and simpler ways, without diminishing the rapidity of the current in the open pipe, the sub-committee are unable to recommend the grant of the medal of the Sanitary Institute of Great Britain to any of the exhaust cowls submitted to them for trial. Signed by W. Eassie, Rogers Field, and Douglas Galton." The cowls were open to inspection at the Experimental House, Royal Observatory, Kew (Richmond Station), from June 3 to June 5, 1878, inclusive, between the hours of 1 and 3 p.m. Lory Marsh, Esq., M.D., is the registrar.

Important Decision in Patent Law.—A petition was heard before the Lord Chancellor on the 15th inst., which had it not been decided in favour of the petitioner would have established a most dangerous precedent in patent practice. The case was as follows: Messrs. Pullan and others, on the 24th of October, 1876, obtained a patent for improvements in locomotive engines, &c., No. 4123. In January, 1878, nine months after filing their final specification, they alleged to have discovered that some drawings had been omitted from their specification, and they, through their agents, on *ex parte* affidavits obtained the Lord Chancellor's permission to attach additional drawings to their specification on the grounds of some neglect or inadvertence, and that they were the identical drawings intended to have been lodged therewith. During this interval of nine months Mr. Crickmer had obtained and filed the final specification of a patent for improvements in cocks and taps, dated March 13, 1877, No. 1001. At the Christmas Agricultural Show, and at other places previous in 1877, articles made in accordance with this invention had been exhibited. Mr. Crickmer was threatened with an action for infringement by Messrs. Pullan, but on referring to their specification found nothing to interfere with his invention. A second time he was threatened, and on again inspecting their specification he discovered that additional drawings had been attached thereto by permission of the Lord Chancellor. Mr. Crickmer seeing that these additional drawings embodied his invention, and that they were not described in their specification, at once, by the advice of his agents, petitioned the Lord Chancellor to rehear the matter. Affidavits were filed on both sides, and the hearing was set down for the 15th inst. Eminent counsel were engaged, and his lordship, after hearing the facts on the petitioner's behalf, immediately reversed his former permission, and ordered the drawings in question to be cancelled from Messrs. Pullan's specification, with costs.

ANSWERS TO CORRESPONDENTS.

***

**** All communications should be addressed to the* Editor *of the* English Mechanic, 31, *Tavistock-street, Covent Garden, W.C.*

HINTS TO CORRESPONDENTS.

1. Write on one side of the paper only, and put drawings for illustrations on separate pieces of paper. 2. Put titles to queries, and when answering queries put the numbers as well as the titles of the queries to which the replies refer. 3. No charge is made for inserting letters, queries, or replies. 4. Commercial letters, or queries, or replies are not inserted. 5. No question asking for education or scientific information is answered through the post. 6. Letters sent to correspondents, under cover to the Editor, are not forwarded; and the names of correspondents are not given to inquirers.

The following are the initials, &c., of letters to hand up to Tuesday evening, June 4, and unacknowledged elsewhere:—

Hannah.—L. Briant.—F. W. Greene.—C. J. Jones.—P. Kirkup—A. B. M.—T. W. Stanier.—Incog.—Bartram.—Hosnikos.—E. Allen.—Garment Dyer.—N. Sirch.—J. E. Grandin.—Chingachgook.—H. E. Lansdowne.—B. N. N.—W. H. Gnikrod.—F. C. F.—J. H. Cox.—Spot Lens.—Junius.—A. Z. O.—M. Williams.—Clare.—Brickwall.—F. King.—J. W. Gray.—Theo Izod.—A Poor Man.—W. W.—X. X.—E. H.—J. W.—J. H. T.—Bernard McGuire.—Chemicus.—G.—Tory.—R. C.—Francis Ede.—Someone.—Simon and Co.—56in. Superb.—Nose.—Cabinet Maker.—J. H—Excise.—Willington.—Young Engineer.—W. E. P.—George Bell.—Fly Hater.—Ph. D.—F. B. S.—R. J. G.—One Interested.—G. W.—W. J. L.—A. I.—Chinaman.—Old S.—Braemar.—R. T. Harrison.—J. Phelps.—Fred. Foster.—J. D. Dilks.—Scrambler.—Fern Lea.—J. T. Morton.—D. Toomer.—Viscarides.—Planter.—V. T.—J. R.—O.—Zuyder Zee.—Manrico.—Old Lever.—Ajax.—Wm. Ackroyd.

J. D. B. (Metzler & Co. publish a cheap manual of the American organ; order through any music-vendor.)—Nervous Chip. (1. Eat oatmeal or wheatmeal porridge for breakfast, and occasionally lentil meal; eat brown bread always, and partake frequently of figs and stewed prunes. 2. We have very little faith in the appliances named. 3. Both the index numbers referred to are out of print. Instructions for making galvanic belts will be found on pp. 286 and 384, Vol. XII., and more explicit directions with illustrations on pp. 509 and 526, Vol. X. As the dates are rather far back, we quote the shortest method given, which was communicated by "Sigma," and which he declared at the time would only cost a halfpenny for each shilling that would be charged for one of the belts by the maker you mention:—"Get some copper wire, size No. 10, cut it into lengths of an inch or an inch and a half; solder to the ends of each an inch of thin copper wire or wire cord, and wrap a piece of fine flannel round the copper; cut a strip of sheet zinc an inch wide into pieces, which turn round a rod into cylinders large enough to surround and grip the flannel-jacketed coppers, and solder the wires from these to the next zinc in series.")—Navis. (You seem to be unaware that a series of articles on canoes was concluded on p. 159, of the present volume.)—Anxious. (First query unsuitable—consult a veterinary surgeon; second inserted.)—B. and C. (You can hardly have tried those who advertise in these pages.)—Macabrick. (Engines more perfect for the purpose than railway locomotives have already been constructed and applied to tramway traffic. A very simple and effective contrivance is in use for lifting submerged torpedoes, and the crews of the ships in the Dardanelles have been well exercised in its application.)—Lightening. (Colour stains can be removed by soaking the parts in alcohol; but if, as seems probable, you have burnt or scorched the pipe, the case is hopeless. A solution of nitrate of silver, carefully applied, will turn the whole to a beautiful mahogany colour, as nearly like the real thing as possible.)—Chemical Student. (Napier's "Manual of Dyeing," published by Chas. Griffin & Co.; or a better book is Crookes' "Handbook of Dyeing and Calico Printing," published by Longmans & Co.)—Thick Thread. (Gum lac is probably discharged by the *Coccus lacca* as a defence for its eggs, which are deposited in the small branches of trees; the word lac is Sanscrit in its origin, meaning a hundred thousand, from the countless insects which the Hindoos believe discharge it from their stomachs, and at length destroy the tree in which they form their colonies. In its natural state it is called "stick lac;" "seed lac" is pounded stick lac after it has been separated from the sticks, and the colouring matter extracted from it. This latter makes lac-dye or lake, for dyeing woollen goods. Shell lac is produced from seed lac by melting and straining it through a bag.)—Lyme Regis. (Frankfort-black is the principal ingredient in the ink used by copperplate printers, and is imported from Germany. It is obtained by burning the lees of wine, and the finest samples come from Frankfort, though great quantities are manufactured at Metz, Strasburg, and also in France.)—Curious. (The coin is a Moorish Mitkal, worth about 3s. 1d.)—E. W. N. (It would be illegal, and you would soon have the Excise authorities down on you.)—Hudor. (Directions for preparing animal charcoal were given on p. 476, Vol. XII. It can, however, be bought more cheaply of the vendors—wholesale chemists and drysalters.)—G. Grundy. (We know of no book; the best makers advertise on our front page, and, we believe, send full directions with the apparatus.)—A. O. (£15,000.)—Poor Tom. (Get Smith's "British and Foreign Ferns," published by Hardwicke and Bogue).—Poor Workman. (No good for celestial objects, and possibly would not be found by every one to answer the description given, but still a serviceable glass and certainly worth the money.)—Dublin. (Use fine glass paper and white spirit varnish.) H. R. F. (The makers are obviously the proper persons to answer your first question. Directions for making fire balloons appeared on p. 520 and 613, Vol. XXIII.) J. H. Biggs, Adelaide. (Envelope and letter to hand, but no P.O.O. enclosed).—Ertibbe. (Hardwicke and Bogue, Piccadilly, can probably supply a work that will suit you.)—L. M. N. (Send the information for publication that other readers may benefit as well as the querist.)—Cricketer. (No remedy can be applied with safety.)—S. W. Burnham. (The drawing for 61 Virginis did not come to hand or was mislaid.)—56in. Superb. (You have omitted the *number* of spokes. Your letter is in type; but please send on the number of spokes to the inch—diameter.)

Amateur Polisher, X. Y. Z., W. H. Birnini, S. Hunt.—See indices to back vols.

Ticket, Archimedes.—Your queries are advts.

Thomas Kay, T. E. J., F. E. C., Glatton, Brickwall, R. J. Johnson, G. B., J. J. S., Nero, W. K., Bernard McGuire, H. F. R., E. Sargent. C. E., E. W. Furrell, A. A. Watkins, Roscoe, C. P. Bolton, F. F. C., B. A., and others have replied to queries already similarly answered.

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FRIDAY, JUNE 14, 1878.

ARTICLES.

F. TYNDALL ON FOG-SIGNALS.

recent loss of a Transatlantic liner the coast of Wexford, though unattended by any injury to ers or crew, serves to draw renewed n to the subject of fog-signals. It rhaps, be too much to say that the vould not have been wrecked if fog- had been placed at suitable points coast; but there is every reason to that if such a warning note could en heard, a fine vessel and a valu- argo—of beef, too—would have the treacherous rocks. Those who perienced the difficulty of tracing ay along roads during a thick fog erhaps, be able to appreciate the of the mariner on a fog-bound ith only his lead and a calculation listance run to guide him as to his bouts, but it is obvious that it must ition of extreme difficulty, requiring rcise of both judgment and skill. eans of guarding vessels against ts during fogs are, unfortunately, most imperfect kind, though every as been made by the Brethren of the House, and by private inventors, to n effective system of signals. For ears Prof. Tyndall and the engineer Trinity Board have been engaged in of experiments to ascertain the ans of warning ships of their prox- to danger during fogs, and the has embodied the results in a paper ed to the Royal Society. In 1872 73 experiments were made at the oreland to test the value of guns of t kinds in producing loud reports discharge of small quantities of and it was then discovered that a in. howitzer and 3lb. of gunpowder louder and further extending report he same charge fired from an der gun. The howitzer could not be as- o be the best form of gun for the pur- d accordingly the first step in advance provide it with a parabolic muzzle, ent the landward waste of sound ssist in projecting it over the sea was most needed. A number of ith models were previously made, performance of the gun itself was it to show that its construction had sed on sound principles. About this n-cotton was suggested as a possibly sound-producer, though, as a mat- fact, theoretic considerations had convinced Prof. Tyndall that the ce used to produce the required nust be capable of yielding an in- ffect. A sound-wave, it is known, essentially of two parts—a conden- nd a rarefaction; but air is a very luid, and if the shock imparted to sufficiently intense and prompt, the ave is not produced. A familiar in- s seen in the clock pendulum. The be supposed to condense the air in of its line of motion, leaving a par- um behind; but, in reality the air obile that the particles in front before the bob, and those behind so rapidly that no sound-pulse is

To convert even a fractional part ergy of the shock into aërial waves, ck must be imparted with great rapidity and intensity; consequently a substance like gun-cotton must be superior to a comparatively slow burning explosive like gunpowder. The truth of the theory here briefly propounded was fully demonstrated by some experiments made in 1875, when eleven observers noted the effects produced by the firing of equal quantities of different-sized powders. Without a dissentient the eleven observers pronounced the sound of the fine-grain powder loudest, and they were equally unanimous in declaring the pebble powder the worst sound-producer. Such a result was expected, for the *raison d'être* of pebble powder is that it burns slowly in comparison with fine-grain or large-grain powders. In 1876 the parabolic-muzzle gun being ready it was pitted against some other guns, and also against gun-cotton detonated in the open, and in front of a reflector. The parabolic gun, with 3lb. of powder, demonstrated its superiority over all other guns, and established its equality with 1½lb. of gun-cotton fired in the open. Fired in the focus of a reflector, however, the gun-cotton (1½lb.) was superior to all the other sound-producers tried. To reinforce sound in one direction by means of a reflector implies its withdrawal from some other direction; consequently, for stations where the sound is required to be heard from several points of the compass, the gun-cotton fired in the open is superior to either the parabolic-muzzle gun or the cotton fired in front of the reflector. While, then, the parabolic-muzzle gun and the reflector may be useful where it is desired to direct the sound over a limited area and in a certain manner, the gun-cotton fired in the open must be used on lightships and on those signalling stations which are more or less surrounded by the sea—*e. g.*, the "nesses" and promontories which run out for considerable distances, and are bathed on both sides by navigable waters. The great disadvantage of gun cotton is found, however, in the fact that a suitable spot and considerable care are necessary to its use, and although this disadvantage might perhaps be overcome in the majority of instances it is advisable to avoid the difficulty by using the gun-cotton rocket.

The necessity for a signal suitable for discharging from rock lighthouses, and capable of clearing obstacles casting what is known as an acoustic shadow, suggested the gun-cotton rocket to Admiral Sir Richard Collinson, the Deputy Master of the Trinity House, and in 1876 some tentative experiments were made at Mr. Brock's place at Nunhead. The rockets were calculated to be capable of ascending to elevations of 1,000 feet or thereabouts. They were of the ordinary form, but carried a disc of gun-cotton at the head, which was fired by a fuse and a detonator just as the rocket reached its greatest altitude. The results were considered so promising that further experiments were soon made at Shoeburyness, when the reports of the rockets were heard clearly at the Mouse and Chapman lights, each of which was distant 8½ miles from the firing-point, but in opposite directions, thus showing that the sound extended over an area of 17 miles, and an unknown distance beyond. That was in the summer. In the following December, and again in March, further experiments were made, with the view of testing the rockets under different conditions of weather, and also for the purpose of comparing the reports of the rockets with those of gun-cotton discs fired near the ground. The mean value of the explosions in the air exceeded that of the explosions near the ground by a small but sensible quantity. Last October a series of comparative trials were made at Dungeness with rockets charged with gun-cotton and cotton-powder, the 18-pounder gun, and the syren. The gun-cotton and the cotton-powder were practically equal; but all the rockets, save the 2oz. or smallest, gave a louder report than 3lb. of gunpowder in the parabolic muzzle howitzer, and all decisively eclipsed the 18-pounder. The syren, too, was beaten by the rockets. A curious fact was noticed in these experiments—viz., that a 6oz. gun-cotton disc gave a very little louder report than a 2oz. disc. Other experiments yielded similar results; but the most remarkable results were those obtained by Mr. Prentice with gun-cotton rockets fired at Stowmarket. A number of observers at distances varying from 6 to 25 miles heard the reports of the rockets distinctly—the reply from the 25-mile station being:—"Rockets seen through a very hazy atmosphere; a rumbling detonation heard." Professor Tyndall may well say that "it is needless to dwell for a moment on the advantages of possessing a signal commanding ranges such as these." The reports were very loud at distances of 10 miles; and such a distance as that should be sufficient to warn any vessel of her approach to danger. Under favourable conditions of weather it means more than half an hour's voyage to the fastest steamer afloat, and if during foggy weather the sounds would not be heard so clearly, it must be remembered also that, under similar conditions, 10 miles would probably represent more than an hour's run. Thanks to the Woolwich authorities, to Mr. Prentice, to Mr. Brock, and last—though perhaps not least—to Prof. Tyndall, the gun-cotton rocket—which the latter suggests should be called the Collinson rocket—is now at the service of mariners, and, it is to be hoped, will shortly be supplied to dangerous places around the coast for use during foggy weather. It is manipulated with ease and rapidity, occupies very little room, and, by grouping and timing the discharges, forms an excellent means of signalling from the admiral's ship to a fleet.

The phenomenon of aërial echoes noticed during the experiments is not the least interesting feature of the acoustics of the subject. They were, we believe, first noticed by Prof. Tyndall when testing the syren at Dungeness, and also when listening to it on board the Galatea; and he was at first puzzled to account for them, as there was no visible reflecting surface from which they could come. On days with hardly a cloud and scarce a ripple on the sea, the echoes reached the listener, standing behind the syren, with magical intensity. So far as the sense of hearing enabled the observer to judge, the echoes came from the body of air in front of the great trumpet, which sent out blasts of five seconds in duration. Before the blast ceased, the echoes struck in, adding their strength to the primitive note of the syren; and after the sound of the blast had ceased, the echoes continued, retreating further and further from the point of observation, and dying away at great distances. So long as the sea was clear of ships it was noticed that the echoes were continuous—"tapering," so to speak, to silence; but when a ship crossed the course of the sound, the echo was returned as a shock, rudely interrupting the continuity of the dying music. On one occasion—a particularly fine day—while off Dungeness in the yacht, a single ship lay about half a mile distant between the Galatea and the land. A rocket was sent up which exploded at a great height: the echoes retreated as usual, becoming less intense as the reflecting surfaces became more distant; but about five seconds after the report a single loud shock was sent back from the side of the distant vessel, which obliterated for a moment the less intense echoes, which, however, were again heard dying away into silence. This phenomenon of acoustic reverberation has been repeated in the laboratory. A rectangle 22in. by 12in. is crossed by twenty-three brass tubes, each having a slit from which gas can be burnt, thus forming twenty-three low flat flames. A reed fixed in a short tube is placed at one end of the rectangle, and a sensitive flame at some distance beyond the other. When the reed sounds the sensitive flame in front is violently agitated, roaring boisterously. If, however, the gas jets are lit, the air above them becomes so heterogeneous that the sensitive flame is instantly quieted by the aërial reflection, and rises from a height of 6in. to a height of 18in. That represents the acoustic opacity of the air in front of the South Foreland. Turning off the gas, and removing the sensitive flame to some distance behind the reed, it burns tranquilly, although the reed may be sounding; but now, as soon as the gas is lit, the heterogeneous air above the flames reflects the sound, and throws the sensitive flame into violent agitation. That is a representation of the aërial echoes heard when standing behind the syren trumpets at the South Foreland. These researches of Prof. Tyndall, which first attracted his attention while prosecuting his work in connection with the Trinity House, are very interesting, and they have already resulted in the introduction of signals which should help to prevent such disasters as those which overtook the Schiller, the Idabo, and the Vanguard.

TECHNICAL EDUCATION.

THE report of the Executive Committee appointed by certain of the Livery Companies of the City to prepare a scheme for the establishment in London of an institution for the Technical Training of Artisans has been published, and is, undoubtedly, an important document. The first step taken by the committee was to apply for advice to a number of gentlemen, selected for their knowledge of pure science, for their acquaintance with scientific education and technical examinations, or on account of their position as employers of skilled labour, and the letters obtained by this means contain a number of ideas and opinions of considerable value, which the committee have summarised and collated, and on which they have based their proposals. At the commencement of their report the committee state that it would be unwise to attempt to teach workmen skill in handicraft in the training institution, because such skill can be best acquired in the workshop, except in the case of the introduction of a new industry or the revival of an old one, when, under special circumstances, an opportunity might be afforded for the training of artisans in the actual work of their craft in the institution. The wisdom of this decision will commend itself to employers of labour, except those who would like to obtain skilled workmen without the trouble of teaching apprentices. The committee, consequently, recommend that the teaching should be confined to imparting a knowledge of the principles of science and art—to familiarising the artisan with the great facts and theories upon which the industry he is to pursue is based. To illustrate by instances: they would not propose to instruct an ironworker in the actual manipulation of his tools and appliances, but they would endeavour to impart such instruction as would enable him to understand why, in spite of his manual skill, his puddle bar is occasionally bad, or his pig-iron of an inferior quality. Chemistry, as applied to ironworking, would therefore be the most important subject in the curriculum of technical education for ironworkers. Similarly with regard to textile manufactures. It would be unwise to establish model factories, as has been done on the Continent, with the view of enabling the operator to acquire extra dexterity; but it is essential to improvement that the pick of the workmen should have such an acquaintance with chemistry as to appreciate the effects of different kinds of water, and to estimate the properties of dyes and their effects upon the materials; while their artistic taste should be trained to avoid those combinations and designs which offend against the accepted canons. This is a fair exposition of the principle upon which an institution for promoting technical education should work, and if the details are well worked out and adhered to in practice, the result will doubtless be of incalculable benefit to the country at large. But it is important to observe that the instruction in chemistry, for instance, must not be of that kind which is required for passing the present examinations of the Science and Art Department. Applied chemistry is what is required—not theoretical, we had almost said hypothetical. Neither the ironworker nor the maker of textile fabrics will need to be versed in atomicities, valencies, and the arguments by which the various formulæ are supported: those are for subsequent study. What he will require is a knowledge of chemistry as it affects the industry in which he is engaged, or which he is about to follow. Its further and deeper study must be left to his own inclinations, for no institution for technical training can afford to devote more time than is absolutely necessary to its students—the aim being, as we take it, to spread a knowledge of principles amongst the mass of workers rather than to turn out a limited number of specially skilled and highly-instructed artisans. The committee direct particular attention to the advice of Sir W. Armstrong, and others, that too much should not be attempted at once, but that the scheme should be so formulated that a small beginning may develop step by step into a thoroughly successful and widely-extended system. The proposition put forward by the committee is, then, the establishment of a central institution with local trade schools. The central institution would furnish competent teachers for the local schools, but no one would be received into the classes who had not shown by previous examination in some of the existing science and art schools, or otherwise, a sufficient degree of knowledge to enable him to profit by the instruction given at the central institution. What is to be understood by "otherwise" is not stated; but unless the examinations of the existing science and art classes are specially modified, they will not, as we have already pointed out in a previous article, attract many of the rank and file of even our best artisans. If, before entrance could be obtained to a local trade school, foremen, workmen, and apprentices will be required to show that they have acquired sufficient elementary knowledge of the principles of science and art—such elementary knowledge being tested by the usual syllabuses of the Science and Art Department—the numbers applying for admission will be as ridiculously small as those which have hitherto responded to the invitation of the Society of Arts. The preliminary examination must be devoted more to testing the capabilities of the candidates than to an endeavour to discover whether they can pass the elementary grades of the Science and Art Department; for, as we pointed out on p. 441 of our last volume, it is doubtful if any large number of artisans will take up the study of any sciences which are not, to their limited perception, obviously connected with their trades. Instead, then, of making admission to a trade school depend upon the successful passing of the elementary examination of the Science and Art Department, it would be better to hold what we may term a matriculation examination at the trade school itself, and to supply textbooks specially adapted to the wants of the artisans. An ironworker, for instance, requires a knowledge of inorganic chemistry; a maker of textile fabrics is most interested in the organic branch of that subject, but neither would find much that it obviously concerns him to know in the syllabuses issued from South Kensington. The committee believe that trade schools would be founded by the residents of the localities, if encouragement were afforded by the Livery Companies, but, failing their establishment, they recommend the founding of two to serve as models. The Central Institution might for a time find a home in any suitable spot near London, and they recommend that the staff should consist of professors, demonstrators, and assistants in applied physics, applied chemistry, applied mechanics, and applied art. The salaries and general expenses would be covered by an outlay of £10,000 a year, and £1,000 for rent would complete the annual expenditure, but at the outset a certain sum, perhaps £3,000, would be required to adapt the building to its intended purposes. The committee make many other suggestions, but they express a hope, and this is the gist of the whole plan, that the Livery Companies will undertake to furnish a sum of £20,000 per annum, as from January 1 last, in order that the scheme may be at once put into work. We believe there is reason to think that such a sum will be forthcoming, and it is to be hoped that no time will be wasted in establishing the Central Institution. Meantime the great centres of industry should start their trade schools, and be prepared to affiliate them.

THE ORGAN: A COMPREHENSIVE TREATISE ON ITS MANUFACTURE, PROCURAL, AND LODGMENT.*

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PART I.—GENERAL TREATMENT IN MANUFACTURE.

h. WHERE this distance is considerable and the Reservoir can be placed near Swell-Box, it will be manifest that a material economy has been effected, but care must be taken that it be not lost another way, thus: The area of the Feeders must of course be sufficient for the full Swell: now it is well known that perfect practical steadiness will not be compromised if the Receiver area be no larger than the total of that of the Feeders; but it will be evident that here, if the Bellows be made in the usual way, the Receiver area will *exceed* this, for there will be the Reservoir to add, and the labour and material of this excess of Receiver may easily balance the saving of work of the second Trunk. It is true there remain the advantages—*a*, of avoidance of the space of the second Trunk; *b*, of greater steadiness by the larger Receiver surface; *c*, that the Receiver can be made smaller if so desired. *a* does not amount to much, for the size total of the Trunk is always the same in both cases, the two thus not really required to occupy palpably more space than the one; *b* is, of course, real, but remember that practical steadiness does not require it; *c* saves little, if the Receiver be set in, the space over the Feeder must obviously be boarded over; still a little *is* saved, and the Reservoir will furnish, as already said, Vent to practically bring the Receiver surface up to proper Area. The amount fed by the Reservoir is very rarely here considerable enough to render it necessary that it be constantly in use if the primary Receiver be reduced at all. (*See* APPORTIONMENT, 10, y.)

i. Caution, therefore, as already said, must be exercised. Where the distance from Bellows to Windchest is long, and the amount to be supplied by the Reservoir small, this will undoubtedly be the best method. When the distance is short, and the amount for the Reser-ir considerable (as the Bass of the entire well or Great, *see* AUGMENTATION OF PRES- URE), it will, as a rule, be best to have Two a Combined Bellows (*see* 7, f., and more fully reafter in *Detailed*).

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j. No. 2. This will be only likely to occur in mparatively unimportant or inconsiderable struments—at least it ought not to in any her. We will suppose the space to be *very* nfined every way, the best course will often to have a Whole-drop Double-action eeder (*see* STRUCTURE, 6, x.); but as this ill be nearly or quite the size of the Receiver, d, in addition, feed, as its name implies, both ays, it will be obvious the steadiness of the eceiver is perilled. Here the Reservoir is of e greatest utility, for it may be placed in any nvenient position, and at all times when tually being drawn from will afford valuable nt for the *blows* of the powerful Feed (for pportionment under such circumstances, *see* , a.). The arrangement is, however, in some spects unfavourable to blowing by Gas (*see* a.)

k. No. 3. It has already (9, n.) been seen at two Bellows will be capable of supplying very considerable amount of wind, sufficient, deed, for a large Organ, and this with only o Blowing *Handles* required; but it will very equently happen in such cases that more than o distinct *pressures* are desired (*see* 12, o.), d in such event a Reservoir is desirable, as it obviously not worth while to multiply andles and Feeder area beyond the real re- irements of the Instrument.

l. A design for *Combined Bellows* has already en given (*see* 7, f.) which will provide two essures from one Handle, but this, as there stinctly pointed out, is only an imperfect rangement. Where the requisite space can allowed it is better to have the Bellows- roper of the usual kind (that is Receiver un- minished), and a separate Reservoir or Re- iver for the lighter pressure, of course drawing om the Bellows proper as already described 4, k.). For *size* of the Reservoir *see* Descrip- on (14, o.). The *location* will depend on cir- mstances; if height can be spared may place over the heavier Receiver from which it aws; if plan room sufficient place the Reser- ir and Bellows side by side; this latter, as a hole, is preferable because Reservoir more cessible for repair, &c. *See*, however, for ocation more fully in ARRANGEMENT (7, l.).

m. No. 4 relates chiefly to Blowing by Ma- inery; it does, of course, apply partly to anual Blowing, for, as already stated (14, u.), e Reservoir applied as an *Intermediary* is un- ubtedly a safeguard against bad blowing; t it must be understood, once for all, that in l ordinary cases provided the Bellows be large ough (and if they be not, no machinery will prove matters), and any defect yet appear this point, it will be owing to the stupidity, niggardliness, or other fault of the authori- s; for the requisite muscle and intelligence n, so to speak, be obtained at any street ner.

n. But with Machine Motors the case is dif- rent. Here the supply, if waste is to be oided, must be automatic—that is, the llows when full must cut off the *power*, and t simply "blow off," as with ordinary Manual bour. The choice of Machine Motors lies actically (as is set forth in Blowing action, 21, m.) between Steam, Water, and Gas; e first two of these present no difficulty, as e cutting-off valve can (by making of oppo- ion surface or other suitable form, or even in ny cases a common cock) easily be light ough to be governed by the rise of the Re- iver without offering sufficient resistance to actically alter the pressure of the latter.

o. But with the Gas Engine the case is dely different, at all events in the present ge of the invention (1877). Here any effec- e automatic governance by attaching the ceiver to the *Supply-cock* is out of the ques- n; and the only alternatives are a fast-and- se pulley, as it is termed, or the letting the eders discharge into each other; the latter is course silent, and as one valuable quality the Gas Engine is that the *rate of its explo- ns may be regulated automatically* by the *tual work to be performed*, this plan can in many cases be resorted to, and the Reservoir saved; but it will be obvious that the method may not always be practicable (as with Double-action Feeder, as just said, 15, j.), and in such case the fast-and-loose pulley becomes the only one that is so. As this requires some little power to push band on and off, it is evident that the resistance offered may affect the pressure of the Receiver. In such case, therefore, the *Intermediary* or complete Reservoir often becomes called for, of course weighted slightly lighter than the Supply Bellows, and trapped in the usual way; the Supply Bellows taking the Automatic throwing off and on of the Band, and always keeping wind in the Reservoir. More exact information as to necessity for Reservoir in such cases is given in Blowing Action (*see* 18, v.)

p. For No. 5 *see* GENERAL LOCATION (7, l.).

q. It will be seen that No. 1 presents an example of an Auxiliary Reservoir. No. 2 may be either an Intermediary or an Auxiliary as the first Receiver has *not* or *has* its own Trunk—the latter always when two Pressures are desired. No. 3 is obviously an Auxiliary. No. 4 is, remember, a strict Intermediary, correcting, not *unsteady Manual* Blowing, but *Machine* Blowing of *non-uniform pressure*. No. 5, of course, is an Intermediary.

*** SIZE.

r. For size of Reservoirs *see* that Head (14, o.). *See* also Size for one Handle (9, n.).

s. It will be at once obvious that the size of the Bellows will exert a very important influence upon the laying out; it is therefore desirable here to go into it so as to enable the builder to ascertain with sufficient accuracy what amount and nature of space to allow for this portion of the Instrument; more information will be given hereafter, accompanied with Examples from existing Organs.

t. I have not thought it necessary to waste time in demonstrating that the supply must be copious enough to serve the fullest amount of power of which the Instrument is capable; I leave that to Forkel, and others who might have shown more sense than to follow him. The idea of extraordinary sagacity which these writers seem to consider involved in old Sebastian's well-known habit of testing the Wind-supply of an Organ would probably have been instantly scouted by the old Cantor himself; and those clever critics who dwell with such unction on so very obviously necessary a matter seem to the present writer to exhibit most conclusive, although indirect, evidence of their own want of knowledge of the innumerable vital but *hidden* requirements of a really good Organ.

u. It must be distinctly borne in mind that the real size of the Bellows means the Area-and-Drop of the Feeders; but as such an admeasurement has its disadvantages, and exact figures are not here really necessary, it must be understood that the dimensions here given are as *over all*—that is, the size at Middle-board or Trunk-band; it being also assumed that the Feeders occupy, as they ought to do, the whole of this portion (or merely such amount less as is convenient in practice—say a set-in of Feeders of ¼in. or so); thus the "size," as here understood, will be, approx., the framing or space provided for the Bellows. It must be also understood that any considerable projection of middle portion beyond Feeders is to be reckoned extra, and that Feeders are assumed to be as close together as is safe (say 1in. apart; the Waste-pallet is never by Author placed beneath Middle-board, *see* 5, z.). The Size is thus practically, though not exactly, brought to the Feeder Area. Ordinary cuneiform or *hinged* Feeders are also taken for granted.

v. It will be seen that the Size is calculated at per Register or Stop of Sounding-size, the latter being simply the total number of Sounding Stops that can be brought into use at once. Thus, an Instrument possessing 10 on Gt., 8 on Swell, and 1 on Ped. (latter, of course, is here too small, only given as an instance), will have a Sounding size of 19 Stops or Registers, as Swell to Great ought in all cases to be present. If a Choir were added, but no Choir to Swell or to Great, the Sounding-size would remain the same; the addition of the Choir to Gt. or to Swell will at once increase the Sounding-size by the number of Stops in the Choir. Of course Swell to *Choir* makes no difference to the Sounding-size unless the Choir be larger than the Gt., which it certainly never ought to, though it is in some Continental Instruments (*see* 1, v.).

w. The following Table will give safe general rule, though it is evident that nothing more than approximation can ever be furnished in such a matter as this. The figures giving the pipe-lengths are normal only,—thus by the 4ft. long C is meant either CC stopt or Ten C open, though in the latter case the real length is considerably under 4ft. Size of tone by which a pipe 8ft. actual length approx. is called a 16ft. has nothing to do with this calculation, which uses only the *actual* approximate length.

MINIMUM SIZE OF BELLOWS.

With no Pipe longer than the 4ft C approx. length the allowance per every Stop of the Sounding-size will be 2 square feet.

With no Pipe longer than the 8ft. C approx. length the allowance per every Stop of the Sounding-size will be 2¼ square feet.

With no Pipe longer than the 16ft. C approx. length the allowance per every Stop of the Sounding-size will be 2½ square feet.

With no Pipe longer than the 20ft. G approx. length the allowance per every Stop of the Sounding-size will be 2¾ square feet.

With no Pipe longer than the 32ft. C approx. length the allowance per every Stop of the Sounding-size will be 3 square feet.

x. This is, as said, the Minimum allowance, and assumes everything of not more than ordinary structure for wind demand—that is, Pallets, Scales, Winding, Size of Registers, not excessive; usual Couplers Man. to Ped., but no Octave Coupler. The only deductions that can be made are for Short Stops, which may, if they descend no lower than Ten C, be allowed to reckon 3 as 2; if going no lower than Fid. G or Ten F, a little more might be taken off, but this latter is quite exceptional. No *Manual* should fall short of Ten C. Stops that descend only to Gam. G may as well be reckoned as if to CC, G being the vocal limit.

The Maximum may be considered found by adding to the Minimum one-third of that Minimum; thus the Maximum for the largest Organs will be 4 sq. feet per Stop, exclusive of Extras, which are pretty sure to be involved in such case.

The Extras are as follows:—

y. *Gr. Organ.* When the Great descends to GG a little extra may be allowed if the Swell go down to Gam. G, but not if it descends only to Ten. C, as then one may be considered to balance other.

z. *Registers.* When these are more than usually powerful, or there be more than common proportion of large ones, allow a little extra for this, say another ¼ square foot per Register; reckon this extra ¼ on the whole of the Registers of the Sounding-size.

(*To be continued.*)

THE GREENWICH VISITATION.

THE report of the Astronomer Royal to the Board of Visitors of the Royal Observatory, Greenwich, contains, besides the usual notice of matters of detail, references to several matters of special interest. It is satisfactory to learn that the railway through the town of Greenwich has not produced any perceptible effect at the Observatory, from which it is distant about 1,700ft. It has been worked for several months, and it is fair to assume that any appreciable effect of its proximity would have made itself apparent. Some of the instruments in use at the Observatory have been repaired, their increasing age rendering them more liable to injury. The sidereal standard clock preserved a rate approaching to perfection so long as it was left without disturbance of the galvanic-contact springs (touched by its pendulum) which transmit signals at every second of time to sympathetic clocks and the chronograph. A readjustment of these springs usually disturbs the rate. The Astronomer Royal contemplates the possibility of using the standard clock, leaving the pendulum free from the touch of springs, to give, from its wheel of 30 double-seconds, bi-secondly currents, which currents would regulate, on Mr. Jones's principle, the movement of a seconds' clock, by which the desired signals would be actually produced.

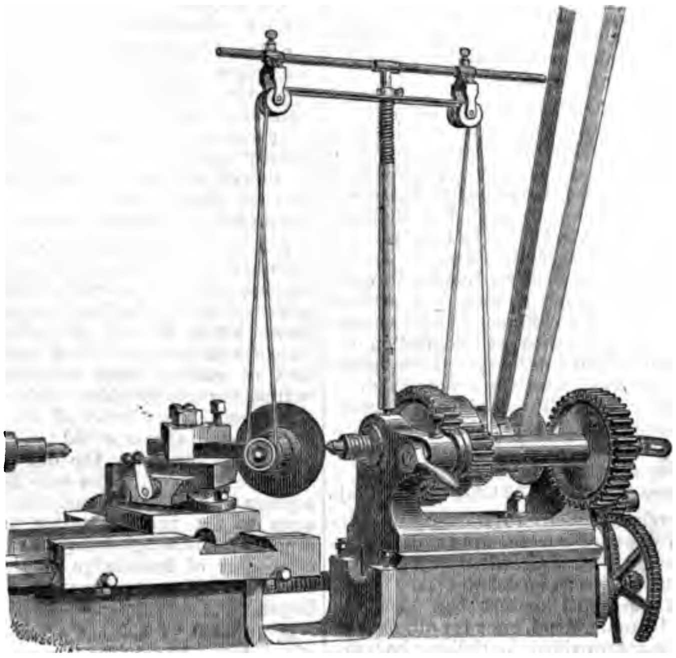
The ordinary work of the Observatory has been carried on with its usual regularity, but the Astronomer-Royal regrets that his power of advantageous observation of the small planets is limited by the want of ephemerides, which he would be glad to possess for the first eighteen of those objects. To facilitate the observations of stars, a new working catalogue has been prepared, in which are included all stars down to the third magnitude, stars down to the fifth magnitude which have not been observed in the last two catalogues, and a list of 258 stars of about the sixth magnitude, of which the places are required for the United States Coast Survey. The whole number of stars in the new working list is about 2,500.

The computations for the "Nine-Year Catalogue" of 2,263 stars, including some supplementary investigations, were completed in the course of 1877, and the introduction has been prepared and sent to the printer. The catalogue is drawn up in the same form as previous catalogues, the only noteworthy alterations being the addition of another decimal place to the R.A.'s and annual precessions in R.A., which are carried to 0·001s. and 0·0001s. respectively. The right ascensions are thus made to correspond more nearly with the North Polar distances as regards the degree of accuracy exhibited. For the determination of the systematic errors in right ascension, depending on the assumed places of the clock-stars used, a comparison has been made of the R.A. of clock-stars found from groups which extend over 12h. at least with those of the catalogue, and also a comparison of the R.A. of circumpolar stars above and below the Pole. For the first-named discussion new ledgers of R.A., from groups of 12h. and upwards, were formed for the 208 clock-stars, of which 3,130 observations were available, and the mean places deduced for 1872 were assumed as standard, and corrections to the "Nine-Year Catalogue" were tabulated according to R.A. and N.P.D. respectively. From these mean corrections have been deduced by a graphical method, ranging from + 0·014s., about 23h. to − 0·011s., about 9h. as depending on the R.A., and from − 0·005s. at 50° to + 0·003s. at 100° and upwards as depending on the N.P.D. In preparing the assumed mean right ascension of clock-stars for use in 1878, these corrections have been applied to the places of the "Nine-Year Catalogue," so that in future the assumed places of clock-stars will virtually depend on groups of 12h. and upwards. The R.A.'s of clock-stars in the first and second "Seven-Year Catalogues" have also been compared with the standard 12h. groups, the result being to show that the errors of the assumed places of clock-stars, originally derived from Pond's observations, have been carried through the successive catalogues, though gradually diminishing in amount. For the first "Seven-Year Catalogue" the corrections range from + 0·041s., about 23h. to − 0·044s., about 8h.; and for the second "Seven-Year Catalogue" from + 0·023s., about 23h. to − 0·037s., about 8h. With regard to the circumpolar stars, the mean excess of R.A. above the pole over R.A. below the pole, reduced to equatoreal interval, ranges from + 0·020s. at 23h. to − 0·010s. at 3h., rising again to + 0·027s. at 6h., and falling gradually to 0·000s. at 14h. to 19h. The mean excess from the whole of the observations is + 0·010s. The North Polar distances have been corrected for error of the microscope-micrometer screws for the years 1868 to 1875; the observations in 1876 do not require any such correction, as new screws were applied at the beginning of that year. A correction of − 0·20″ has also been applied for error in the assumed co-latitude, 38° 31′ 21·60″, a new determination based on all the observations of circumpolar stars having given the value 38° 31′ 21·40″. In this investigation 5,976 observations above Pole and 2,685 below were discussed, and the result has been adopted as the basis of the N.P.D.'s of the catalogue.

The spectroscopic work of the Observatory has been carried on with increased energy, and the magnetical, meteorological, and photographic observations have received due attention. The final result of the examination of the transit of Venus observations, so far as the official astronomers are concerned, appears to be a parallax of 8·82″ or 8·83″; but it seems that in some instances there are serious errors in the times recorded by the observers. The results obtained from photography have "disappointed me much," says the Astronomer Royal; many photographs which to the eye appeared good, lost all strength and sharpness when placed under the measuring microscope. The photographs were measured by Mr. Burton and Captain Tupman, the result obtained by the former being 8·17″, and 8·08″ by Captain Tupman. Alluding to proposed additions and alterations, the Astronomer Royal expresses the hope that "Flamsteed Hill," which, though limited, possesses great advantages, will never be abandoned.

A LATHE-CENTRE GRINDER.

THE accompanying engraving shows an ingenious method of applying an emery-wheel for grinding lathe-centres. The usual process occupies considerable time, and is not unaccompanied by a risk of injury, which it is at all times advisable to avoid when possible. The patent lathe-centre grinding machine, manufactured by Messrs Simon and Co., can be fixed to any lathe in a couple of minutes; will grind the centres true without destroying the temper, and insures accuracy that can only be obtained by the usual means, with the exercise of considerable skill. The holder is held in the slide-rest as shown, the spindle carrying the wheel being conical, so that any wear can be readily taken up by turning a screw. The spindle is surrounded by an oil-chamber, thus obviating the necessity for frequent lubrication, and avoiding the risk of damage from the neglect to which a general tool is usually subjected in a large workshop. To prevent any dust entering the bearing, a leather washer is placed in the holder. The standard carrying the pulleys for the driving belt is made of iron pipe, and is readily adjusted as to height and distance between pulleys. This centre-grinder has been tried for some time at the North London Railway Works, Bow, and, having proved successful, and afforded another instance of the utility of the emery-wheel, is introduced to the notice of machinists.



ACOUSTIC REPULSION.

WHEN in a resonator (say, cylindrical) open on one side, continuous vibrations of air are produced, and a node of vibration occurs at the closed end, there is on the interior of the closing wall of the cylinder a greater pressure
than outside the wall in the still air. T
be easily shown by means of a sensitive
meter. Suppose that, for the produc
resonance, the mouth of the cylinder is
towards the source of sound, the
must by this internal excess of pressur
pelled from the sounding body. This t
cal deduction has been verified by M.
and he shows that also resonators open
side, that have not a cylindrical form,
pelled from a source of sound. A s
delicate arrangements for observation
interesting phenomenon have been de
by M. Doorak, in the *Annalen der Phy*
deserve to be generally known.

The resonators he employs are made
drawing paper, coated with gum arabi
have the form of a cylinder with some
small paper tube added. He also
spherical resonators of such thin gl
their weight is not greater than that
paper resonators. The resonator is fix
shellac at the end of a splint of wood
other end carries a counter-weight, and
by means of a small glass cap, is supp
a sharp needle point. The source o
preferred is the resonance case of a
fork. The repulsion is so strong tha
peared even with an ordinary Helmhol
resonator, which, with the counter-
weighed 142g. It must previously be
however, that the air of the resonan
vibrates strongly enough. With an o
A tuning-fork (of 435 vibrations) the re
still distinctly appeared at 10ctm. di
with a larger C fork (128 vibrations
sounded for over ten minutes, repulsi
occurred at 20ctm. distance. M. Door
obtained acoustic repulsion of the res
from longitudinally vibrating glass tub
the circular sounding plates of Chladni

On the principle of acoustic repulsio
sonators it is easy to obtain a con
rotation. Four very light paper o
resonators are fixed at the ends of tw
splints, crossing at a right angle, and b
on a glass cap—the openings of the res
all facing in the same circular direction
acoustic reaction-wheel is placed bef
opening of the case of a tuning-for
enters into rotation, when the fork is
by reason of the repulsion above de
The oppositely-acting attractions are
force. An uncommonly quick rotatio
tained, if a large Kundt tube be used
source of sound, and a small acoustic r
wheel be placed before its open end.

If a wooden rod, with resonator atta
hung with a wire, similarly to the l
Coulomb's torsion balance, in a case wh
an opening on the side opposite the re
one may, by means of the repulsion
resonator, by a source of sound c

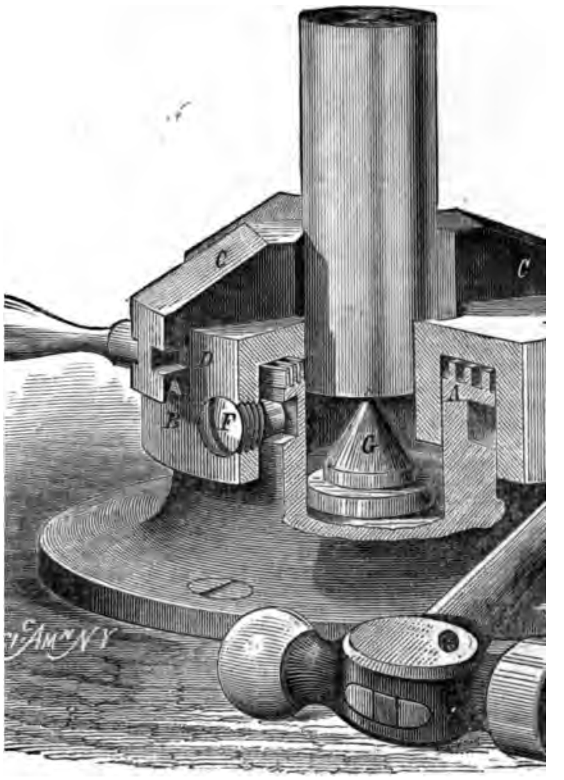
the strength of tones of the same of vibrations. Further experiments, , are required to render this acoustic alance practically useful. M. Doorak a source of sound in his experiments, pipe, which gave the note A with 435 ns. Several special arrangements are essary to prevent the acoustic torsion being affected by the direct air current ipe.

very simple theoretical considerations e proved that the middle pressure in vibration of an air-column is greater the ventral segment, and that it condecreases from the node towards the egment, provided that the amplitude xtremely small. This inequality of must forthwith become equalised by reaming from the node to the segment, he entire column the mean pressure reater than that of the still air; cony the air must stream forth from an of the vessel in which it performs the ns. The experiments above described no perfect equilibration of the pressure, manometer, even in the ventral segndicated a slight excess of pressure, eadily increased on to the node. The nts proved further that, at least in dt tubes, where the air-vibrations are lent, streaming of the air occurred nodes to the segments, and was main long as the air vibrated. Moreover, eriments demonstrated a continuous y flow, which takes place quite close be walls, and is opposite in direction rincipal current. Thus the whole of n the tube is in circulation from the the segments, and on the tube walls in to the nodes. The cross section of ipal current is nearly as great as that be itself, while the cross section of the y current is an extremely thin ring.

eady indicated, it might be expected air would stream out from the vessel continuous vibrations occur. Such an an be readily shown in the following spherical resonator is placed before ant case of a tuning-fork, the resonator with tobacco smoke, and the fork is sounded. The smoke then comes y out of the resonator. Finally, M. ucceeded in producing comparatively currents through sound in yet another hout, however, finding an explanation henomenon, which is probably someplicated. He placed at the opening of the large Kundt sounding-tube a funnel of stiff paper, with its wide mouth towards the tube. The size of this funnel is unimportant, but the action was strongest when the funnel, as a resonator open at both ends, gave the same note as the Kundt tube. When the Kundt tube was now strongly sounded there came out from the narrow end of the funnel an air current of such strength that it quite easily extinguished a candle flame at the distance of 20ctm. With a tuning-fork also M. Doorak obtained a perceptible air current from the narrow opening of the paper funnel, but the latter must in this case give exactly the same note as the tuning-fork.

CUSHMAN'S CENTREING CHUCK.

On p. 260 of the present vol. we illustrated and described Cushman's combination chuck, the invention of a man who has made a specialty of lathe and drill chucks for many years. We are now enabled to illustrate one of his latest inventions in the shape of an improved centreing chuck, which has just been introduced by Messrs Churchill, of Wilson-street, Finsbury. It is simply a four-jawed scroll chuck, with a steel centre, and can be fastened to a bench, or used in an upright position. It will centre round, square, or octagon bars from ¼in. to 1½in. diameter, and is claimed to do it more quickly and satisfactorily than anything else yet produced for the purpose. The illustration renders any detailed explanation unnecessay. The jaws, C, advance or recede equally, when the body of the chuck E is turned round by means of the handles, the threads, A, taking into corresponding threads in the jaws, which are thus forced in or out according to the direction of motion of the handles. F is a screw working in a groove, which facilitates the cleansing of the chuck, and G is the centre punch or point.



SCAMONI'S PROCESS OF PHOTO-GRAVURE.

In the *Bulletin* of the Belgian Photographic Association we have a description of Scamoni's process of photo-gravure, which gives the details of the method by which the negatives and positives are prepared, from the latter of which electrotypes are taken to form the plate whence impressions are pulled in a copper-plate press. The originals which have to be reproduced are carefully touched up, so that the whites are as pure, and the blacks as intense, as possible, and then the negative is taken in the ordinary way, the plate being backed in the camera with damp red blotting paper, to prevent reflection from the camera, or back of the plate. The negative is developed in the ordinary manner, intensified by mercuric chloride, and varnished. A positive picture is taken in the camera, the negative being carefully screened from any light coming between it and the lens. This is intensified by pyro-gallic acid, and afterwards washed with a pure water to which a little ammonia has been added. It is then immersed in mercuric chloride for half an hour, and again intensified with pyro-gallic acid. This is repeated several times. When the intensity of the lines is considerable, the plate is well washed, treated with potassium iodide, and finally with ammonia, the image successively appearing yellow green, brown, and then violet brown. The plate is then thoroughly drained, and the image is treated successively with a solution of platinic chloride, auric chloride, ferrous sulphate, and finally by pyro-gallic acid, which has the property of solidifying the metallic deposits. The metallic relief thus obtained is dried over a spirit lamp, and covered with an excessively thin varnish. This varnish, which is evidently a special preparation, retains sufficient tackiness to hold powdered graphite on its surface (the bronze powder now used may be employed instead), which is dusted on in the usual manner. After giving the plate a border of wax, it is placed in an electrotyping bath, and, after a few days, a perfect facsimile in intaglio is obtained.

STOPWORK AND THE PATENT SLIDING CLICK.

In a little pamphlet, published by the English Watch Company, we find some arguments on behalf of the Going-Barrel *versus* the Fusee and Chain, the latter being described as still existing through the exceeding vitality of a thorough-going prejudice. The following extract in reference to the stopwork, will interest watchmakers and others :—Where a chain forms a part of the winding mechanism of a watch, some arrangement, by which a "stop" is interposed at a given point is indispensable; neglect this, and the chain snaps at every winding. Luckily, with the fusee movement, this safeguard can be applied quite readily, and if it is well made, the stopwork of the fusee watch is durable enough to satisfy all reasonable requirements. With the going-barrel, however, the application of a reliable stopwork is a problem still unsolved.

There have been many contrivances intended to meet the difficulty; speaking broadly, however, they have all gone out of use except the star wheel and finger piece, so well known in Swiss watches. It may be inferred that the practical monopoly enjoyed by this stopwork is a case of "survival of the fittest," and a proof that with all its faults it is the best yet devised, but that it has no claim to be regarded as a perfect arrangement is notorious. Every experienced watch jobber will admit that a large number—perhaps a fourth, or in some districts a third—of the Swiss watches in wear are *without* the protection it was designed to insure; not that they never had stopwork, but rather that it has broken down and been taken away, for nothing is more common than for the affair upon the slightest strain to become a "stop" work indeed to the whole watch, and when this occurs it is, amongst a large class of repairers, quite an ordinary thing to bodily remove one of the pieces (generally the star wheel), as the shortest way to get over the difficulty, and make the watch go at all; that this condition of affairs is not overstated will be confirmed by every practical man in the retail trade.

Here it will be well to mention the advantages sought to be attained by the use of stopwork to the going-barrel. They may be summed up as an effort —1st. To obtain an approximate adjustment of the main spring (by the E. W. Co. this is done by the use of a light long mainspring); 2nd, to prevent the tearing away of the barrel hooking; 3rd, to prevent blocking, overwinding, or overstraining of the mainspring; 4th, to prevent the undue acceleration of the escapement whilst the mainspring is fully wound up and on the strain. Now, whilst the stopwork is in perfect order these objects are, no doubt, practically attained, but—and a very important qualification this is—when the least strain or derangement occurs, as has been pointed out, the watch stops, and is either despoiled of the stopwork altogether, or has, with whatsoever success may be possible, a new one fitted. Of course the inventive faculty of modern watch manufacturers has been directed to overcoming the drawbacks involved in this weak point of the going-barrel, but hitherto they have gone no further than by the adoption of various improved modes of hooking in the mainspring —notably the pivoted brace—to secure the second of the desired advantages named above. This hooking, at once simple and effectual, is perfectly secure from the risk of tearing away, the pull of the spring against the rivet being under all circumstances in a direct line; but it does not meet, nor does it pretend to, the danger of blocking—that is, winding the spring so tight and close that it binds itself, and remains coiled up and immovable. The other serious fault of undue and violent acceleration of the escapement is also left unremedied, together with whatever of risk to the mainspring may be involved in a daily overstrain. Nevertheless, the balance of advantage in favour of stopwork has been judged to be so small that the designers of the American watches have almost entirely abandoned it, preferring the limited but certain gain, already referred to, to the complication, the risk, and the insecurity of every known barrel stopwork.

By a recent invention, however, known as "Haseler's Patent Sliding Click," the whole of the weak points hitherto existing are completely met and covered, and the going-barrel, with pivoted brace and patent sliding click, may now be considered in the point of safeguards as fully equal to the old stopwork; whilst in simplicity, strength, certainty of action, and impossibility of failure or breakdown, it is immeasurably superior. The principle and action of this beautiful little arrangement are so elementary that it is a matter of wonder it has never been hit upon before. The principle is, that if provision is made for a certain amount of "give" or return in the ratchet work, it will be alike impossible to leave the mainspring on the strain or to block it; and, consequently, the disadvantages of over-winding on the one hand, and excessive action of the escapement on the other, vanish together; and, in point of fact, this is exactly what does happen. The application is simply this: that instead of the click having a round hole to receive the pin or screw on which it turns, the hole is elongated, or is what is technically called a slot, whilst the click spring is so formed that its action always throws the click forward, at the same time that it presses the point downward to engage in the ratchet teeth. In operation—supposing the key to be upon the winding square, and turned forward to wind the watch up—the click does not immediately begin to rise over the teeth of the ratchet, but first follows the forward movement of the ratchet for a certain distance, this distance being regulated by the length of the slot in the click. Having reached the end of its sliding limit, its ordinary action as a click begins, and continues as long as the forward action of the key is maintained. When, however, the power is taken off the key, and the mainspring instead of the hand of the winder comes into play, the arbour and ratchet return, and the point of the click being engaged in the ratchet, it is carried or pushed backward just as much as it had gone forward in the action first described, this return affording the relief to the mainspring which is required to effect the second, third, and fourth objects, and hitherto sought to be attained by the use of stopwork.

EXPLOSIONS IN COAL-MINES.—III.

By T. Wills, F.C.S.

In reference to the subject of ventilation, I would here call attention to an anemometer devised by Messrs. Arthur Le Neve Foster and H. Hall, in which the telephone has received one of its earliest applications. An anemometer of the ordinary kind used for determining the rate of the ventilating current is so arranged that, at every tenth revolution, a small pin on the axle strikes forcibly against a piece of steel watch-spring. This watch-spring is placed in front of an ordinary telephone, having the iron plate removed, the steel spring occupying in fact the place of the ordinary metallic plate. The telephone is connected by wires carried to any required distance with a second complete telephone, and on listening at this instrument every twang of the spring can be distinctly heard; by counting the number of these sounds in a given time, the number of revolutions of the anemometer, and consequently the rate of the air current, can be calculated. In this manner it is easy to ascertain at any point above ground the actual state of the ventilation. This ingenious form of instrument is quite successful in use, and is being employed already in some collieries, its extreme simplicity, coupled with the small amount of apparatus required, rendering it easy of application.

An explosion occurring in a coal mine, by the accidental firing of a mixture of fire-damp and air, will vary considerably in its effects according to the different conditions under which the explosion takes place. Thus the inflammable mixture may be of large or limited extent; it may be that the air and gas are mixed in their most explosive quantities, or be only just within the range of the explosive limits. Upon these points will depend the amount of local damage done by the accident, and the mechanical effects produced; in any case a mixture of this nature being ignited rapid inflammation of the whole takes place, a considerable amount of heat is developed, causing a corresponding expansion of the gaseous matter, and the mixture of fire-damp and air becomes resolved into new compounds. Starting with marsh gas and air, we have produced carbonic acid gas and steam mixed with the residual nitrogen contained in the original air, together with any excess of unfoul air or fire damp which may have been present. The steam is almost immediately condensed to water, the other bodies remaining in the gaseous condition. Those workmen exposed to the first shock of the explosion will suffer from the burning and scorching of the flame, and receive injury from the mechanical force of the combustion, which is sometimes tremendous, hurling men, horses, timber, and stones to great distances from the first point of ignition; but the primary effects of an explosion are by no means the worst—life being dependent upon the proper supply of air. Any interference with this supply will bring about most disastrous results, and a very common result of an explosion is seriously to effect the ventilation. Sometimes the ventilating apparatus is destroyed or seriously damaged, or by the blowing down of doors, brattices, and stoppings, the air current is diverted from its proper course, with the result of leaving portions, or it may be the whole mine, in a state of stagnation; drifts or galleries may be stopped up with heaped-up rubbish; a portion of the roof may fall, cutting off the necessary communication. These results would, under ordinary circumstances, lead speedily to the suffocation of all workmen existing under such conditions; but after an explosion, apart from the possible stoppage of the supply of air, this state of things follows with a much more rapid certainty, owing to the presence of the carbonic acid formed during the combustion. This carbonic acid is the much-dreaded after or choke-damp of the mine, and its victims are far more numerous than those from the other causes. One volume of marsh gas, on exploding, forms an equal volume of carbonic acid, and this carbonic acid alone will fatally vitiate ten times its own volume of good air.

The cause of the much greater fatality of carbonic acid in accidents will be seen from the following considerations. It has previously been stated that air containing 30 per cent. of marsh gas may be breathed for some time without injurious effects. On the other hand, air containing 3 per cent. of carbonic acid would speedily extinguish life. Now, suppose 1,000 cubic feet of an explosive mixture of marsh gas and air to be ignited, this mixture would contain about 10 per cent. (or 100 cubic feet) of marsh gas, which would form, when burnt, the same volume of carbonic acid, if measured at the same temperature; the volume of the aqueous vapour formed may be left out of consideration, as after the first expansion it immediately condenses to liquid water; but the whole of the oxygen contained in the original 1,000 cubic feet will have passed into combination as carbonic acid and water. Consequently, we have, in addition to the 100 cubic feet of carbonic acid, about 700 cubic feet of nitrogen, which formed a part of the original air; this nitrogen would be as unbreathable as the carbonic acid, and would produce immediate suffocation; that is to say, starting before explosion, with 900 cubic feet of air and 100 cubic feet of marsh gas, a mixture which is perfectly respirable, after explosion, we have 100 cubic feet of carbonic acid and about 700 cubic feet of nitrogen, a mixture absolutely fatal to life, and not only so, but a mixture which would require to be diluted with about 8 to 10 times its volume of fresh air to render it capable of supporting life at all. In this way the after-effects of an explosion may be most disastrous at places far removed from the locality in which the first ignition took place, seeing that the products of the combustion will pass onwards with the ventilating current vitiating it to the extent mentioned. Probably many lives might be saved in some accidents by a complete stoppage of the ventilation for a short period, as the air existing in places which have not suffered from the immediate explosion would be sufficient to allow the men time to reach the bottom of the shaft, or other place of safety. It is frequently recorded that, in this very endeavour, the workmen are overtaken by the current of fatally-charged air and become victims to its effects.

In underground mining, next to the proper supply of air, artificial light is necessary for the prosecution of the work. It would appear that lamps and candles were in use for this purpose in the very earliest mines, as in some of the old disused workings of such mines which have been discovered, ancient forms of lamps have been found, many of them being of earthenware. In England, candles have been more generally adopted; and where naked lights are used, candles form at the present time the great source of light to the miner. The absolute amount of light required in a coal mine is not great. In the absolute darkness of a pit the eyes are more sensitive to a small amount of light, and it is remarkable how much may be done with an exceedingly faint glimmer of illumination. The frequent explosions from the use of naked lights in early times, before any other form of illumination was introduced, led to the abandonment of dangerous workings, the coal being only obtained from those portions of the pit where tolerable immunity from danger existed. In cases where it was necessary to work in such places, various expedients were adopted. At one time higher wages were paid to those men who could work most successfully in total darkness, and it is stated that in some mines the phosphorescent light emitted by decomposing fish was utilised for the purposes of illumination, and in others smouldering tinder or amadou (a dried vegetable fungus) was employed; but in the bulk of the English coal pits candles were invariably used, the candles being supplied by the miners themselves. By their constant use, a considerable amount of expertness was arrived at by the workmen in recognising the presence of fire-damp. A candle flame in an explosive atmosphere, or in an atmosphere becoming explosive, is exceedingly sensitive in its appearance, and under ordinary circumstances will indicate the presence of fire-damp long before its amount becomes dangerous. In intelligent hands, a candle flame will recognise the presence of about 3 per cent. of fire damp, a quantity far below a dangerous amount; the effect is seen by the formation of a bluish halo round the top of the flame. At the time when no other light was used but naked candles, even in the worst mines, it was usual for workmen to do, with much more risk, very much like what is done now by a fireman with his "Davy"—namely, to go round the workings before the men entered them, and ascertain by an observation of his candle flame the safety or otherwise of the various places. The dangerous limit of an explosive atmosphere is ever shifting its position, and extreme caution is necessary when carrying a naked light.

In the early part of the 18th century Sir James Lowther made the observation that fire-damp was not ignited by the sparks from a flint and steel, and a Mr. Spedding, of Whitehaven, shortly afterwards sought to apply this fact practically by an invention called the steel mill, in which a piece of flint was pressed against a rapidly revolving steel disc, thereby producing a stream of sparks; these sparks gave out a certain amount of light, never very great, equal to about one-half the light given by one miner's candle. The steel mill requires a man or boy to work it, and the expense of keeping so many of them going was great. It is stated that in one colliery near Newcastle, during the time the steel mills were being used, the expense incurred for maintaining them was £30 per fortnight. This expense and the feeble light might have been put up with, had the apparatus been safe; but, not long after its introduction it was proved that, under certain circumstances, the sparks from the mill would inflame the fire-damp.

In the early part of the present century, fire-damp explosions succeeded each other with such frequency that very serious attention was given to the subject, in order to obtain some form of light which could be used in a dangerous pit with some approximation to safety. A committee was formed in the northern districts with this view, and the subject was brought before various scientific men. In 1813, Dr. Clanny introduced a lamp in which a flame was kept burning out of free contact with atmospheric air, the air being supplied to the lamp through a layer of water by means of a pair of bellows. This apparatus was exceedingly cumbersome and hence impracticable. The matter was brought before Sir H. Davy, at the Royal Institution, in 1815, who at once undertook to investigate the subject. He started with the examination of the properties of fire-damp and the conditions of its explosion (some of these properties have been already stated); the limits of the explosive mixture were also carefully determined.

Davy also found that the temperature necessary for explosion was high, not being brought about by red-hot charcoal or red-hot iron. If carbonic acid or nitrogen was mixed with the explosive mixture, in the proportion of about 14 per cent., the power of exploding was lost. Further, if the mixture of fire-damp and air was ignited in a glass tube a quarter of an inch in diameter and 12 inches long, more than one second of time elapsed before the explosion passed to the end of the tube; through tubes one-seventh of an inch in diameter, the mixture could not be exploded when in the open air; metallic tubes were still more successful. Davy considered these effects to point to the conclusion that the effect of the mixture of carbonic acid or nitrogen, or of the tubes was due to the cooling influence which they exerted, and which lowered the temperature below the point at which inflammation could be maintained. This conclusion by a number of further careful experiments was confirmed, and it only remained in some form to apply these facts in the construction of a lamp. The flame of a common oil lamp was surrounded by a system of tubes of a less diameter than that through which the explosion passed. A lamp of this construction was faulty, inasmuch as the light was practically *nil*, and the tubes failed to supply the flame with the necessary amount of air. By reducing the length of the tubes, and decreasing their diameters, Davy says, "I arrived at the conclusion that a metallic tissue, however thin and fine, of which the apertures filled more space than the cooling surface, so as to be permeable to air and light, offered a perfect barrier to explosion from the force being directed between, and the heat communicated to an immense number of surfaces." In this fashion, a flame surrounded with a cylinder of wire gauze, became what has since been called a "safety lamp." The further development of this lamp in the hands vy consisted in the determination of the te fineness of the gauze, which was found to as contained 28 wires, or 784 apertures (the has since been increased) to the square inch; linder of wire gauze was fitted above and an ordinary oil lamp with a wick, the upper the gauze being made double. On plunging lamp into an explosive atmosphere, the in- ble mixture enters the lamp, is ignited, and lamp with a blue flame, which, however, is mmunicated to the external explosive atmo- as the flame cannot penetrate the gauze to the rapid conduction of the heat, the hot which do get through being at a tempera- ir too low for the ignition of the external s. If the lamp be kept continuously in such ure, the gauze will get red-hot, but Davy con- that, even in this state, it was incapable of an explosion. This, however, under certain stances, has since been proved not to be the id safety lamps should never be exposed for gthened period to an explosive atmosphere.

e lamps were rapidly introduced, although to contend with some prejudice, and for a nbounded faith was placed in them, which ared fully by the distinguished discoverer; r, the title "safety lamp," as will be after- pointed out, is misleading. It has often been d, in reference to many discoveries, that two rs have arrived at the same result while g distinct paths; this appears to have been with Davy and George Stephenson. There loubt that previously to 1815 Stephenson ed experiments in one of the northern col- with a lamp which in reality depends upon ne principle as the "Davy," but which ison considered to be due to another— at if a current of an explosive mixture upwards past a flame at a greater rate than losion would proceed downwards, no com- tion of ignition would ensue, which is per- rue, and may be experimentally illustrated; rapidity of draught is not obtained with a burning under ordinary circumstances. In ephenson lamp the air was admitted by a of small tubes situated below the flame; rds these tubes were reduced to small holes plates, a similar set of holes being placed op of the lamp, the body of which was made . Stephenson says:—"My first lamp had a at the top of the lamp, and a tube at the to admit the atmospheric air or fire-damp , to feed the burner or combustion of the I was not aware of the precise quantity d to feed the combustion, but, to know what y was necessary, I had a slide at the bottom rst tube in my lamp to admit such a quantity as might eventually be found necessary to the combustion."

lamp not burning well, it struck me that more tubes in, I should discharge the poi- matter which hung round the flame by ng the air to its external part. . . . . . rds, I altered the lamp so that air was d by three small tubes inserted at the of the lamp, the openings of which were on the outside of the burners, instead of one tude opening directly under the flame. ht that the air would have easier access, effect might be the same if I cut away the of the tubes; and that the flame, if it passed rtures at the top, would not communicate losion to the gas beyond the plate below. ucted a lamp upon this principle, and found holes having been punched very small, the ever passed even through the first plate." on-passage of the flame through the plates ubtedly due to the same cooling effect ex- by Davy; and the two lamps have the same their fundamental principle. In the later f the Stephenson lamp the glass is surrounded ire-gauze cylinder.

the Davy and Stephensonn lamps give but nounts of light. The amounts are—Davy, of a sperm candle, burning 120 grains per Stephenson, about ·15 of a sperm candle, at the same rate.

the introduction of the safety lamp, no ental change has been effected in it. Various have, from time to time, been introduced, which have been tried and found wanting; t forms only have survived, and these are ited at the present time by four patterns, re in general use, according to the district. t is the ordinary Davy, consisting of an oil rrounded with a cylinder of wire gauze, s of double thickness at the upper part; h air enters, and the products of combustion directly through the meshes of the gauze. rly lamps the oil vessel of the lamp had a ening into the air, which was closed by a ug, for the purpose of the fresh supply of as found to be a source of danger, and has all later lamps, abolished, the lamp now o be taken apart in order to be refilled. A ire, working tightly through a tube, and through the bottom of the lamp, serves, , to trim the wick. The Davy lamp of this pattern is exceedingly sensitive to the presence of fire-damp, the indications of the flame being very prompt and delicate; and probably, for the purpose of testing the state of the air, it is the best lamp.

The second form of lamp is the so-called Stephenson lamp, in which the flame is surrounded by a glass chimney within the gauze. The supply of air is obtained through a number of minute apertures in a circular brass plate at the base of the chimney, and the products of combustion issue through somewhat similar perforations at the top. The Stephenson lamp, in explosive atmospheres, is extinguished. In both these lamps the light emitted is very feeble.

The third form is the so-called "Clanny" lamp, a modification on the Davy principle of some points of the original lamp of Dr. Clanny. The wire gauze cylinder is confined to the upper part of the lamp, that part surrounding the flame being of uncovered glass. The ventilation of this lamp forms a beautiful illustration of the action of convection currents. The air has to enter at the top, and descend to the flame, and the products of combustion have to pass up, and escape through the same gauze. If a little smoke be blown into such a lamp while burning, it will be seen that the pure cold air descends at the side of the lamp, turns round at the bottom, and passes to the flame, the hot gases formed pass up in a central column, and escape at the top of the lamp. This lamp necessarily gives more light than either of the former; there is, however, the danger of breakage of the glass. This danger is not by any means so serious as it might at first sight appear, if the glass has been carefully annealed; for, should a crack occur, the opening so produced is usually far less in area than one of the apertures in the wire gauze.

These three lamps are largely used in England; the Stephenson, however, is not found generally out of the northern districts.

The fourth lamp is the Mueseler, a Belgian lamp, the use of which is compulsory in the Belgian pits, in which safety lamps have to be employed. In the above-mentioned Clanny lamp the combustion is not quite perfect, as the supply of air to the flame is apt to be interfered with by the passage through the gauze of currents of air; this is overcome in the Mueseler lamp—which essentially is very much the same as a "Clanny"—by the introduction of a metal chimney above the flame, and enclosed within the wire gauze. The top of the lamp is also separated from the bottom by a horizontal piece of wire gauze placed at the base of the chimney; this causes a more perfect division of the descending and ascending columns of air, and at all times brings the pure air directly to the flame; in this way a steadier and better light is obtained. In the case of any safety lamp care and caution must be exercised in its use—otherwise it will be a mere trap, giving a false notion of security.

MEASURING THE BRIGHTNESS OF STARS.

WE are indebted to the *New York Tribune* for the following abstract of a paper read by Prof. Pickering at the meeting of the American Academy of Sciences. The paper was entitled "Photometric Comparison of the Components of Close Double Stars." It has become generally recognised that systematic errors are of graver importance in astronomy than accidental errors. In the work now done at Harvard Observatory no pains are spared to eliminate errers of the former kind. It is not easy to observe with accuracy the difference in brightness between the components of double stars. If an artificial star be used for determining the magnitudes it confuses the observer by its unlikeness to real stars. To remedy this, after the artificial star has been compared with a real one, the latter is used for a new comparison. It is found that the eye does not, in the beginning of an evening's observations, attain its highest sensitiveness. After doing its best work it again loses power towards the end of the observations, because of fatigue. A want of sensitiveness is one of the most serious sources of visual error.

Prof. Pickering has devised an instrument for the special purpose of comparing the components of double stars. The images are separated by a Nicoll's prism, and there are various contrivances for preventing error. But, even with this double-star photometer, many precautions must be taken to get the best results, and care is especially needed respecting the personal peculiarities of the observer. A chart is in preparation at Harvard of all the double stars north of 40° latitude; at present this work is about half done, 90 stars having been finished and reported upon, requiring 4,000 observations. The probable error in this work is less than the tenth of a magnitude. A star in Cassiopeia gave a great deal of trouble; the discrepancy in the observations upon it at times amounted to half a magnitude; eventually a faint companion was discovered, which accounted for the changes. It was long suspected that Gamma Ceti's companion shines by reflected light. This was a matter of great interest, as no planet has yet been recognised outside of the solar system. The test is, of course, the polarisation of light. After forty or fifty observations the Gamma Ceti case was determined to be no exception to the general rule. A special research to obtain a quantitative estimate of the difference of light in coloured double stars has yielded unexpectedly uniform results from different observers, and shows that such stars yield abundant light, notwithstanding their colour. The companion of Sirius is estimated to be of about the ninth magnitude. Investigations to ascertain whether its light is reflected or not are as yet uncompleted. The working of the double-star photometer is very satisfactory.

Prof. Peters agreed in the opinion that systematic errors are the most to be dreaded. He thought the instrument and methods described were well calculated to avoid them. There is liability to frequent deception in seeing companion stars that do not exist, and Prof. Peters has occasionally been temporarily misled by telescopic ghosts. A good way to obtain an additional number of observations at comparatively small cost is to have them made with both eyes, separately; and they are then found to differ about as much as when taken by different observers in the usual way. In the experience of Prof. Peters, the left-eye observations prove better than the right. In the discussion which followed, Prof. Pickering stated that their photometric estimates made the companion of Sirius of only a ten-thousandth part of the brightness that Sirius has; but if the companion shines by reflected light it might appear different from the other stars in having a disc, and might even show phases like the moon. Prof. Newcomb said that when observing the companion of Sirius he had often thought he perceived a peculiarity of shape, as if its diameter was greater one way than the other. Prof. Hall said that in his very numerous observations of that companion he had never perceived any elongation of its shape, or, in fact, anything different from other stars of like size. Prof. Alexander referred to the supposed changes of colour in Sirius, and said that in the time of Ptolemy it was a ruddy or sub-red star, probably like Aldebaran. It is now of the purest white. Prof. Peters said that the references to the colour of Sirius among ancient writers are much fewer than has been supposed. The passage in Ptolemy where Sirius is referred to as "the ruddy" may, it is supposed, have been a copyist's mistake, the Greek word used being not unlike the word for Sirius. The error was propagated by the Arabians, who repeated this mistaken designation. Prof. Peters thinks the evidence is very questionable about the alleged change of colour.

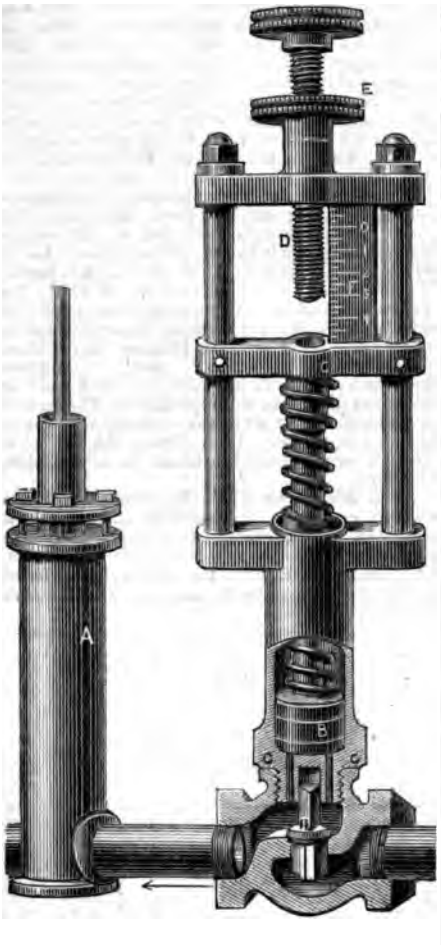
At a later hour Prof. Pickering described the method employed for observing faint objects and satellites. The apparatus used for double stars will not answer the purpose where the companion is exceedingly faint. Prof. Pickering exhibited a table of the preliminary results obtained with four satellites as follows:—

	Phobos.	Hyperion.	Oberon.	Titania.
Diameter, miles	5·8	270	601	595
Probable error mean miles... ...	·3	11	31	20
Average deviation each comparison	·9	54	83	74
Average deviation one reading ...	·6	19	36	41
Diameter primary	4,200	70,500	31,700	31,700
Diameter primary in seconds ...	·25	18	4	4
Diameter satellite in seconds ...	·034	·076	·074	·075
Probable error...	·002	·003	·003	·004
Diff. mag. primary and satellite ...	11·03	12·3	8·6	8·6
Probable error of magnitude ...	·05	·04	·05	·03
Number of sittings	·72	75	85	110

FEED REGULATING APPARATUS.

THE feed regulator shown in the annexed engraving is intended to insure the pump working full of water, whatever quantity may be required by the boiler. According to the *Scientific American* it is the invention of Mr. H. S. Maxim, Coal and Iron Exchange, New York, who contrived it for use in his small and fast steam yachts. A is the ordinary form of feed pump, the discharge valve being on the left and not shown. The regulating apparatus is placed on the right between pump and suction valve. It consists of a cylinder of the same volume as that of the pump in which works the air-tight piston, B. The stem of this piston passes up through the guide-piece, C, and is surrounded by a coiled spring which keeps it down. On the upper part of the device is a screw, D, which may be adjusted so as to limit the upward movement of the piston-rod when the piston is raised against the action of the coiled spring. On said screw is a binding nut E, and beside it is placed a graduated scale F, whereby the screw may be set to limit the movement of the rod or stem at any point, as, for instance, at one-half, one-third, or one-quarter the total possible travel of the piston in the cylinder. Beneath the piston are two apertures or channels, G, and between them is a recess in which plays the stem of the valve, H, which is seated in a horizontal partition in its casing, as shown.

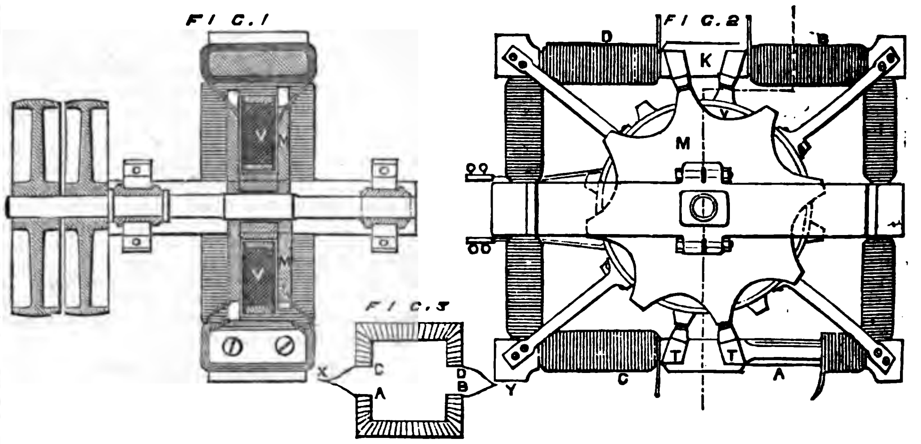
Supposing, for example, the screw, D, is brought down so as to prevent any motion of the piston, B. Then, when the pump makes an upstroke, water will be drawn through the valve, H, and the latter closing in the down stroke of the pump, all the water drawn into the pump barrel will be forced on into the boiler. This is the ordinary condition of affairs with the regulating device being rendered inoperative. Now suppose the screw, D, moved up to 0, so that the piston, B, has full play. The upstroke of the pump draws in water through valve, H, as before, but on the down stroke the conditions are altogether different from before. The water will, as a matter of course, pass in the direction where it meets the least resistance, and it must either enter the boiler against the pressure, or it must lift the piston, B, and enter the barrel of the regulator. Now, the strength of the coiled spring in the latter is so adjusted as to make it easier to raise the piston against it, than for the water to pass to the boiler. Hence the contents of the pump barrel will flow into the regulator barrel and fill the same, the piston rising. Consequently no water would enter the boiler, and there would simply be an oscillation of the fluid alternately from pump to regulator, and regulator to pump, as the latter continued in operation. This brings us to the third condition—namely, suppose the screw, D, to be moved partially down, say to 3, as in our engraving. Obviously, then, the piston, B, will be permitted to rise only one-fourth of its stroke; only one-fourth of the contents of the pump barrel can, therefore, enter the regulator cylinder, and the remaining three-fourths must go on to the boiler.



It will be clear that we have simply to adjust the screw, D, and secure it by the binding nut so that no jar can displace it, to reduce the quantity of water delivered by the pump by any desired fraction. One very important advantage claimed for this invention is the facility with which the discharge of the pump may be ascertained. A glance at the movement of the piston-rod indicates whether the pump is or is not working. Should the water supply stop, the motion ceases. The contact of rod and screw makes a slight click like that of a telegraph sounder, the cessation of which would attract attention to any failure of supply.

JABLOCHKOFF'S DYNAMO-ELECTRIC MACHINES.

AMONGST recent improvements of the dynamo-electric machine, the device patented by M. Jablochkoff is worthy of notice. In this form, which is illustrated in the engravings, a short bobbin of coiled insulated wire is placed between two soft iron cheeks or discs, which are fixed on a soft iron shaft that passes through the heart of the bobbin, and the shaft and cheeks are caused to revolve, the coil either remaining stationary or revolving with them as required. In order that the principle on which this machine acts may be understood, suppose an electric current is passed through the coil, each of the cheeks will then become magnetic, one pole, north or south, being presented at the circumference of the one and at the centre of the other disc, and the opposite pole being presented at the centre of the former and at the circumference of the latter. The two discs thus magnetised being united at their centres by the soft iron shaft, the whole would form a magnet having a north or south pole at the circumference of the one disc, and the opposite pole at the circumference of the other. Conversely, when the two cheeks are magnetised so as to have polarity of the kind just mentioned, and when this polarity is alternated, then the central coil has currents of alternate direction induced in it. For thus magnetising the cheeks the following arrangement is employed:—Notches are cut in their peripheries so that they present a series of projections or teeth like those of a toothed wheel, and they are fixed on their common axis so that each tooth of the one directly faces a space between adjoining teeth of the other. They are caused to revolve in front of the poles of stationary magnets or electro-magnets, so arranged that as the cheeks revolve their projecting parts or teeth successively pass opposite poles of these magnets, and thus the alternating polarity required is induced upon them, and corresponding currents are induced in the central coil. When electro-magnets are used as the stationary inducing magnets, they are rendered active either by a separate battery or magneto-electric machine producing alternating currents, or by currents from the central coil itself, for which purpose suitable branches are attached to the conductors leading to and from that coil. The machine operating in this manner produces alternating currents, but it may by slight modification be made to produce currents of constant direction, a commutator being for that purpose applied to the central coil or its conductors. When the machine is required to be of considerable power, its dimensions may be increased, or preferably several sets of cheeks may be fixed on one driving shaft with their appropriate bobbins and magnets, the latter arrangement being convenient as it affords means of producing electricity either of considerable tension or in considerable quantity, as may be desired. In the drawings, Fig. 1 represents a longitudinal section taken in the dotted line shown in Fig. 2, which is a front view. A, B, and C, D, are two powerful electro-magnets having cast-iron bores. Their poles are separated by pieces K, K, of brass or copper; T, T, are soft iron armatures; V is the bobbin of coiled insulated wire which is kept stationary; and M, M, are the two notched cheeks or discs, which revolve with the shaft, one on each side of the bobbin. In order to excite the magnets A, B, and C, D, any known source of electric power may be employed, or a small machine producing alternating currents; or the alternating currents produced from the machine itself, in which case the cores of the electro-magnets are preferably made of iron or steel, or hardened iron. These magnets are, in the first place, excited by a strong current giving the extremities A and D of the same polarity, and B and C the opposite polarity, and being in hard iron or steel they retain the magnetism. On causing the shaft with the cheeks, M, M, to revolve, alternating currents are produced in the coil, V, which, being led through the coils of the magnets, as shown by the diagram, Fig. 3, produce the following results:—The current, in flowing from X to Y, divides into the two branches. Half the current would increase the force of the poles, A, B, and the other half would diminish that of C, D. But this diminution is scarcely sensible, the previous magnetic force being retained by induction from the opposite poles, and this magnetism causing resistance in the line, so as to reduce the amount of electrical force passing by it. When the current passes from Y to Z the conditions are inverted. Thus the patentee is enabled to reinforce both magnets by means of the alternating currents without changing their polarity. The alternating currents produced by the machine above described may be deviated by any known commutator so as to give currents of one direction at each terminal. Also by means of such commutator continuous currents may be transmitted through the coils of the electro-magnets, which in that case should have soft iron cores. The shaft in Fig. 1 is carried in bearings, and is fitted with fast and loose pulleys for driving the apparatus by a steam or gas-engine.



THE LATHE.—VII.

By Fred. Hoffmann, Engineer.

IN many classes of work where it is necessary to turn anything to an irregular outline a template is often so fastened to a slide-rest that the point of the tool must follow its shape, to which it is held against by a heavy weight, as in Fig. 1, where by feeding the screw the underneath slide travels along the spindle, while the weight, which works over the pulley by a cord, keeps the top slide with its nose close to the template. In turning any small work, such as handles, the best way is to rough out by using both handles, and running a high speed, and finish with a water tool, and a slow

g. 2 shows a ratchet feed, and Fig. 3
consisting of an eccentric on the
lle, and an adjusting nut on the
dle it moves. The chain passes over
pulleys overhead. The weight may
ı, with a wrought-iron ring or hook

Of course, every ratchet must be
to feed the tool both ways. This is
ratchet illustrated by taking off the
het (first unhooking the weight and
putting it on with its back to the
designing teeth of ratchets the work-
of a tooth must not be in a line
ntre, or be near to it, or the paul
ver the teeth, Fig. 4. This is the
it is better to use these kinds of
a ratchet of the form of Fig. 5.
ethod of feed is by using a star feed.
the form of a star without any rim
one of its spokes by a pin on the
every time it comes round. The only
s forging the star. This feed is
l in turning steel, which, it is un-
:o state, is always a slow process.
me to perhaps the most important
t a lathe—setting the tools. Many
sons why a tool will not cut fast
he fault is generally attributed to
eing out of truth, the strap not being
gh, or the speed too slow or too high;
ck in turning is so to arrange the
eed that the lathe will have as little
ssible. Let us first consider what the
that are caused in turning. Fig. 6
e in which a great deal of the strain
he length of the tool, and Fig. 7
tool offers an immense amount of
to the lathe, and the tool has a
tilt up. Fig. 8 shows a case in
spindle that is being turned rides
int of the tool, turning on the point
l as a centre. It is a general
suppose that the point of the
be somewhere about the centre;
y referring to Fig. 9, we see that
would cut a shaft very well at a
eter would, on turning it down, be
table, as the point would not come
work at all. For this reason, in
ds, where there are several different
to be cut with the same tool, it is
e the tool made so as to cut at the
hen the packing under the tool need
anged. The principle of turning
e same as that of planing or other-
g off layers of metal: the thinner
edge the less power is needed, and
turning is so to set the tool that
innest possible edge the tool will
ff. Now, a tool will not break if
f the cut comes along the length
but if the strain comes at all on the
ool it will break it, and therefore
be taken not to grind the tool, as

If the tool is too far from the rest,
nt thin and weak, the tool will dig
ork, and take the point off. This
plies equally to all spring tools,
ld not be above the centre, as they
arly liable to dig in. This principle
ps, be understood better by refe-
tool-box of a planing machine. It
wn that if the tool is in front of the
ot, the point of the tool will dig in,
1. Now, a difficulty is often found
spindles parallel: the tool should
up, and then down again, not fall
nd care should be taken that the
own nuts of the top rest are tight,
may slip away from its work. The
applies to such work as truing-up
r in cross traversing of any kind.
—or at least one reason—that the
taken first up, and then down, is
the wear of the tool. Sometimes a
in. off the edge, which would, of
ke a difference of $\frac{1}{16}$in. in the
f the shaft. Suppose, again, we
rn a taper shaft, and that we begin
lest end. Now, the more the tool
the deeper it digs in; so that it will
t when the tool has been slided
is, supposing the rest true with the
s), the shaft will be tapered the

This shows that it is better, if
t *to turn in steps*, but to take it all
ut from the commencement. Practically, it is rather a hard thing to *finish* a spindle or shaft of any length with the tool, on account of the difficulty of getting the rest true, the wear of the tool and the knots or hard places in the iron, and the shaft bending in the middle, or between the stays, more particularly as, in order not to leave any ridges on the surface, such as would be left by a quick feed, it is necessary to use a broad tool and a slow feed. If filing is carefully done, it will leave a shaft as true as can be done by a water tool. One seldom sees a shaft roughed out that does not show some steel veins, which, of course, produce jarring in the tool.

FIG. 1

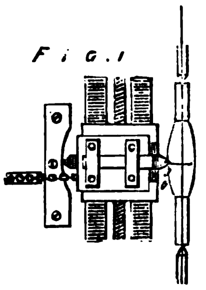


FIG. 2

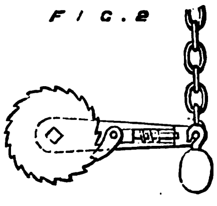


FIG. 3

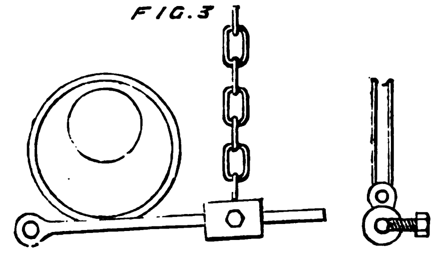


FIG. 4

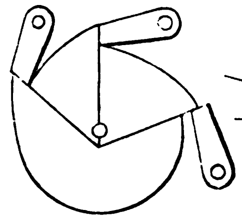


FIG. 5

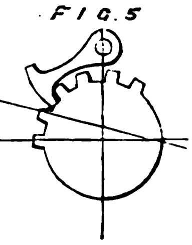


FIG. 6

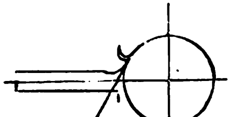


FIG. 7

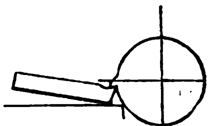


FIG. 8

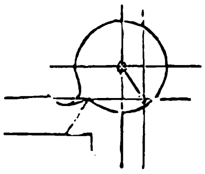


FIG. 9

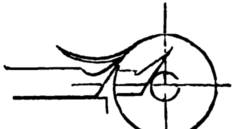


FIG. 10

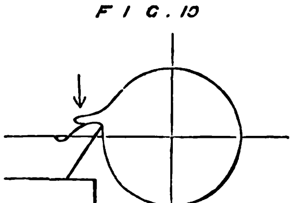
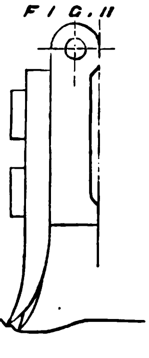


FIG. 11



MILLING MACHINES.[*]

By Prof. J. E. Sweet.

MILLING machines, or machines operating rotary cutters, have grown up on the reverse principles to those of the boring machine. That is, instead of the machines being modifications of the ordinary tools, they were built originally for special work, as gear cutting, gun work, &c., but their utility for all classes of work has become so well known that now they are high up in the list of machines deemed necessary in shops of very moderate pretensions.

A rotary cutter has its advantages and disadvantages. As a simple cutting tool it is costly to make and keep in order; and for doing plain work that can be done in the lathe or sharpening machine its economy is doubtful. But the cutter, when made, possesses a number of cutting edges which will do a large amount of work before they get dull, and which are hence especially fitted for producing irregular forms. It would seem that it ought to be possible to use a higher cutting speed with a rotary cutter than is possible in a lathe; for the cutting edges are in action only about one-eighth of the time, but as there are always some of the teeth in action the body of the cutter is heated up about as fast as if only one cutting edge was in constant action; so the speed of cut cannot much exceed that of the single tool.

There is a great diversity of practice in regard to the number of teeth in the cutters, which must be of necessity partially owing to the size and kind of materials operated upon, and mainly because of the difference in the stability of the machines. If the machine is frail and the work light, a fine tooth-cutter is necessary. If the machine is absolutely rigid and the work firm then a cutter of either few or many teeth can be used.

It is desirable to use a coarse-toothed cutter when possible: first, because it can be sharpened without drawing the temper; and, second, because every cutting edge can then be made to cut, and so work faster. When there are too many cutting edges a part of them are sure to slide over without cutting, thus dulling and burnishing down the metal, making it all the harder for the following cutting edge. In work of an irregular form, but not such as requires absolute size (such as the grooves in a tap or a reamer), the cutter can be ground by hand on an emery wheel or a dry grindstone, without any other requirement than experience; but for work requiring absolute accuracy the cutter should be formed like Brown and Sharpe's cutters for cutting tooth wheels, so that they can be sharpened by grinding the face without changing the form. Many times in the making of cutters for a single job, or for a special job where there is but little to do, much time and money are uselessly wasted by making the cutter as complete as would be possible for a standard tool. Often a four, three, two, or even a one tooth cutter can be made, and the job finished in less time than it would take to make a complete circular mill. Tempering cutters, so as to maintain their truth, is not a job that every smith can do; and with a cutter of one to four teeth, each tooth can be tempered separately, and the danger from springing avoided. A two or more tooth cutter sprung in tempering is sure to cut wider than itself, but a single tooth cannot. Cutters made to cut upon their end exclusively should have but few teeth; two, three, or four are likely to give better satisfaction than more.

Cotter cutting—that is, making round-ended mortises or cutting channels for keys and feathers, is a sort of milling, though usually done on a special machine; the tool generally used is two-toothed or two-lipped.

A similar tool extended in size may be used in the milling machine for facing work, and, from the fact that this tool is cheaply made and kept sharp, it can, I think, be worked as profitably on flat surfaces as a cylindrical cutter.

The standard American milling machines bear a close resemblance to each other, and the Brown and Sharpe Universal machine is certainly a fair, or more than fair example. The larger sized machines are supplied with back gear, giving greater driving power, and the outer end of the mandrel has a movable support. The defect in all the machines is their lack of rigidity, and the move that will improve them, if they can be improved, is that which will make them more rigid. A short block working on a long slide, or a long slide working in a short block, is all wrong. All the sliding surfaces should be of equal length. And, as a milling machine is the worst of all machine tools to keep clean, the sliding surfaces should be protected as far as possible. The great distance from the feed-screw to the work is the worst feature about the machine. It is impossible to work machinery in that way and prevent springing, and springing is not only bad on account of producing bad work, but is the cause of dulling and breaking the cutters. The feed-screw ought to play through a stationary bracket, working horizontally 2in. or 3in. below the main spindle, and so as to strike directly against the work itself or the vice, chuck, or other device in which it is held. That is, the screw to drive the work, and the work to actuate the slide, instead of the screw driving both the slide and the work secured to it. Next, the feed-screw ought to be provided with an open nut as much as a lathe should. It is a waste of time, this having to "crank back." This arrangement avoids all the complicated mechanism for driving the feed-screw, although, on the other hand, it is not applicable to a Universal machine or to one for cutting spiral work. But for all plane milling, gear cutting, &c., this positive motion feed-screw would be far superior to the present stilted arrangement.

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[*] From the Polytechnic Review.

For a Universal machine, or one where the feed can be turned round a central point for cutting spirals, placing the elevating screw directly beneath the turning point, and operating the feed by bevel gearing, driving telescopic sleeves around the lifting screw obviates the complication of feed works usually encountered on the different standard machines.

The arrangement for working both the vertical and the cross motions by one handle on the Brown and Sharpe machine is a piece of misapplied ingenuity or economy. Too many mistakes have been made in our experience, by getting the crank on the wrong stem, for the results to challenge our admiration.

Index circles on the screws for moving the slides to scale are great conveniences; and if the feed-slide was graduated or fixed to read off the movements in like manner it would be an additional convenience. Besides, the feed-slide ought to be provided with a binding screw conveniently located for making it fast in any position.

IS THE BRAIN A PHONOGRAPH?

SPEAKING recently at the Society of Telegraph Engineers, Dr. C. W. Siemens "ventured to draw an analogy between the action of the phonograph and the action of the brain in the exercise of memory," and in *Nature*, for May 30, he enlarges upon his speculation to the extent of making his reasoning clear enough to submit it to the critical test. All impressions received by us from without, either through the tympanum of the ear, the retina of the eye, or through the sensitive nerves of the skin, are, it is generally believed by physiologists, communicated to corpuscular bodies in the brain, which lie imbedded in a grey substance, the nature and precise function of which have not yet been fully explained. It would appear that the corpuscular bodies in which the sensitive nerves terminate are connected, through the medium of extremely delicate filaments, with the nervous system of volition, the reaction of the one system upon the other being attributable to mental energy. It may be conceived that any fresh impressions received on the extremely complex sensitive network of the brain may give rise, then and there, to acts of volition; but how, it may be asked, can acts of volition arise from impressions that were communicated through the sensitive nerves years before, having been committed in the meantime to what we term the memory? But in order that the mind can deal with an impression previously received it seems necessary that it must have the power of reproducing the same from some material record by which the impression has been rendered permanent. Take the case of a tune that we have heard in early youth and which may not have since recurred to us. By some incident or other that tune and the words connected with it become suddenly revivified in the mind. If the tune had been sung into a phonograph it could have been reproduced at any time by releasing a spring moving the barrel of the instrument; and it seems a fair question to ask whether the grey substance of the brain may not, after all, be something analogous to a storehouse of phonographic impressions representing the accumulated treasure of our knowledge and experience, to be called into requisition by the directing power of the mind in turning on, as it were, one barrel or another.

Such a hypothesis might possibly serve also to explain how in sleep, when the directing power of the mind is not active, a local disturbance in the nervous system may turn on one or more phonographic barrels at a time, and thus produce the confused images of dreamland! A powerful mind would exercise a complete control over the innumerable barrels constituting our store of knowledge, whereas in a weak mind the impressions of the past would be brought back into evidence in a confused and irregular manner. Such a supposition might also account for the more vivid recollection of impressions received in early life, when the mechanical record stored up in the brain may be supposed to have been more distinctly and indelibly rendered. In speaking of these impressions as phonographic it does not follow that they were originally conveyed through the tympanum of the ear. Mr. Willoughby Smith, at the meeting above referred to, called attention to the fact that, by substituting crystalline selenium for carbon in the microphone, a ray of sunlight directed upon the selenium produces a noise comparable with that produced by a Nasmyth hammer; and it is quite feasible that the impressions received through the retina of the eye, and the nervous system generally, would be equally susceptible of being recorded in the cerebral storehouse. The record itself might be supposed to be of a mechanical, or, more probably, of a molecular character, the one thing important being that it must be material. These observations are, no doubt, extremely crude, but may serve possibly to direct the attention of physiologists to a point of interest to their science; nor would it be the first occasion on which a phenomenon of inanimate nature had revealed the secrets of animate organisation.

THE ELECTRIC LIGHT AT THE ENGINEERS' SOIREE.

AT the soirée of the Institution of Civil Engineers, held last week at South Kensington Museum, the most interesting and important, and certainly the most attractive object shown was, says *Engineering*, the illumination of the gardens of the Horticultural Society and adjacent buildings, by the electric light produced by Siemens' dynamo-electric machines. The machines and engine were placed in the ground lying to the east of the gardens and between them and the Exhibition-road, and the lamps were fixed one at each end of the terrace above the eastern corridor overlooking the Horticultural Gardens, being connected to the machines by conducting cables. The effect of the pure white illumination by the electric light was very beautiful. It must have struck everybody that the green of the grass and foliage brought out under its rays was exceptionally pure and brilliant, testifying to the fact, still more conclusively shown by a comparison of the solar and electric spectra, that the electric light is far purer and a more perfect white than even the sun itself. In the solar spectrum there are thousands of black lines which are not found in the spectrum of the electric arc, and each of these black lines represents a definite colour in the electric light, which is wanting in the light of the sun. From these considerations, therefore, if among the objects shone upon there be some whose physical properties cause them to reflect those colours which are represented by dark lines peculiar to the spectrum of the sun, it follows that they would appear more brilliant in colour when illuminated by electric than by solar light; and as in that part of the spectrum whose range of refrangibility constitutes the green rays, there is a very large percentage of black lines not to be seen in the electrical spectrum, the exceptional brilliancy of the foliage may be easily accounted for. But another cause is also present. We noticed that in order to increase the conductivity of the carbon "wicks," their surfaces have been coated by the electro-plate process with a thin film of metallic copper, and this becoming volatilised as the carbons were consumed, would throw a large proportion of green rays into the electric arc, and so would help to bring out the colour of green objects with greater brilliancy; but inasmuch as reds and colours belonging to the red end of the spectrum were not destroyed in the proportion that the greens were enhanced, we are inclined to attribute the phenomenon chiefly to the cause first mentioned.

Dr. C. W. Siemens exhibited also another application of the dynamo-electric machine—namely, the transmission of mechanical power to a distance by means of electricity. It is well known that any dynamo or magneto-electric machine is perfectly reversible, and becomes an electro-magnetic engine when it is coupled to another dynamo machine or other source of electricity, and in that case it is driven in the reverse direction to that in which it would be turned if used as an electro-motor itself. On the occasion to which we refer one of the smallest-size Siemens machines was placed in circuit with a large machine through a long conducting cable, and connected by belting to the smaller machine, on which was a small Appold centrifugal pump. Upon placing the small Siemens machine in circuit, it started off at full speed, lifting water from a tank to a height of 10ft., absorbing an indicated horse-power of 3·75. One of the most interesting experiments with this machine was suddenly to throw it into circuit, when it started off instantly at full speed, apparently taking no time whatever to get up its velocity; the moment the wire touched the terminal it ran away, notwithstanding the work put upon it by the pump.

Action of Light on Selenium.—M. Forssman, who has been making investigations into the action of variously coloured lights on the galvanic conductivity of selenium, concludes that it is not the light vibrations or certain kinds of them that produce variations of conductive resistance, but vibrations of another order, which he thinks have neither lighting, heating, or chemical action. This, it is thought, may open the road to further researches to discover whether this hypothesis be true, as, if so, its verification would be of high scientific importance, and amount practically to the revelation of a new mode of motion.

SCIENTIFIC NEWS.

AT the meeting of the Royal Society of Edinburgh, held on June 3, Messrs Bow and Blyth presented two communications on telephony, the one dealing with the splitting up of the electric current as detected by the telephone and the founding thereon of a sounder to act as a call-bell, and the other detailing the results of some experiments with the telephone and microphone. Mr. Blyth's experiments revealed the fact that the microphone of Prof. Hughes could be used as a receiver as well as a transmitter. If some mistake has not been made, that should be a valuable discovery.

The report of Colonel Yolland on the fatal accident to Sir F. Goldsmid should effectively settle the question of continuous footboards. The short iron steps are always dangerous, and are little better than traps for the unwary in frosty weather, but besides those defects, they are simply murderous appliances in the event of a passenger being so unfortunate as to slip and fall near the carriages while a train is in motion. A continuous footboard might push him out of the way, but these simple steps act as so many choppers, and if the passenger does not fall between the platform and the wheels, he is fearfully mangled by the repeated blows of these chopping irons. The Board of Trade must insist that all platforms should be of one height, for there is no reason why a passenger should be required to climb into a carriage, when the companies can easily study both the comfort and the safety of their patrons by making the platforms level with the floor of the carriages. They must be compelled to render continuous footboards inoperative, or else to provide that safeguard on all their rolling stock. It is satisfactory to learn that the London and South Western Company is taking steps to remedy the evil, but it is a sad reflection on the skill of railway engineers, that several accidents should have been required before they could appreciate the danger.

A memorial to Lord Beaconsfield having failed to obtain any recognition of the services of Mr. Thomas Craddock, an appeal has been made to the engineering profession. Mr. Craddock has done a great deal to improve the steam engine; he has devoted nearly all his life and all his means to develop the prime mover of British industry, and now at the age of sixty-eight, having lost his right arm and everything except his character, he finds himself in straitened circumstances. Messrs. F. J. Bramwell, J. Brunlees, G. R. Stephenson, Sir W. Thomson, Dr. W. Pole, E. Woods, E. J. Reed, Lieut.-Col. Manby, 'and many other well-known engineers recommended his case, and Messrs. H. and R. Powell, 17, Bayswater-terrace, W., will receive subscriptions. If Mr. Craddock had only written a book or two he would have received a pension, but he has done a great deal more than that, and the Government cannot assist him.

Sir George Airy, Astronomer Royal, has been elected a foreign associate of the Dutch Academy of Sciences. Rather late.

The death is announced of Baron von Ettinghausen in his eighty-second year.

The *Gardeners' Chronicle* says that the potato disease has already made its appearance in more than one locality. There is no doubt that the old "curl" is one of the phases of the same disease.

The *Sydney Mail* announces that Mr. Swan, of Newcastle, N.S.W., has discovered that a simple form of string telephone will enable deaf people to hear and to distinguish voices. A looped string attached to a flexible membrane stretched over the end of a cylinder cut from an old tin can, passed around the forehead and over the hands of the listener—the hands being pressed against the ears—will enable the deaf to hear words spoken near the open end of the can.

Prof. Osborne Reynolds, alluding to the collision between the König Wilhelm and the Grosser Kurfürst, points out that it was a fatal error to reverse the engines of the former. The question has, it will be remembered, engrossed much of his attention, and the result of his xperiments has demonstrated that a screw-ropelled vessel loses all power of steering when the screw is reversed, until suffiient time has elapsed for the vessel to gather ay in the reverse direction. It is proved eyond a doubt that to reverse the screw is to se all power of steering for a time.

Sir W. Armstrong's jointed gun has passed hrough the series of firing tests, and has been dopted for service. The gun unscrews into hree parts, and is thus easily transported on he backs of mules. When the pieces are crewed together it forms a powerful longange gun, perfectly gas-tight at the joints.

New lead-squirting machinery for the manuacture, by hydraulic pressure, of rods for converting into rifle bullets is being erected at Woolwich Arsenal.

A Beluga or white whale has been safely odged in the Aquarium at Westminster, but t is a moot question whether it is more cruel o confine such an animal in such a place, or to vivisect it for the purposes of so-called science.

M. Mouchot, the inventor of a successful form of sun-engine, has presented to the Paris Academy an account of his experiments with t in various parts of Algeria. In that country he has demonstrated that solar heat can be tilised for cooking food, baking bread, and distilling alcohol, besides furnishing the motive power for machinery.

An extraordinary statement is made by *Galignani*—viz., that M. Duclaux, Professor of Sciences at Lyons, has discovered a method of hatching silkworm eggs at will. If, when the eggs are not more than two or three days old, they are rubbed with a brush, subjected to the action of electricity, dipped for half a minute in concentrated sulphuric acid, or chlorhydric, nitric, acetic, or tartaric acids, they will hatch out, and as the mulberry is in full leaf two crops of worms are thus obtained in one season. Immersion for a few seconds in water heated to 122° Fahr. is said to be equally efficacious. The worms from the artificial hatching are said to be hardier than those reared in the ordinary manner.

An accident in a match manufactory, in which a girl's clothing caught fire, and she was badly burnt, lately induced M. Sieborath, of Dresden, to experiment upon impregnation of articles of clothing. Saturation with 5 or 10 per cent. alum solution gave no good results; the stuffs burnt with a flame after the impregnation, which, moreover, spoiled their appearance. On the other hand, a 5 per cent. solution of phosphate of ammonia proved quite successful; the impregnated clothes did not burn with flame, but were merely destroyed by carbonisation. Lastly, a solution containing 5 per cent. alum and 5 per cent. phosphate of ammonia was tried on linen and woollen stuffs. Here, too, there was no burning. The stuffs treated with phosphate of ammonia did not even burn when they had before been vigorously rubbed with gunpowder. The powder flashed, but left the stuff unconsumed. The cost of saturation is estimated at about 2·5 mark per garment (say 2s.). The clothes may lose their incombustibility by getting wet or being washed. It is a disadvantage that they can only be worn in certain places, and that, after washing, they necessitate the expense of a fresh impregnation.

Carl Vogt's notorious "secretion simile," in which, many years ago, he characterised the activities of the mind as mere functions of the brain substance, and said that "thoughts stood in much the same relation to the brain as gall to the liver or urine to the kidneys," attracted a good deal of notice in Germany and elsewhere at the time. It is interesting to find, as Dr. Berthold has recently pointed out in the Berlin Academy, that an idea of this kind is traceable back to the time of Frederick the Great. The materialism of that time put forward audacious hypotheses, which Frederick treated with severe scorn. In a letter regarding them to Voltaire, of 4th December, 1775, he wrote: "From these comparisons between meditation and digestion, between the formation of ideas and the generation of animals, the distance is short to the comparison of thought with the bile, the blood, the chyle, to that secretion of he brain which has been the last secretion of materialism." A quarter of a century later this idea was enunciated anew by Cabanis.

The following figures we take from *Deutsch Ind. Zeitung*:—The London Exhibition of 1851 numbered 13,917 exhibitors, and was visited during 142 days by 6,099,194 persons; the Paris Exhibition of 1855 had 24,954 exhibitors, was open 200 days, and visited by 5,121,330 persons; the London Exhibition of 1862, 28,650 exhibitors, 176 days, 6,211,103 visitors; the Paris Exhibition of 1867, 50,226 exhibitors, 210 days, 10,200,000 visitors; the Vienna Exhibition of 1873, 42,584 exhibitors, 186 days, 7,254,687 visitors; the Philadelphia Exhibition of 1876, 159 days, and 9,857,625 visitors.

When the pneumogastric nerve of a dog is cut, and the extremities of the nerve are electrified, the respiration and movements of the heart cease for a time, but if the electrification is continued, there is a renewal of both these functions. M. Vulpian has observed that where the animal is previously anæsthetised by sulphuric ether, chloroform, or hydrate of chloral, this revival does not take place, and death occurs from syncope of respiration. He is of opinion that this fact explains many of the fatal cases of anæsthetised persons, in whom the nerves are subject to traumatic excitation (*i.e.*, through a wound) or other irritation.

The Lombardo-Venetian Institute has proposed the following subject for prize competition:—"Expound the rules to which architects must conform, in order to put theatres, halls destined for spectacles, lectures, numerous meetings, &c., in conditions favourable to the uniform diffusion and distinct perception of sounds. The rules relate both to the form of the hall, and to any other expedient that may be thought opportune. The competitors are to base their affirmations both on theoretical precepts, and on the practical results obtained in buildings already constructed; and when these do not suffice to solve the problem completely, they should have recourse to fresh experiments, which must be described with great care." The value of the prize offered is about £125.

The retreat or descent of the flame of a Bunsen burner is prevented by M. Renard (*Chem. Central Blatt*), thus:—"He takes a strip of thin copper sheeting, about a finger's breadth, and 2in. or 3in. long, and having rolled it up doubly or triply, inserts it to the extent of a half in the upper opening of the burner-tube, where it remains by the force of elasticity. He gives the following explanation of the retreat of the flame: The mixture of gas and air coming out of the cylindrical tubes does not escape with the same velocity in all its parts; the outer part, by friction on the wall of the tube is retarded, and has less velocity than the middle part. Hence, arise countercurrents, which, with weak gas-pressure, cause the combustion of the outer parts of the gas mixture to extend downwards. Where the tube is somewhat narrower in its lower part than in its upper, a countercurrent and retreat of the flame occur the more readily. This can be proved by widening the tube from above with a file. Thus is explained the action of the sheet cylinder. It narrows the opening of the combustion-tube, so that the gas current escapes in all parts with the same velocity, and the counterflow is compensated. Platinum may be used instead of copper, where a flame is desired to be free from volatile copper compounds.

The *Scientific American* of June 1, contains an account, with illustration, of a gyroscope driven by electricity (the device of Mr. Geo. Hopkins). The movement is thus rendered continuous, and can be more easily studied. The principle appears similar to that applied in Edison's electric pen. The same number has an interesting paper on "meddlers in arts, in which they are not skilled"—a class that Mr. Raymond lately protested (in the U.S. Committee on patents) against giving patents to. It is a notable fact, of which such names as Whitney, McCormack, Fulton, James Watt, Howe, Bessemer, and Bell, supply illustrations, that much of the most important invention has been by "meddlers" of the class Mr. Raymond condemned.

Aliments may be divided into three great categories—fatty substances, feculents, and azotised albumenoid matters. To these three correspond, in the human system, three ferments, which have received the names of pancreatine, diastase, and pepsine. All the forms of dyspepsia may be attributed to bad working of the organs charged to elaborate these ferments—viz., the pancreas, the salivary glands, and the stomach respectively. Proceeding on this assumption, M. Tissy (in the French Academy) represents that it is possible and useful to associate these ferments which are all soluble in water, slightly alcoholised, and to administer them at meal time in suitable doses, so as to ensure integrity of digestion. He has, it appears, subjected the liquor in question to long clinical experimentation.

Gastuch, or gas-cloth, is a name given by Dr. Hirzel, of Leipzic, to a gas and water-tight stuff, which he has recently patented. This is produced by placing a large smooth piece of so-called guttapercha paper between two pieces of some not too coarse and dense material—*e.g.*, shirting (undressed)—and then passing the arrangement between heated rollers. The outer pieces of shirting combine in the most intimate way with the enclosed guttapercha to form a material which is impenetrable by gas and water. It may be made still denser and more resistant by being coated on both sides with, *e.g.*, copal lac. The substance is conveniently flexible, and will remain proof against variable influences of weather and external temperature. It can be applied to all those purposes for which waterproof material is used, and it is well adapted to form gas-tight membranes for regulators of pressure of compressed gas, bags or sacks for dry gas-meters, as also dry gas-reservoirs.

An interesting lecture on the prehistoric peoples of central Europe was recently delivered by M. Bertrand, director of the Saint Germain Museum, at the Sorbonne, in Paris. In summing up, he said that Gaul, as far as the Rhine, had, in the prehistoric period, been successively peopled by savage hunters, whose coarse arms of fractured stone have been discovered by Boucher de Perthes; troglodyte shepherds, whose instruments of cut stone, and the drawings (of extraordinary perfection) made on them, were first studied by Lartet; the hierarchically organised population that raised the dolmens; later on, this population was transformed by a first Asiatic immigration, which introduced certain Oriental stones, and afterwards bronze, which characterises the Celtic civilisation; a new layer of Indo-Germans carrying iron is developed to the east of the first; these were the Gaulois and primitive Germans; afterwards their armament is modified as well as their rites; they bury in cemeteries warriors armed with shorter swords; lastly, the incineration of bodies is extended among the Gaulois till Rome subjects them, and transforms them into Gallo-Romans.

Skeleton Leaves.—At a recent meeting of the Scientific Committee of the Royal Horticultural Society Mrs. Cussons, of Southport, exhibited some skeleton leaves, with the following note:—"For the dissection of leaves I find the process of maceration too long and tedious, to say nothing of the uncertainty as to the results; I have therefore adopted the use of alkali in saturated solution, the specimens to be introduced while the liquid is heated to boiling point. The time of immersion to be regulated by the character of the various leaves, and the nature of the epidermis to be removed. When the specimen is freed from epidermis and cellular tissue, it must be subjected to the action of chlorine to destroy the colouring matter. The introduction of peroxide of hydrogen serves not only to render the lace-like specimens purer in colour but preserves it also. In destroying the colouring matter in ferns this also is invaluable; added to the chlorine it gives a solidity to the bleached fronds, and appears to equalise the action of the chlorine. For skeletonising capsules the slow process of maceration by steeping in rain-water is alone available—a moderate heat may be applied to hasten the process, but alkali is useless. The only known flower which can be dissected is the Hydrangea japonica. The fibrous nature of the petals renders it easy to skeletonise in the perfect truss in which it grows. Skeletonised leaves and capsules appear to gain in the process a toughness and durability not possessed by them in their natural state."

SCIENTIFIC SOCIETIES.

ROYAL INSTITUTION.

Minute and Low Forms of Life.

THE Rev. W. H. Dallinger, on Tuesday week, delivered the first of a course of lectures at the Royal Institution, descriptive of the recent researches of Dr. Drysdale and himself. The object of the first lecture was mainly to explain the method of research which had been employed. The first essays of the opticians to produce "high powers" were, as might be expected, feeble. These powers amplified, but did not analyse; hence it began to be questioned whether "one could see more really with a high power than with a moderate one." And this was true at the time. But it is not so now. The optician has risen to the emergency, and provided us with powers of great magnifying capacity which carry an equivalent capacity for analysis. They open up structure in a wonderful way when rightly used. The lecturer began by projecting upon the screen the magnified image of a wasp's sting—an object about the 1-20th of an inch in natural size—and beside it was placed a piece of the point of a cambric sewing needle of the same length, magnified to the same extent. The details of the sting were very delicate and refined, but the minute needle point became riven and torn and blunt under the powerful analysis of the lens, showing what the lecturer meant by "magnifying power;" not mere enlargement, but the bringing out of details infinitely beyond us save through the well-made lens. This was further illustrated by means of the delicate structure of the *Radiolaria*, and still further by means of a rarely-delicate valve of the diatom known as *N. rhomboides*. With a magnification of 600 diameters no structure of any kind was visible; but by gradually using 1,200, 1,800, and 2,400 diameters, it was made manifest how the ultimate structure of this organic atom displayed itself.

But this power of analysis was carried still further by means of the minutest known organic form, *Bacterium termo*. The lecturer had, in connection with Dr. Drysdale, discovered that the movements of this marvellously minute living thing were effected by means of a pair of fine fibres or "flagella." These were so delicate as to be invisible to everything but the most powerful and specially constructed lenses and the most delicate retinas. But since this discovery Dr. Koch, of Germany, had actually photographed the flagella of much larger bacteria, such as *Bacillus subtilis*, and expressed his conviction that the whole group was flagellate. Mr. Dallinger determined then to try to measure the diameter of this minute *flagellum* of *B. termo* that the real power of magnification in our present lenses might be tested. This was a most difficult task, but 200 measurements were made with four different lenses, and the results were for the mean of the first 50 measurements 0 00000489208, for the second 0·00000488673, for the third 0·00000488024, for the fourth 0·00000488200, giving a mean value for the whole, expressed in vulgar fractions, of the 1-204700th of an inch as the diameter of the flagellum of *B. termo*.

With such power of analysis it was manifest that immense results might be expected from a good use of the "highest powers." The proper method of using them was next dwelt on, and then the apparatus was described, by means of which a drop of fluid containing any organism that was being studied might be prevented from evaporating whilst under the scrutiny of the most powerful lenses, and for an indefinite length of time. The importance of studying such organisms in this way—by continuous observation—was then plainly shown, some of the peculiar inferences of Dr. Bastian, as to the transmutation of bacteria into monads, and monads into amoebae, &c., being explained by discontinuity of observation.

Improvements in Bicycles.—Mr. J. Keen has obtained letters patent for an invention which consists in abolishing the back fork and making the continuation of the backbone to the centre of the back wheel in one continuous steel tube without any join. Also in making the axle or pin upon which the hind wheel revolves of a hollow steel tube for the purpose of containing a sufficient quantity of oil to lubricate it for a considerable time.

Improvement in Pianofortes.—Mr. W. G. Eavestaff has obtained a patent for the following improvements. In order that the frames may resist the tension of the strings, they are constructed thus:—For an upright pianoforte a rectangular frame of hard wood is made to correspond in breadth and height to the desired back frame. Parallel bars of wood equal in length to the height of the frame are glued thereto at equal distances apart, the end bars being laid upon the side bars of the frame. Between the ends of the bars filling-in pieces are glued, thus forming a kind of grid frame with a flush surface, to which a second frame made in the same manner is attached by glue. The back frame thus formed is capable of resisting the parallel, cross, and diagonal strains of the most modern arrangement of pianoforte strings.

LETTERS TO THE EDITOR.

[We do not hold ourselves responsible for the opinions of our correspondents. The Editor respectfully requests that all communications should be drawn up as briefly as possible.]

All communications should be addressed to the Editor of the ENGLISH MECHANIC, 31, *Tavistock-street, Covent-garden,* W.C.

All Cheques and Post-office Orders to be made Payable to J. PASSMORE EDWARDS.

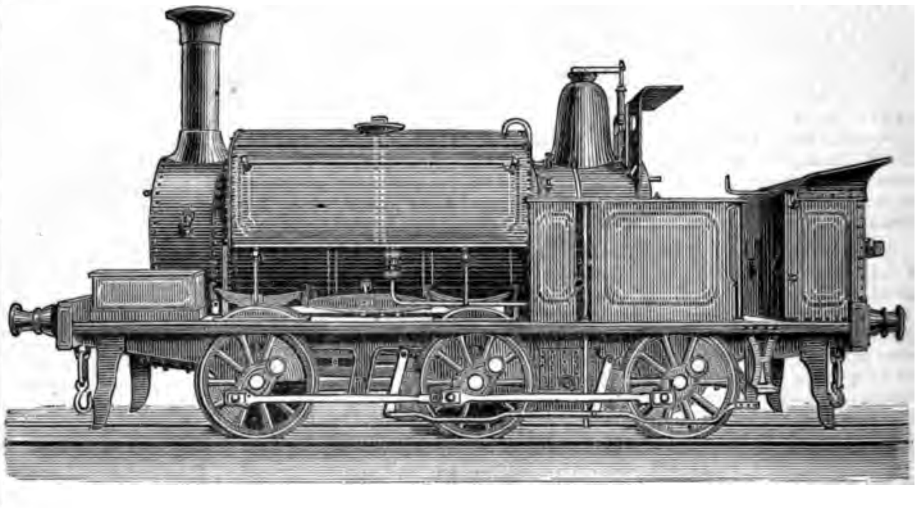
*** *In order to facilitate reference, Correspondents, when speaking of any Letter previously inserted, will oblige by mentioning the number of the Letter, as well as the page on which it appears.*

"I would have everyone write what he knows, and as much as he knows, but no more; and that not in this only, but in all other subjects: For such a person may have some particular knowledge and experience of the nature of such a person or such a fountain, that as to other things, knows no more than what everybody does, and yet, to keep a clutter with this little pittance of his, will undertake to write the whole body of physicks: a vice from whence great inconveniences derive their original." —*Montaigne's Essays.*

TANK LOCOMOTIVES FOR MINERAL LINES.

[14448.]—UPON p. 268 I gave a diagram of a four-wheeled tank-engine, built by Messrs. Fletcher, Jennings, and Co. Within the last fortnight a number of experiments have been made with this engine, and it has given the greatest satisfaction. The accompanying diagram is copied from a photograph of one of the latest six-wheeled tank-engines, built by the Hunslet Engine Company, Leeds, and is so clear that any lengthened description is rendered unnecessary.

This engine is of a powerful type, as it is required to run upon a mineral line, which has unusually severe gradients, over which heavy loads have to be conveyed.



	Ft.	In.
Diameter of cylinders (15)	1	3
Length of stroke (22)	1	10
Diameter of wheels	3	7

Since this engine commenced to run it has been very severely tested upon gradients of 1 in 18, and 1 in 24. The steam brake with which it is fitted works admirably; but I am always of opinion that, when a brake is applied to a coupled engine, brake blocks ought to be fitted to all the coupled wheels.

June 5th. C. E. S.

THE WESTINGHOUSE AUTOMATIC BRAKE — EXPERIMENTS ON THE BRIGHTON RAILWAY.

[14449.]—IN my letter upon p. 170 of the present volume I mentioned the experimental van which was being fitted up at the Brighton works. This van is now completed, and the series of experiments has now commenced. A short description of the apparatus will no doubt prove interesting. The experimental van has been built specially at the Brighton works from the designs of Mr. Stroudley, the locomotive superintendent, and is somewhat similar to a guard's van. The weight complete is 8 tons 1cwt. The Westinghouse automatic brake is fitted to all four wheels, and it is also arranged that it can be applied to one pair only. The apparatus within the van has been specially designed by Mr. Westinghouse, and is most ingenious and complete. It is desired to ascertain what is the strain on the brake hangers, what are the conditions to secure the greatest stopping power, and the maximum frictional resistance between the wheel and the rail.

There are five indicators, three speed measurers, a distance measurer, and a water clock. The brake hangers of one pair of wheels are fixed to two scale beams working on pivots. When the brake is put on, one end of these beams or levers is pushed up, and the other, of course, pulled down. This action compresses shallow cylinders filled with water, and the pressure is registered by two of Richards' indicators. Two other indicators also register the air pressure applying the brake, and the other one shows the pull on the dynamometer. The speed indicator and recorder I need not here describe, as I have fully illustrated the apparatus in Vol. XXV., p. 11.

There are also two of Mr. Stroudley's speed recorders—one driven from each pair of wheels. On Monday, May 27th, this van was tried for the first time. The experimental train left Brighton shortly after noon, and ran to Three Bridges. The engine was Grosvenor, No. 151 (the same one which drew the Brighton train at the Newark brake trials). There were present Mr. Westinghouse, Captain Galton, Mr. Stroudley, Mr. Knight, Mr. Darwin, Mr. Gutch, Mr. Jeffreys, Mr. Reynolds, Mr. Williams, and a party of engineers. The trials were continued the following day, and nearly fifty experiments have been made, and some most important information has been acquired.

For want of time, I shall be unable to give the tracings and the diagrams until a future letter. But I may mention one stop, the quickest ever made.

The engine ran with the van at a speed of 46 miles an hour down a gradient of 1 in 264. The van was "slipped," the brake fully applied to all four wheels, and stopped in 12 seconds, after running only 90 yards, and the wheels were not skidded. Great difference of opinion has always existed as to skidded or unskidded wheels, but the well-known phrase, "No brake can do more than skid the wheels," is almost universally considered to be correct. As your readers are aware, I am of opinion that the wheels should not be skidded. This opinion is based upon a series of experiments made by me about seven years ago with an engine, tender, and train upon an incline, the results obtained being in favour of an unskidded wheel. Theoretical reasons are decidedly in favour of "skidding" the wheels. Why the theory and the practice do not coincide has never been satisfactorily explained, because reliable data could not be obtained with the apparatus in use. This is now no longer the case, as the "experimental van" contains appliances for ascertaining every possible information with regard to the action of brakes, which can be required, either in practice, or as data for the theoretical investigator.

The results of the experiments conclusively prove that an unskidded wheel retarded is a far quicker train-stopper than a skidded wheel.

A strange discovery was also made—that, at the instant of skidding, the friction is reduced upon the rails to a minimum, and that afterwards it gradually increases.

The diagrams show the pencil of the indicator as rising when the brake is put on; then travelling horizontally, the brake was then skidded; when the pencil rises to a great height, and instantly falls very low indeed; then it slowly rises till the end of the stop. Why the friction, after being so far reduced at the moment of skidding, should afterwards increase, and why for a short space of time a skidded wheel slides upon the rails with so little resistance, are questions which cannot yet be explained. A long series of trials will be conducted, and the information obtained will be given by Captain Galton in his paper on "Continuous Brakes," to be read at the meeting of the Institution of Mechanical Engineers to be held at Paris.

C. E. S.

(*To be continued.*)

GLE AND COUPLED ENGINES.

.]—In letter 14433, "W. J. S." states as the Midland who "forced the running" Liverpool and Manchester, doing the 31½ th a 3 minutes' stop at Warrington) in 45 with 6ft. coupled engines. This is a mis- It was the "Cheshire Lines Committee," the Midland have, along with the M. S. L. ., a one third share. It is true, but it was ced by them or with their stock, these aving been run for a considerable time by . and L. Company with their own engines iages, which were plainly marked M. S. and withstanding this, however, it was stated at of the opening (if I remember right) by the Manchester papers, that it was the Mid- npany, and this may have led "W. J. S." For the credit of "ours," however, it is as orrect it. **Finem Respice.**

SPEED TWENTY YEARS AGO.

.]—In my letter on this subject (No. 14038, wo misprints occur which considerably alter ing. Instead of "the steady rise to Potter's miles of which is about 250ft. higher than ross," I wrote "the steady rise to Potter's miles, which [i.e., Potter's Bar] is about gher than King's Cross." Secondly, in the , "some speed was lost up the Welwyn ut rarely went much, if at all, below 50, am was shut off for the Hitchin stop," I 60" instead of "50," intending to convey speed, which had risen slightly above 60 ng down the Hatfield branch, did not fall ow 60 afterwards, even including the pull ert Welwyn bank.

ealand. **C. R. M.**

PROVEMENTS IN BICYCLES.

.]—As readers of the English Mechanic ys pleased to receive notice of any really improvements in connection with machinery no doubt appreciate the following in con- with the construction of the bicycle. I have d one or two of them before, but as I now ittle time to spare, I give a few rough Fig. 1 shows my machine in profile. I given it some eight months' trial, and am no better can be made. The saddle I have ther large—otherwise my sketch is pretty It embodies the following improvements. he wheels are constructed with — spokes to (diameter) and are rendered perfectly rigid of four tensional spokes in the interior of I have descanted on this before, so shall that Fig. 2 shows the arrangement on one the hub, the opposite spokes being so as to cross them as shown by the dotted econd. The head is of Stanley type, but proved in construction. The nuts on the one away with, and the steering is adjusted angement of nuts in the interior somewhat o the "Duplex" steering of the Duplex . Both centres are on the spindle, the e being adjustable for wear as explained find it very rigid and less liable to loosen I have tried. The points of danger on the one away with, and it is beautifully strong Third. The handles are buffalo horn and tly round, like a cricket ball. They are ly comfortable and very unique. Fig. 3 e back of the head-piece, illustrating the mode of adjustment; it also shows the The smaller handles seen below are those ourth novelty, the brake which I fully and roughly illustrated in letter 14369. he pedals are also different from any I erto seen. They consist of four gun- ss arms in one solid piece, through the the longest of which the coned pin runs. nds of the two shorter arms small rat- ootplates are attached, the ends of the ishing with oval end pieces. They are ough one of the shorter arms, which is d fitted with a screw cap for the purpose. nd my feet slip, and the whole concern is and neat. Fig. 4 gives a fair idea of it. treets we have a sixth improvement. The consists of a simple fixed sawedged bracket fitted with a spear-shaped guard or pro- ing which is worked by a small piston and g rod pushed down by the foot when putting rest. It serves to keep the heels out of and answers its purpose well, although rider it is unnecessary. Fig. 5 shows the the guard when down, whilst its appear- n up is seen on the machine (Fig. 1). All the large nuts are fitted with the patent y" washer, with the details of which no t of "ours" are familiar; if not, they e understand that it is a short coil of l very highly tempered and when screwed t by the nut entirely prevent its coming matter how much vibration there is from ds, &c. They are an excellent addition to e, and I have never found my nuts loosen, although I have ridden in one instance over a mile of newly laid stones down hill. Fig. 6 shows the bearings, which I think I have mentioned before: so I will say no more about them than that they run beautifully, although a little stiff at first, and the machine is as free from side shake now as on the day I had it. A represents the axle; B, the fork and bearing clips; C, crank which overlaps the bearing; D, the collar of the hub, which also overlaps the bearing. The dark portion shows the bearing itself, which is a steel cylinder. This drawing is in section. The ninth improvement is found in the step. It is adjustable to any height on the backbone by means of a solid collar to which it is attached, and a split cone of flexible steel apex upwards on the backbone. The step itself is hinged underneath, and so turns with the foot and gives a firm hold all the way round. It is circular with a roughened surface. I have only found it to slip once from its place on the backbone. These are the principal novelties about my machine, and I will mention some more I have lately seen, with my opinion on them at a future time.

FIG. 1

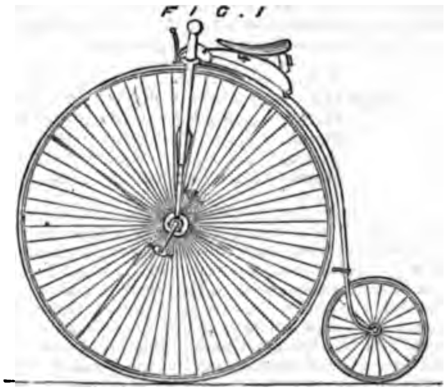


FIG. 2

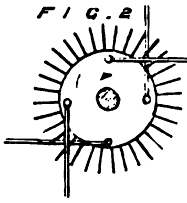


FIG. 3

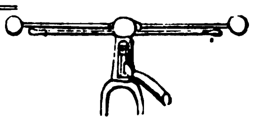


FIG. 4

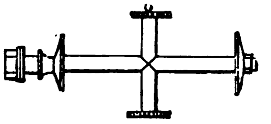


FIG. 5

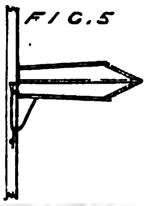
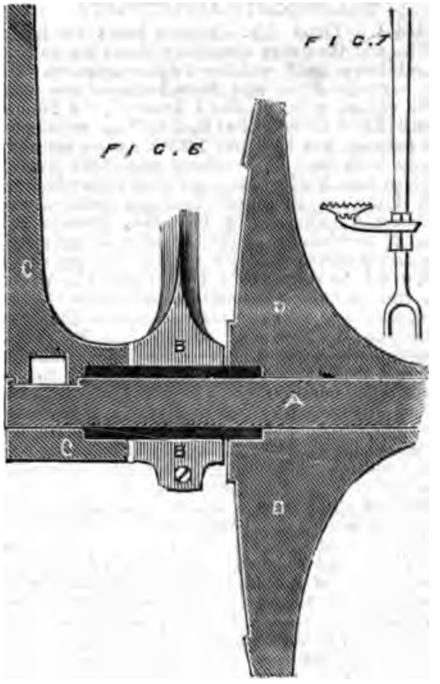


FIG. 7

FIG. 6



In my last letter I am made to say by a printer's error that "X. X." seems to put a great deal of faith in back bearings. It should have been ball bearings. **56in. Superb.**

BICYCLING MATTERS.

[14453.]—In reply to "56in. Superb" (let. 14369), as regards backbones breaking beneath the saddle, I think that is not so much the lightness of it as the pinning and brazing where it is jointed on to the head. Of course, I don't expect very light iron backbones to stand the same as steel ones carefully forged.

I find now that the 54in. which beat the 54in. and 52in. roller bearings was not a "ball-bearings" but plain ones. There was very little difference in weight and none in height of the two 54in. riders. I have now given up the 54 rollers, and have one with double balls, and can now gain only about a dozen yards in a hill half a mile long, leg over the handles. I, too, wear low leather shoes for riding in, but "56 S." must not suppose I recommend braking with the instep for regular use. I mentioned it in case a "brother" should have a runaway steed. I live in a town where the streets are all paved either with large sets or the small granite ones. I guess "56in. S." can imagine any one going down one of our steep streets with a ground brake. I don't intend trying the experiment, wishing to save my neck for elsewhere. I know of one or two very bad "smashes" through the back wheel roller brake cord breaking when descending a hill. Front wheel brakes are generally very noisy on rough roads, and anybody deserves to go over the top if he has not the sense to use them gradually. **X. X.**

[14454.]—With reference to the "Otto Bicycle" (letter 14404), will F. Baker kindly tell us where it may be seen and examined practically? So far as I can glean from his description and drawing I fancy it cannot be nearly so light as the ordinary bicycle—in fact, quite as heavy as many tricyles, as they are now made. There also appears to me to be a lot of complication about it; yet he claims for it "lightness and simplicity." I opine that the room it must necessarily occupy is also an objection to its use, as well as that fault found with tricycles—the having two tracks to select instead of one.

I believe the idea of friction wheels as bearings for bicycles, mentioned by "F. R." (letter 14405), has often been entertained by makers, but abandoned on account of the size and awkwardness of the box to contain them, as well as on account of the extra fitting required.

Mr. F. L. Striffler, in his letter 14406, gives us some account of various novelties, for which I am sure we ought to thank him. Regarding the mode of fixing the saddle he mentions, I find it in the *Bicycle Times* of last week, described as simply consisting of several lengths of half sections of spoke wire soldered across the spring, a series of grooves being cut in the saddle block, so that any of our friends can easily do it for themselves. The saddle of my "Superb," and also of a "Defiance" I have, has never yet slipped, as the surface of the spring is roughened in the same manner as the top of a step; the wood of the saddle block consequently receives a series of corresponding indentations, which make it a matter of equal impossibility for it to slip. In my "Superb" the pedal nuts are entirely prevented from loosening by the use of the Thackray washer mentioned in my last letter. I don't quite understand Mr. Carver's new style of head as mentioned by F. L. Striffler. How is the steering adjusted? Does it in any way resemble the "Superb nutless Stanley head," described and illustrated above?

The detachable and adjustable handle bar I can understand, and was certainly most surprised to find it in use, as I have seen the same idea in this town (Weymouth), being the invention of Mr. G. Downing, who has occasionally given us a practical paper on bicycling matters, and who was just on the point of bringing it out in connection with a well-known firm, when, lo! and behold! we find it is already out. Has Mr. Striffler completed his new roller bearings yet? We are all plainly anxious to have particulars.

56in. Superb.

SUNSPOTS.

[14455.]—Will you allow me to make a slight correction to the statement of "Mac" (letter 14418) concerning the absence of sunspots between the 20th of March and the 21st May? On the 7th April, at 9.20 a.m., a plain spot was seen on the sun, small, and without any penumbra. At 1.5 p.m. it had become much fainter, so that I could hardly see it, and I suspect it disappeared later on in the day. Working after Carrington's method, I made the heliocentric latitude of this spot 6° 43′ S., the longitude 9° 10′.

"I. V. V." (letter 14419) speaks of a group not visible two days before Saturday, June 1st, but I fancy it must have been visible on the 30th, for I saw this group on the 29th and 31st May very plainly. In fact, since the 7th April there have been three sets or groups of spots visible on the sun:—

(1) The solitary spot visible on 7th April.

(2) A group of spots which I saw from the 26th May to the 6th June.

(3) A group of very faint specks seen on 31st May, 2nd and 4th June.

The largest spot in group (2) had a curious appearance on 31st May; there was a dark umbra with bridge of light across it, and a delicately-shaded penumbra round it; this was surrounded by masses of penumbra and specks, which seemed to have a concentric arrangement around the umbra as centre. I was struck by the general circular appearance of this spot, and it suggested to me the idea of circular or vertical motion.

E. E. Markwick.

East Acton, W. June 8.

P. XIV. 212 LIBRÆ.

[14456.—On reading Mr. Burnham's very interesting note on this double star, I examined the original MSS. of Smyth, and found, as I expected, that there was no misprint in the "Cycle" The Admiral, I suppose, concluded that Sir J. Herschel's "B. C." in the 5th Cat. was a misprint for "A. C.," and so measured his star accordingly. He gives, moreover, a charming little diagram of the field, in which the little star, C., appears exactly where he says he measured it, but where it is evident that it could by no possibility have been. He remarks: "C. can only be caught by very occasional glimpses in my refractor." This sort of thing is beginning to be rather unfortunate for the worthy Admiral. I find from Sir J. Herschel's MSS. that he had noted the discrepancy between Smyth's and his own descriptions of this object; but was unable to decide which was correct. I am very glad that Mr. Burnham has pointed out the mistake in the "Cycle," as the star in question is, I think, almost the only 16m. one of Smyth's I have been unable to see easily with my 6½in. reflector. I examined this object on the evenings of May 16th and 17th, 1876, and remember feeling somewhat disgusted at my inability to perceive "C;' this, however, I attributed at the time to the small altitude of the object, and the haziness of the sky near the S. horizon. I saw Mr. Burnham's C. D. E. F., the angles being estimated 175°, 50°, 170°, and 320° respectively; I placed the nearer stars, however, somewhat too close to A., C. being est. at ± 40″ and D. at ± 45″. F. was rated 13m. on the 16th, and 12m. on the 17th (which was somewhat the better night of the two for faint objects), D 16m., and E 15m. On the first night I noted "a faint point 15″ or 20″ *f* ?;" and on the next, "faint point suspected at ± 100° 25″ [from A.]" I should be glad if Mr. Burnham would turn the 18½in. on this object again, and see if any star really does exist in the position of the faint point I suspected, as the observations, though probably illusive, were made quite independently of each other. I may mention that this star, if it exists, is certainly much fainter than the companion to τ Boötis (rated 11·7m. by De, 11·5m. by Σ, and 11½m. by D), or than the star near M. 57, which D'Arrest calls 19m., as I can see both of these objects with ease with 6½in. Herschel, in 1791, says of the principal pair of P. xiv. 212: "Considerably unequal. May 25th. Position *s.p*, but near the parallel". Smyth, in 1837, made a measure of the triple star, 54 Sagittarii (Cycle D.C.C.V.) the two principal components of which he rates at the 5½ and 8th magnitude. One would have supposed that in the case of an easy couple like this, even Admiral Smyth could hardly make any very serious blunder; and yet his measure of the distance of B. is totally erroneous; and, as Smyth's error has even escaped Mr. Webb, and so forms one of the very few mistakes in that most admirable little book, "Celestial Objects," it may be as well, perhaps, to draw attention to it. The error is a characteristic one, being very similar to that which Smyth has committed in the case of δ Cancri, 53 Virginis, 61 Virginis, &c.; and it appears to have been merely by a piece of unusual good fortune that he did not make an equally bad mistake in the position-angles of this star also. The star in question is No. 1,424 of Sir J. Herschel's fourth Catalogue, where it stands thus:—

6, 8 : 13·6° . 25″
6, 18 : 273·0° . 15″

[14m. 5th Cat. "a dot barely perceptible") (MSS.).] It is, however, first mentioned in the second Catalogue as H. 599, and the measures of A. B. are there recorded as 6, 10 : 40° [50° *n f*] . 40″. [1826-58]. Smyth did not notice this, and consequently gives in the "Cycle":—

5½, 8 : 42·8° . 28·5″
5½, 16 : 280·0° . 20 0″ 1837-58

The two principal stars were measured by Jacob in 1845, and Main in 1861. The latter gives:

5½, 7½ : 41·4° . 45·90″ . 1861·73.

So that Smyth's 28·5″ is rather unfortunate. Jacob's distance in 1845·8 is 45·6″. Smyth has fallen into a somewhat similar pitfall in his measures of μ′ Sagittarii.

I have lent the volume containing my notes on some other discrepancies of Smyth's to a friend, and therefore I can only just give the salient points of a few of them here. I do not think these errors have been alluded to before; but I cannot at the present moment be certain about this.

		P.A.		D.	E.
α *Cygni*.	H 1.	90° est.	:	60″ est.	1790·69
	H 1.	90° est.	:	not given	1809·04
	Smyth	102·5°	:	108·5″	1837·65
	Bond i.	88·3°	:	95·5″	1848

		P.A.		D.	E.
O¹ O² *Cygni*.	Σ. (A.D.)	. 323° 41 9′	:	338·0″	. 1835·95
(A.D.)	Smyth.	333·8°	:	387·833″	. 1838·67

This is remarkable, as Smyth *quotes* Struve's measure as 333° 41·9′, with which the Admiral's position-angle agrees to within the *tenth* of a degree. Smyth gives his measure and weight of 9.

		P.A.		D.	E.
54 *Hydræ*.	H 1.	128° 15′	:	11·29″	. 1783-03
	H. S.	136° 40′	:	9·95″	. 1822-87
	Smyth.	138·4°	:	9·8″	· 1831-49
	Secchi.	130 72°	:	8·560″	. 1856-45
	Howe.	129 8°	:	9 68″	. 1876-39

Smyth remarks that Herschel and South's observations show "a considerable direct motion in the elapsed time, which my measures appear to substantiate." He also calls the star "10" Hydræ.

A detailed examination of the errors in that much-vaunted book, the "Cycle of Celestial Objects," would require a volume; but it is sufficiently evident from Mr. Burnham's admirable criticisms that the "rigorous re-examination" of the Bedford Catalogue could have been only a farce. I do not suppose that any one (with, perhaps, the exception of Flammarion) would now attach much importance to an observation of Smyth's having a weight of 1 or 2 assigned to it; but, at first sight, a higher value than this would warrant a considerable trust in the intrinsic accuracy of the measures which the Admiral made, or said he made, of any fairly easy double star. But even this seems doubtful now; at the most one can only borrow the remark of an eminent modern astrometer *à propos* of the measures of a certain contemporary of Smyth's, "Toutefois il faut les employer avec une certaine circonspection, et ne point s'y fier aveuglement;" or, to use the Astronomer Royal's words, in presenting the gold medal of the Astronomical Society to Admiral (then Captain) Smyth, with a slight difference: "I can truly say that if an [*in*] accurate observation were required, I should desire that it should be made by Captain Smyth." (President's Address, 1845.)

June 3rd. **Herbert Sadler.**

TELESCOPIC APERTURES.

[14457.]—Thus Mr. Dennett heads his letter 14334, and then says something about my having been taken in hand, and how Jupiter appeared. Of the correspondents who have honoured me with their notice, only one that I know of, "A Fellow of the Royal Astronomical Society," has written to the purpose, and he (letter 14134) in some measure agrees with me. Some offered what they termed explanations, kindly telling me what I knew before, but I do not remember that any refuted my statements. Considering how Mr. Dennett has himself been handled in the English Mechanic, I am rather surprised at his saying anything about me, and if he reverts to it, I will supply him with a few real, *not sham*, quotations from some of your back numbers, which *ought* to convince him, that "he who lives in a glass house," &c., &c. With regard to the three extracts from Dr. Kitchiner's book, I should say that, if any impartial person reads them, he will conclude that the Dr. would have drawn Jupiter about 1½in. in diameter, that one of his friends would have drawn Jupiter and the Moon of the same size, whatever that might be, and so on; but how closely their drawings of Jupiter, even with the use of a 2¾in. aperture telescope, would have resembled those on page 433, of Vol. XXV., of the English Mechanic, I cannot say.

Mr. Dennett says (let. 13840), "not a slice some 3in.," &c., but when he (letter 12847) divided the lunar power of Mr. Bassnett's object-glass by its diameter, 350 by 5·25, was not this slicing it? Only, fortunately for Mr. B., not in a practical sense. He says it is 67 to the inch, and so it is nearly. Well, five slices of 1in. in width, each bearing a power of 66·66666 times, and one slice of ¼in. in width, bearing a power of 16 66666 times, make together 349·99996 times, equal, very nearly, the linear power of Mr. B.'s object-glass. If he proceeds a step farther, and squares the linear power, and squares the diameter, in inches, of the object glass, and divides the former by the latter, I believe he will get, not the power to the *inch* of aperture, but the power to the 0·785398, nearly, of an inch of aperture —that is to say, if, as is usually the case, the object-glass be a round one. I shall be obliged if Mr. Dennett will give the date of the Vol. I. of Dr. Kitchiner's "Economy of the Eyes," he mentions.

8½in. O.-G.

MICROSCOPY—HISTOLOGICAL OBJECTIVES.

[14458.]—It is not unusual for those wh
unacquainted with the microscope to expres
prise at its power when only 30 diameters are
used. 1½in. gives this, and in histology is
the most useful objectives we can have, the ra
subjects it will take being so extensive. It is
glass with which to begin an examination, w
we can get a comprehensive view as a whole;
a large field of view, and with a binocular
brings out a good stereoscopic effect, this
very evident when a moderately thick injectio
capillary system is examined. For what reas
not know, but am told that a really good 1½i
very difficult combination to make (so als
4·10th); the beauty of this objective is shown
the tubes of a binocular are of a large diamet
also the lenses of the eyepieces. Many micr
are cramped in this respect: we then have
field of view, and, the power being so low, ple
penetration. One that I am acquainted wi
beautiful glass; it has the above power a
angular aperture of 230°, the diameter of th
lens being ½ an inch clear; there is so muc
that on many subjects a condenser is unnec
to show its qualities it should be tried on one
hygrometric urn mosses or the villi of an in
mounted as an opaque object. I have this
from a lion, and it is one of the gems of my c
It differs much from the human, having a mu
of long narrow teats, the surface of whi
covered with a fine network of absorbents.
return. This glass undoubtedly gives me grea
faction, and consequently is quite a favourite
quite as important to be able to display object
a low power with beauty as it is with a high.

We will now come to the next power, w
many respects takes quite a leap. All
scopists are well aware that there are two cl
objectives—those of large angular apertu
those of small—each in their way having
qualities. I wish it to be distinctly underst
I do not run down high-angled glasses, no
that the collar adjustment is only expensive b
I have too great respect for the work of
Andrew Ross to think that he did not know
was about. But the histologist does not w
kind of glass, except in cases where a surfac
ing has to be made out. In addition to de
he wants plenty of penetration, and one qual
not be sacrificed for the sake of the other.
take an ordinary ¼in. power, with which
may have been performed in resolving the n
upon diatoms. This sort of glass is entirel
able for the histologist. It works closely do
the slide, and only transmitted light can
Opaque illumination by a top light is entire
the question. Now, the one I wish spe
refer to is a ¼in. power of a very short and
appearance, bringing the combination clos
the binocular prism. The front has a co
shape, the diameter of the front lens being
of an inch—the combination of lenses front
being only ⅛ of an inch apart. The back le
diameter. The power of this glass is about
meters, and I claim for it especial advantag
histologist. It has no adjustment, and cons
is easy in manipulation. It has plenty of
tion, and there is plenty of working distanc
the shape you can examine well with a
tried on the under side of a leaf of the w
we have the stomata shown up in a marke
Now try it on an ivy leaf, water-cress, a
not forgetting the calceolaria. If we wis
penetration, try it on the tail of a tadpo
some of the thick and clumsy sections we
cut at times, proving that we have one of
suitable powers that could be used.

The next power I would draw attenti
1-5th with a taper front and capable of a t
nation for surface examinations. How ma
1-5ths can do this? It has an adjustment
ness of glass. The front lens of this is l
the ¼in., being 1-6in., the back lens bein
down to ¼in. diameter, power about 250
I was not aware until I obtained these tap
objectives that such a high power could b
to bear with a top light. Having alw
informed that it could not be done—neither
the high angles generally adopted—I was
kind of glass by the desire to detect adult
tea, working with "Hassall's Adulter
tected," &c. A glass is required that wil
various forms of stomata. This glass
you to take up an examination where the
off. There are many stomata rather
resolve, and we can now bring them u
effect. In fact, for a proper examination
have an objective of this kind, and why
not more of them made I cannot imagine
great desire to try the ⅛ of a similar form
advantage to go as high as possible, othe
also being considered.

I have used a ¼in. power without col
ment, which would work well through a
covering glass, and, when good, is one c
useful forms for general purposes, wha

points may be brought against it in other respects. Certainly, it must have been a glass of this kind that induced "Essex" to say what he did, in which there was some truth, but no one doubts that these glasses would break down in delicate work.

A microscopist's battery of powers should undoubtedly comprise objectives with adjustment and without. A 1-5th from either of our three leading makers although expensive, one being close upon six pounds, is worth all the money in the long run.

I regret to notice that in a leading textbook on "Practical Physiology," just published, no notice whatever is taken of English talent with respect to the manufacture of microscopes. I cannot understand how it is that Englishmen should turn their backs upon their own countrymen. We have to give way in many respects to foreign competition, but surely we can hold our own in the quality of our microscopes. Our opticians are bowing to the professors, producing instruments exactly similar to the extraordinary foreign model, when clearly enough our own are better. English manufacturers can produce quite as cheaply and as good as any foreigner. There is only one exception, and that is with respect to cheap objectives of a high power—say, beyond ⅛, and in this case I am afraid at present we are beaten—the difference being the English optician makes a better glass, and will have a workman's price.

"Essex" (let. 14381)—This is satisfactory to me. I have a ⅛ by A. Ross, date 1857, bought a year ago when I was a diatomaniac, which entirely "gets over me." As to adjustment, although I am well acquainted with the process, yet I have been advised by two undoubted authorities not to part with it on account of its excellence. Truly we have grains of reason for our complaints. I thank "Diatomaniac" for the hint.

Theo Izod.

MR. DENNETT'S CAUTION TO YOUNG OBSERVERS.

[14459.]—In Mr. Dennett's letter (14390), speaking of depressions appearing sometimes as hillocks, and vice versâ, he appears to me to attribute the fact to a wrong cause. I have long been familiar with it, and as I have been using none but the same set of eyepieces it cannot be caused by my being unaccustomed to them. Moreover, the phenomenon is by no means confined to lunar objects; I have observed it for many years with terrestrial objects viewed with no eyepieces at all—*e.g.*, in buildings and furniture I have seen cornices which were convex appear so plainly concave that I could hardly satisfy myself that they were not really so. I cannot explain the cause, but I have always thought it must be possible to explain it by some optical law. On the moon, the angle at which the light strikes the object, or is reflected from it to our eye, must have something to do with it, I should think, for the appearance varies curiously. I could give instances where at one time I have distinctly seen an object as a circular concavity, and at other times, perhaps in the next lunation, I have equally distinctly seen it as a convex hill. I do not ever remember noticing the change from night to night. If we could catch it in the act, so to speak, it would be more possible perhaps to fix upon the angle of light necessary to cause one or the other appearance. I should think, however, our optical friends must be able to explain it for us.

Brickwall.

ADVICE TO PHONOGRAPH MAKERS.

[14460.]—I am induced by the great number of queries which have lately been addressed to me to offer a few words of advice to those who wish to make a phonograph. The great majority of such persons have probably already made a telephone, and may not unnaturally think that no more care than was sufficient to obtain decent results with this instrument need be bestowed upon the construction of a phonograph. No greater mistake could be made. The most slatternly workman can make a telephone, and, provided that the magnet and the diaphragm are firmly fixed, it matters little what variation is made in the form or arrangement of the several parts. In the phonograph the utmost accuracy of workmanship and the most minute attention to every detail are absolutely indispensable. Without such care the performance of the instrument will not even be indifferent; it probably will refuse to perform at all, or at best will give out nothing more than the low musical note," which more than one correspondent has complained of.

I began my experiments at the beginning of January, being led to do so by a letter from "Asor," which was published in this journal. I continued these experiments almost without intermission up to the middle of April, devoting the greater part of my spare time to them. During that period I tried literally dozens of diaphragms of different materials and different thicknesses of the same material, dozens of points of various lengths and thicknesses, and ground to various angles and various degrees of sharpness, and dozens of springs bent into many different forms, and varying in size from the hairspring of a watch (which was my first) to a stiff clock mainspring. It was not until I became convinced that it was beyond my power to effect any further improvement that I wrote the article at p. 157 of this vol. That article embodies the results of my experiments, and I think I may safely promise that if any one will slavishly follow the directions therein laid down, paying a scrupulous regard to every detail, he cannot fail to make, with a minimum expenditure of time and trouble, a really good and effective instrument. Of course I do not pretend to say that many of these details may not be varied without ill effects, or possibly even with advantage; but it is extremely difficult, at least for an amateur, to say beforehand what is really material, and an apparently insignificant variation may well be the unsuspected cause of failure. At all events, those who wish to make alterations should be prepared for a long and sometimes disappointing course of experiment.

Where the possible causes of failure are so numerous, it is not easy for me to point out to any individual querist what is the nature of the fault in his instrument. I would say, generally, look carefully over every part of it, see where it differs from mine, alter it and try again. At the same time, I shall always be ready to give all the help I can, and will gladly send a specimen of indented tinfoil, which will be found useful for comparison, to any correspondent who will advertise his address.

Several querists have asked whether one diaphragm will answer as well as two. I have made a very great number of experiments with the object of dispensing with the second diaphragm. Of course, I soon found that if only one diaphragm was to be used the point must not be fixed directly upon it, but upon a spring connected with it. Then I tried many ways of connecting the spring to the diaphragm; first rigidly, then with a spiral steel spring interposed, then joining it with a piece of silk (like the paper diaphragm), and several other ways. The best effects were obtained by making the end of the spring press lightly against the centre of the diaphragm, and interposing a small cylinder of indiarubber. The reproduction was then fair, but not equal to that of the paper diaphragm. I should much like to compare my phonograph side by side with one of Mr. Stroh's beautiful single-diaphragm instruments. I may be unduly prejudiced in favour of my own child, but I am certainly of opinion that it would be found superior both in articulation and fulness of tone. I must admit, however, that the last of Mr. Stroh's phonographs which I saw was much better than the first, and, of course, further improvement is still possible.

I can assure "Wiesendanger" (reply 32998, p. 323) that there is no difficulty in mounting the tinfoil upon a cylinder having eight threads to the inch, even when the thickness of the tinfoil is less than half that recommended. Fourteen threads would be better than eight, because it would enable the tinfoil to take in more words; but it would necessitate finer work and increased accuracy. First-class work would bear 20 threads.

Shelford Bidwell.

THE PILE MICROPHONE.

[14461.]—This instrument differs in several important points from any of the microphones yet made, and I may briefly refer to them before giving more details respecting its manufacture. From my short letter (14409) it will be evident that I have removed a considerable objection to the use of Professor Hughes' microphone in doing entirely without cells in the circuit—in fact the letter of "Wiseaf" (14422) will give a general idea of the instrument. The plate of zinc screwed on the box and the carbon base of microphone form the couple, and having only one thin sheet of blotting paper between them we get rid of the greater part of internal resistance. Again, by making the carbon plate part of the cell and microphone I reduce it to its smallest limits, and a further important factor is found in the fact that the current suffers so little from external resistance before doing its work in the microphone. While working out these improvements I came across a peculiarity which, I think, is highly important, and as soon as I can spare time I intend to devote a few hours to the experimental part of the subject. It is that by well rubbing either of the plates in the microphone the spark between the upper plate and rod is much more intense than when seen between the two terminals from pile. This seems to be due to the peculiar vibratory motion of the carbon, and the point I wish to mention is that by rubbing periodically an interposed carbon block in circuit the spark between carbon points should be so much augmented, and I would suggest to those having (what I have not) time to continue such experiments, that they should follow out this idea with experimental work on a light from 30 to 40 cells, and note whether the rubbing or the vibration of the carbon will augment the brilliancy of the light. Now, the other portions of the pile microphone to which I would call attention are, first, the carbon rod; this should be in unstable equilibrium—in fact, it should be so erect as to nearly fall. This is the arrangement for very minute sounds, and I have just improved this part by a simple addition which renders it much more sensitive—viz., making a deeper depression in the bottom plate, and pouring into the depression a drop of mercury; on this the carbon rod rests, and the most inaudible sounds are rendered disagreeably loud. The carbon rod should rest against a knife edge in upper plate, and the upper plate may be lengthened to obtain best results. The pad of blotting paper may be soaked in a solution of common salt, or in ordinary well water, and even with distilled water, but the sounds produced, although being astonishingly sensitive on a galvanometer, even going so far as reversing the current entirely, yet are scarcely audible. With the addition of a few grains of salt to water the pile microphone develops sounds to a remarkable degree. I have just devised an arrangement for auscultation, but have not time this week to fully describe it. I will endeavour to send diagram and particulars to our next number.

W. J. Lancaster.

THE TELEPHONE—FRICTIONAL ELECTRICITY.

[14462.]—While experimenting with a telephone in April last it occurred to me that it may be sensitive to frictional electricity, and upon allowing the two insulated wires, a few feet long, and which were connected to a single telephone, to rest against the prime conductor of a frictional machine while sparks were drawn, I could distinctly hear every spark so drawn. I continued to experiment in several ways for some time with frictional electricity, and obtained some very remarkable phenomena. I made this fact known at a lecture, on May 2nd last, at the Co-operative Institute, Castle-street, Oxford-street, and a few days previous to that day called at the Meteorological Office, and suggested that in all probability it would form an additional means of observing atmospheric electricity by being connected to a lightning conductor; and I understand that some experiments will be made at the Kew Observatory. I would now suggest that probably the microphone may in some way be employed to advantage, in connection with the arrangement above indicated. I see, on page 263 M. Grenier is, to some degree, on the same track, and cannot help seriously thinking that some very important phenomena are yet to be discovered in this direction.

75, Upper Grange-road, S.E. J. W. Gray.

WALKER'S IMPROVED TELEPHONE.

[14463.]—I was somewhat interested to read in Mr. Walker's note (14408, p. 295) that in his improved telephone the diaphragms are placed at an angle to the axis of the mouthpiece, having directed the attention of telephonists to the probability there is that "the best disposition of a membrane designed to receive aërial impulses is that of a less or greater angle to the resonating cavity in which it is placed, the value of this angle probably depending upon the depth and form, &c., of such cavity."* Pressure of other pursuits has prevented me from experimenting on the matter. If Mr. Walker could, however, give some of his results in this direction they would be alike interesting to the physicist and the physiologist.

Wm Ackroyd.

THE CELTIC BAGPIPES.

[14464.]—Logan, in his "History of Celtic Music and Poetry," says the scale of that national instrument extends from G on second line to A above the staff, and that C and F are sharp, so that its notes are G, A, B, C♯, D, E, F♯, G′, A′. I have lately tried in how far the notes differ from the true diatonic scale of these notes. By means of an Æolian harp with a movable bridge, I easily found a unison to each note as the piper played them in succession, and measuring the vibrating lengths of wire for each note, I obtained the necessary data for computing the pitch of each. The results are given below:—

G♯, the lowest note about correct.
A, the second note also correct (the key note).
B, about two commas too flat.
C♯, about 1½ comma too flat.
D, about 1 comma too sharp.
E, about true.
F♯, about one comma too flat.
G♯, about 1½ comma too flat.
A, about true.

Thus the scale is A major—three sharps, very nearly.

The scale cannot be extended by different modes of blowing, as is done with fife and flute. There are 8 holes in the pipe, giving 40,320 permutations of fingering, the result of which has never yet been published—probably never has been studied completely by any player. I am told that a prevailing spirit of jealousy among the pipers of different regiments prevents a superior player from making known the secrets he may have discovered by which he obtains more truthful music than his competitors. Is it not possible that out of all these 40,320 permutations a mode of fingering may be discovered by which all the above small errors may be corrected or reduced to insensibly small quantities? Perhaps this may meet the eye of some ingenious and truth-loving member of her Majesty's bands of Celtic musicians. The result would be full of interest.

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* *Nature*, for Feb. 21st, p. 330.

J. S.

AMERICAN ORGAN MATTERS.

[14465.]—No doubt a good many general readers of the ENGLISH MECHANIC as well as those more particularly interested in the above subject, were pleased to see "Eleve's" name again. No doubt, either that the last-mentioned part of "our" community observed that since "Eleve" wrote upon American organ matters in 1873, he has added considerably to his stock of knowledge. My object in writing now is to ask him to impart some of it to us.

"Eleve" might very well supplement "Organon's" useful letters by giving a chapter or two on the construction of some of the more elaborate instruments. If I may give a general outline of what I want to know myself, I believe I shall only indicate the class of information required by others, too. I judge so from the correspondence columns. I now address myself to "Eleve." A one-manual instrument: How many rows of vibrators can it successfully accommodate? Supposing three, and sub-bass, what is the best arrangement? Ordinarily it would consist of a 4ft., an 8ft., and a 16ft. set of the same kind of reeds; but there would be plenty of sound, but little variety. Now, variety is one of the chief charms; therefore, how can we get it? Suppose we have a super-octave coupler, we can then dispense with the 4ft. row, and substitute—please tell us what? a set of 8ft unvoiced reeds? (which said reeds are very "brilliant" and quite a change from the others, if nothing better can be said of them). A set of vox humana, which you partly described, or a set of aëoline, which please to describe, as also the reason of their characteristic differences. Tell us what you know of Estey's sub-bass, and if possible how to get a good, round, deep, rolling tone, in contradistinction to a loud tone. Then the pedal attachment, how is that managed? Finally, can you give us a good-sized diagram, in section, of such an instrument as the foregoing, so that a tolerably good amateur mechanic might work from it?

There are several other points on which I (speaking for others as well) am at present hopelessly ignorant—*e.g.*, the cause of the difference of tone in the styles indicated by letters, and by figures in the Mason and Hamlin Co.'s organs. Are the reeds thicker, thinner, broader, or longer, or has the soundboard aught to do with it? I saw an Alexandre organ of 5 rows, sold by public auction the other day, and it had a stop, drawing a set of reeds having a peculiar string-like quality of sound, something similar to the reed stop on a real organ. Do you know anything of it?

In conclusion, I believe that a "comprehensive treatise" on the American organ might well be written in a few chapters, and would help to obtain the "procural and lodgment" of one of these charming little instruments in the homes of many a subscriber to the ENGLISH MECHANIC who never dares hope to possess a real organ.

W. H. Gnikrod.

MUSICAL TONES.

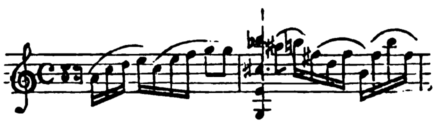
[14466.]—IN letter 14402, p. 293, "G. P." states that certain authorities give the note, D♭, lower than C♯, and desires to be shown how the values of flats and sharps are obtained. I should think it will be found on examination that "G P." has put C and D here instead of B and C, or E and F, because the statement is not strictly true with any of the three values of these symbols that arise in the theory and practice of melody and harmony. (See these values fully deduced, p. 509 of last volume.) There is, however, a fourth value of the same symbols which fulfils the conditions stated by "G. P.;" but this value is used only for analytical purposes by Helmholtz and some other writers. It is not executed by either singers or violinists. That value is $\frac{1}{8}\left(\frac{3}{2}\right)^7 = \frac{2187}{2048}$ = 34·105 in the notation of p. 509, where the full tone C to D = 61·173.

The use of these four values—especially the three largest—by writers, without defining the differences, is a serious cause of stumbling to the readers of their books. Thus, Bosanquet, on page 2 of his book on "Temperament," uses the two values, $\frac{25}{24}$ and $\frac{135}{128}$, without any hint to aid the reader in understanding his meaning. Helmholtz, too, sometimes uses two values, even in the same line, without any intimation of the change. Mr. Ellis, in his translation, however, generally aids the reader by his notes. In Colin Brown's harmonium it will be seen that the round keys are sharper than the white keys adjacent to them on the left by $\frac{25}{24}$; whereas the black keys above and adjacent to the same white keys, are sharper by $\frac{135}{128}$.

On p. 509 these values are shown, both in degrees and logarithms, so as to be easily plotted, for comparison, to any scale we please, or by a simple inspection of the numbers themselves. J. S.

[14467.]—"G. T." has asked a most pertinent and far-reaching question (letter 14402), and the writers on the "Mathematical Theory of Music" would do well to think long before they commit themselves to a reply. "G. T." says: "It is sometimes stated that the vibrations of C sharp are to those of C natural as 25 to 24, and those of D flat to those of D natural as 24 to 25. . . . Will some of your correspondents kindly tell me how the mathematical values of C sharp and D flat are determined?"

Some years ago I tried to draw the attention of the readers of the ENGLISH MECHANIC to the importance of this question, but with very little result. The cut-and-dried ratios of the intervals of the diatonic scale were then beginning to work upon the half-knowledge of readers who became interested in the subject; they admired the short, simple, and suggestive elements of the "Mathematical Theory of Music;" and any question of the truth of this compact and symmetrical formula was received with disfavour; and, now that the subject has attained larger proportions, and we have become familiar with marvellous keyboards, allotting 70 or 80 notes to an interval, where the men of a rude and bygone age (like that of Mozart) were quite satisfied with 12, there seems to be still less likelihood of gaining a patient hearing for the doubts of a sceptical inquirer. However, I must venture, though with bated breath, to repeat these doubts, and to second the question propounded by "G. T."—viz., what is the relative interval of a sharpened or a flattened note expressed in figures?



If our kind Editor will engrave the above passage of old Leclair from a violin suite, I should like to ask our enthusiastic lovers of musical mathematics and symmetry whether they consider the A sharp in this enharmonic change higher or lower in pitch than B flat? With any one who replies "lower" I should decline all argument on a musical subject, as I would with a blind man on a question of colour. To any person who replied "higher" I should have more to say, and a further question to ask. There is, however, a third supposition. It might be replied that the notes are really identical in pitch; the enharmonic change being merely a conventional way which musicians adopt for the purpose of convenient reading, and avoiding too many flats or sharps, as the case may be, when they modulate into a key which requires them; or, in other words, that the change is one only in appearance. I have nothing to say of this last supposition, except to express my firm belief that when a great musician wrote a passage of this kind, making, for instance, in an ascending phrase A sharp follow B flat and precede B natural, he meant the notes to be played as he wrote them, and as any one whose ideas rise above a tempered keyboard would play or sing them.

This question is not a simple or easy one. It is attended with serious consequences. De Morgan saw this; he found it to be a nut too hard for his teeth, and he left it to musicians. It must not be supposed that I wish to depreciate a careful study of the vibrations of the notes of the scale and their ratios; on the contrary, I say let us be as exact as possible—only, before applying your "mathematics," let us have accurate data to begin with.

H. C. K.

A HINT TO PHOTOGRAPHERS.

[14468.]—MANY will remember the unpleasant feeling which came over them when sitting for a portrait. Being told to look at some certain spot they start off well enough, but soon there is a mistiness experienced, and, as a relief, the eyes are gradually opened until a comical stare is obtained, much to the delight of the photographer. Some have a feeling of giddiness and an irresistible desire to give a jerk, and there they sit until tears come into their eyes. All this can be entirely prevented. In the *Lancet* of 20th April last, there is a clever article by Thomas Buzzard, M.D., headed, "A Physiological Hint to Photographers." His plan is to take a piece of paper and draw upon it a circle of about 4in. in diameter, converting it into a sort of clock-face by adding the usual Roman figures in their accustomed places. The paper is to be nailed to a post, and when the sitting begins fix your eyes upon the figure XII., then upon I., II., III., and so on, "all around the clock," the gaze shifting leisurely from one figure to another. By this simple contrivance great relief will be obtained, and it will
enable any one to sit a much longer time w
any sense of fatigue. For children a disc
single aperture towards its edge might be m
revolve in the direction of the hands of a
before another disc prepared with pictures,
one would appear at a time. Theo I

MECHANICAL POWER ON STRE TRAMWAYS.

[14469.]—I AM glad at last to observe th
subject of tramways is being revived in
columns, and cannot help thinking with "Tr
Engineer," that it deserves more attention t
has generally received from correspondents.
that now it has been so energetically broach
this gentleman, it will not so easily escape i
measure of notice.

On the Continent engines for this purpos
been constructed, and experimented upon to
extent, and other makers are now again in th
It would seem, that on the whole there are l
pediments raised abroad against their use t
home, or, at all events, the restrictions as to e
appearances, &c., are less binding.

The most successful thus far, of Continental
seems that of Winterthur, in Switzerland (B
patent), which was lately tried in Berlin
Cologne, with considerable approbation, and
being tested at Hamburg.

Of English make, at least nominally, onl
that of Mr. Hughes, has been tried on the Co
(excepting those of Mr. Merryweather, whic
worked in Paris, and are in regular work at
at Hanover and Cologne, and is now being
mented with at Hamburg. This engine has
according to the newspaper reports, very
satisfaction at the above trials, and I unde
that a number of them are in regular an
manent work at Glasgow and Swansea. B
these types are draught engines—*i.e.*, ada
being employed with any of the ordinary ca
in use, and which type is unquestionably th
suitable.

The Swiss engine is a most handy machine,
all the machinery above the foot-plate, an
easy of access at any point of the journey
power is communicated to the cranked wheels
oscillating lever arranged vertically for each
der. The boiler is a combination of the vertic
horizontal, and steams well. The engine is, ho
not closed in, which might be objectionable o
tramways, but it has, of course, a roof, and th
sides and ends allow of plenty of room for dr
pass all around the engine. Of late an impro
has been made in providing it with a parti
surface) condensation on the roof, so that the
is confined, and partially condensed when p
horses, &c. The Hughes engine is completely
in, being exteriorly like a small tram-car, and
absolute condensation (by water injection),
horses without causing the slightest alarm to

Of the greatest importance in connection w
use of engines is unquestionably that of
line. The ordinary horse trams on wood sl
and of light make, will scarcely prove suffici
hope, therefore, that the discussion in
columns will deal also with this, as also wi
comparative economic working of lines with
and horses.

I notice that "Beaver" has worked out a
of air-surface condensation for these engines,
adheres to the type of combined engine an
which, I think, can have only exceptional c
It would be desirable to learn, in connectio
this, if "Beaver" has experimented upo
amount of condensing surface required to de
a given quantity of steam, and, also, if the
discharged under the furnace grate, as here des
would accelerate or diminish combustion. A
point is, if the water resulting from surface
sation may be regarded as good for feedin
poses. I have heard it stated that, owing
oil, grease, &c., passing over with the stea
the cylinders into the condenser, such water
for feeding, and speedily renders the boiler u

At any rate, there seems to be a number
culties in the way of realising a sufficiently
machine for this purpose, and doubtless a dis
in this journal would lead to their being, at
a large extent, surmounted. I trust, therefo
our friends will come forward with their hel
early attainment of this desirable end.

N.B.—The type of reversing gear describe
227 I have seen applied to a Belgian tramway
system—Vaessen. This engine was also p
with a system of coils immersed in tanks of
for steam condensation. The cylinders (
ones) were seven inches in diameter. The
weight of engine empty 6½ tons, and in
8½ tons, including 134 gallons of water and 6
coke. The boiler (ordinary locomotive ty
provided with a slab or plate of fire brick, pl
edge on back fire-grate girder, to protect tub
Front axle, bogie form, and two main axle
about 3ft. apart from centre to centre. Co
tion of fuel said to be 10½lb. of coke per mil
gallons of water.

Swiss engine is said to consume as little as coke per mile on run of ordinary level lines. cipal dimensions, &c., are—weight empty, 5 in service 6 tons, carrying 140 gallons of n boiler and 100 gallons in tank; diameter of of which there are four, 23¾in.; wheel base, greatest length, 11ft. 9⅜in.; greatest width, n.; greatest height, 10ft. 5½in. Maximum pressure in boiler, 15 kilos per square centi- or 213·4lb. per square inch—the ordinary pressure being 12 kilos. The working cost of 16 hours is put down at 6 francs for ation and interest, 3¼ francs for repairs, 10 for two attendants, 4 1-5 francs for 140 kilos b.) of coke, 3 francs for oil, grease, and , total francs 26 7-10ths or 21-5ths. The s only about 4ft. long in the horizontal por- cluding smoke-box, by 2ft. diameter, the portion being about 6ft. high by 3ft. dia-

ally speaking neither the Belgian nor the d Swiss engine can be said to condense y, although perhaps enough for suburban

A. W. E.

ANALYSIS OF TEA.

).]—WITH reference to Mr. Allen's letter page 316), I may briefly state that tannin and al 26 plus 18 equal 44 is equivalent to tannin 8, and 20 for extractive matter, which was ally omitted. I cannot at present see my make any alteration in the percentage amount and ash as given in my letter, page 192.

llen, as a practical analyst, is doubtless hat the composition of different samples of es very much according to the age of the nd the species of tea-plant from which they ained. The method of cultivation and the f the soil also doubtless have some effect on ntage composition. For instance, caffeine etween the limits of ½ and 6 per cent. in the other constituents similarly vary more

In my table I endeavoured to give the approximate composition of pure tea. Of we analyse the artificial mixtures of tea- t, and sand, or the "Lie-tea" appropriately we obtain remarkable results. However, write further on this subject after I return is, where I go to-night.

ally thank Mr. Allen for his favourable of my letters, and hope he will soon recover al condition, and give us an occasional thout overstraining his energies.

, June 7. **Hugh Clements.**

UNFERMENTED BREAD.

]—THE caution of "Philo" is a timely gh I believe both "A Physician" and my- stress on the necessity of obtaining pure bread-making. The "manufacturing" quote three prices for it:—"Commercial" r 3d.; "pure" at 6d.; and "pure for ' at 1s. Either of the latter will do. I found arsenic in any sample of the "pure," have used a good deal both from London hester. The other impurities to be looked free chlorine, ferric chloride, sulphuric, s, or nitric acids, organic matter; but, if they would be practically harmless in the ntities required in bread-making. By the would "Philo" easily detect or avoid ntities of arsenic in HCl?

ery glad to see by "F.R.A.S.'s" letter 312) that we have his powerful influence le. Might I ask him if he has ever noticed tion in the quality of the aërated bread; he quality (brown or white) is different ined from different depots, or at different

rise for asking "A Physician" an unneces- ion (letter 14266, p. 170), but, judging by e, brown bread by our process really get moister by keeping. On putting it to scales and weights, however, I find, as have expected from analogy, it really r daily. So much for the value of mere

Daghbert.

S FOR WATCHMAKERS AND OTHERS.

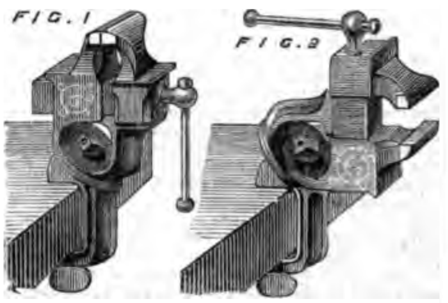
—UNDER the above heading in the ENG- CHANIC, No. 679 (letter 14154, p. 68), ." seeks a reply concerning a statement copied from an American journal relative ing lustre" to tarnished watch wheels. a many occasions had recourse to the troduced by "J. T. M.," with much reply.

ll wheel—watch wheels I specially refer r attached to an arbour with pinion or not, tored to its original brilliant polish by set forth by our contributor, though r of manipulating is not sufficiently set sed as follows: For instance, a duplex en much tarnished, having a piece of re attached to it, and dipped in muriatic acid, and allowed to remain therein not more than one second, and the instant that it is removed therefrom dipped and rinsed in rain water or water that has been boiled, will have the old tarnish removed. Directly it is taken from the rinsing water it must be placed in slaked lime for a minute or two. When removed and brushed, as is usual with such slender pieces, it will be quite clean and bright; not omitting to rub the "crosses," &c., with a pointed peg. Should the pinion have been blued that colour will also disappear with the tarnish.

Seconds' Practical Watchmaker.

AN ADJUSTABLE VICE.

[14473.]—A SHORT time ago I sent you a note on parallel vices, which you were kind enough to print on p. 120; I send now a short description, with illustration of a useful adjustable vice, designed by Mr. W. Stevens, of East Brookfield, Massachusetts. It will seen that the vice is so hung on an angular swivel that the jaws may be placed at any angle of inclination between the vertical and the horizontal, and be made fast in the required position by the screw-bolt shown. The illustration represents a small vice, suitable for attaching temporarily to a bench or table; the larger sizes turn on a cylindrical bearing projecting into the lower plate, the binding-bolt being turned by a wrench beneath the bench. It will be seen that the position can be altered in a very few seconds, and it is the only vice I am acquainted with which can be shifted from the vertical to the horizontal.



Oberhof.

ORGANO SILICON, ORGANO BORON, ORGANO METALLIC COMPOUNDS.

[14474.]—SILICON, like carbon, is a tetrad element, and bears a considerable resemblance to carbon in its chemical behaviour, and in the complexity of the compounds which it forms. Like carbon, it can be obtained in three allotropic forms.

SiH_4 corresponds to CH_4 (methylic hydride), and it is obtained by acting on magnesic silicide by hydrochloric acid, thus: $SiMg_2 + {}_4HCl = 2MgCl_2 + SiH_4$. And we have $SiCl_4$, $SiBr_4$, and SI_4 corresponding to CCl_4, CBr_4, and CI_4.

SiO_2 corresponds to CO_2 occurring in the form of quartz, &c.

Silico-formic acid, HSiOHO, corresponds to HCOHO formic acid, and is obtained by the action of water on silicon chloroform.

Si_2Cl_6, Si_2Br_6, and Si_2I_6 correspond with similar carbon compounds.

And $SiHCl_3$ silicic chloroform and $SiHI_3$ correspond with $CHCl_3$ chloroform.

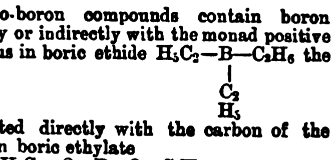
Silicic oxalic acid $(SiOHO)_2$ corresponds with $(COHO)_2$ oxalic acid.

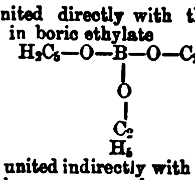
By the action of zinc methide on silicic chloride, at a temperature of about 150° C., silicic methide is obtained thus:—$2ZnMe_2 + SiCl_4 = 2ZnCl_2 + SiMe_4$. It boils at 31° C. Its molecular weight is 88·5, and one litre of the vapour weighs 44·25 criths.

Silicic ethide, $SiEt_4$, is prepared by acting on $SiCl_4$ by zinc ethide, thus:—$2ZnEt_2 + SiCl_4 = 2ZnCl_2 + SiEt_4$. It boils at 153° C. Its molecular weight is 144·5, and one litre of the vapour weighs 72·25 criths. Chlorine can be substituted for one or two atoms of hydrogen, producing siliconylic chloride, $SiEt_3C_2H_4Cl$ and $SiEt_3C_2H_3Cl_2$, which latter, when acted on by potassic acetate and alcohol containing water, produces disilicic oxyethide $(SiEt_3)_2O$.

Silic propionic acid, C_2H_5SiOHO, can be obtained by the following series of actions—viz., $ZnEt_2 + 2SiClEtO_3 = 2SiEt_4O_3$, and $SiEt_4O_3 + 3CH_3COCl = 3CH_3COEtO + SiEtCl_3$, and $SiEtCl_3 + 2OH_2 = EtSiOHO + 3HCl$.

The following are some of the other silican compounds that have been prepared—viz., silicic methylate, $SiMe_4O_4$; silicic dichlorethide, $SiEt_2Cl_2$; silicic chlortriethide, $SiEt_3Cl$; silicic dimethylate diethylate, $SiMe_2O_2Et_2O_2$; silicic triethethylate, $SiEt_4O$; silicic triethohydrate, $SiEt_3HO$; silicic chlortriethylate, $SiClEt_3O_3$; silicic ethylate, $SiEt_4O_4$; and siliconylic alcohol, $SiEt_3C(MeH)HO$, boiling at 120° C., 129°, 144°, 145°, 153°, 154°, 156°, 167°, and 190° respectively.

The organo-boron compounds contain boron united directly or indirectly with the monad positive radicals. Thus in boric ethide  $H_5C_2-\underset{\substack{|\\ C_2\\ H_5}}{B}-C_2H_6$ the boron is united directly with the carbon of the radical, but in boric ethylate



$$H_5C_2-O-\underset{\substack{|\\ O\\ |\\ C_2\\ H_5}}{B}-O-C_2H_5$$

the boron is united indirectly with the carbon atoms. The organo-boron compounds are produced by the monad positive radicals, methyl and ethyl, replacing the methoxyl and ethyoxyl in methylic or ethylic borate.

Boric methide, BMe_3, is prepared by adding boric ether to an etherial solution of zinc methide, thus: $3ZnMe_2 + 2BEto_3 = 3ZnEto_2 + 2BMe_3$. The molecular weight is 56, and one litre of the gas weighs 28 criths. It combines with NH , forming ammonia boric methide, thus: $BMe_3 + NH_3 = BMe_3NH_3$. Although the molecular weight is 73, yet a litre of the vapour weighs only 18·25 criths, one-fourth, instead of 36·5, the half, as is usual.

Hydrochloric or other acids, or cupric chloride, absorbs the ammonia from the compound, leaving the boric methide.

Boric methide burns spontaneously in the atmosphere, and is reduced to a liquid by a pressure of 4 atmospheres at a temperature of 10°C. Its molecular weight is 56, and one litre of the gas weighs 28 criths.

Boric ethide is prepared in the same way as the methide—that is, by the action of zinc ethide on boric ether, thus:—$3ZnEt_2 + 2BEt_3O_3 = 3ZnEt_2O_2 + 2BEt_3$. Its molecular weight is 98, and one litre of the vapour weighs 49 criths. The liquid has a specific gravity of ·7, and boils at 95°C.

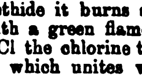
Like the methide it combines with ammonia, forming ammonia boric ethide, which is decomposed in the same way by acids, leaving boric ethide, thus:—$BEt_3NH_3 + HCl = BEt_3 + NH_4Cl$.

Like the methide it burns spontaneously in the atmosphere with a green flame. When heated to 100°C. with HCl the chlorine takes the place of one atom of ethyl, which unites with the hydrogen of the acid, forming ethylic hydride, thus:—$BEt_3 + HCl = EtH + BEt_2Cl$.

Oxygen converts boric ethide into boric binoxyethide, a colourless liquid, thus:—$BEt_3 + O_2 = BEt_3O_2$, which boils at 125°C.

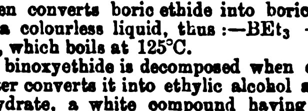
Boric binoxyethide is decomposed when distilled, and water converts it into ethylic alcohol and boric ethodihydrate, a white compound having a very sweet taste—$BEt_3O_2 + 2OH_2 = 2EtHO + BEtHO_2$.

The organometallic bodies contain a metal which is either directly or indirectly united to an organic radical. For instance, in zinc methide the zinc is directly united with the carbon of the radical, thus:



$$H-\underset{\substack{|\\ H}}{\overset{\substack{H\\ |}}{C}}-Zn-\underset{\substack{|\\ H}}{\overset{\substack{H\\ |}}{C}}-H;$$

But in the ethylate the zinc is only indirectly united to the carbon through the oxygen, thus:



$$H-\underset{\substack{|\\ H}}{\overset{\substack{H\\ |}}{C}}-\underset{\substack{|\\ H}}{\overset{\substack{H\\ |}}{C}}-O-Zn-O-\underset{\substack{|\\ H}}{\overset{\substack{H\\ |}}{C}}-\underset{\substack{|\\ H}}{\overset{\substack{H\\ |}}{C}}-H.$$

A monad metallic element, such as sodium, unites with one atom of a radical, say ethyl, thus: NaEt.

A diad combines with two, thus: $ZnEt_2$.

A triad with three, thus: BEt_3.

A tetrad with four, thus: $PbEt_4$.

A pentad with five, thus: $AsEt_4Cl$.

The organometallic compounds may be formed by various methods, viz.: By the displacement of one metal by a more positive one, as mercury by zinc, thus: $HgAy_2 + Zn = ZnAy_2 + Hg$; by the action of a haloid compound of a metal on an organic compound of another metal, thus: $2ZnEt_2 + SnCl_4 = SnEt_4 + 2ZnCl_2$; by the action of a haloid compound of a radical on a metal, or an alloy with K or Na, thus: $2EtI + Zn_2 = ZnI_2 + ZnEt_2$, and $2MeI + SnNa_2 = SnMe_2 + 2NaI$.

Zinc methide, $ZnMe_2$, is obtained by sealing up methyl iodide with sufficient granulated zinc in a glass tube, and heating to a temperature of between 150°C. and 160°C., till the methyl iodide disappears. When the capillary extremity of the tube is broken the methyl escapes as a gas, and the liquid zinc methide may be obtained by distillation in an atmosphere of hydrogen.

Zinc methide is a transparent colourless volatile fluid. The molecular weight is 95, and one litre of the vapour weighs 47·5. The specific gravity of the vapour is 3·3. The odour of this liquid is unbearable. It boils about 55°C., and is dissolved by ether.

In contact with pure oxygen it burns explosively, and in contact with the atmosphere it takes fire spontaneously, burning with a bluish-green flame. It decomposes water, forming methyl hydride and zinc oxide. It is decomposed by chlorine, oxygen, &c.

Zinc ethide, $ZnEt_2$, is obtained by heating to a temperature of about 130°C. ethyl iodide with granulated zinc in a sealed tube for about fifteen or sixteen hours, and the liquid is obtained in the same way as in the case of zinc methide—viz., by distillation in an atmosphere of hydrogen.

Zinc ethide is a transparent colourless liquid. Its molecular weight is 123, and one litre of the vapour weighs 61·5 criths. The specific gravity of the liquid is about 1·2, and it boils at 118° C.

Its odour is not so disagreeable as that of the methide. It takes fire spontaneously in contact with oxygen, burning with a blue flame, forming zinc oxide, but the action is not so violent as in the case of the methide. When the oxidation takes place slowly zinc ethylate is formed. The halogens decompose it with the formation of a zinc and ethyl compound with the halogen, thus:—$ZnEt_2 + 2I_2 = 2EtI + ZnI_2$.

Water also decomposes it thus:—$ZnEt_2 + 2OH_2 = ZnHO_2 + 2EtH$.

It is dissolved by ether. It takes up one or two atoms of oxygen, thus:—$ZnEt_2 + O = ZnEt_2O$ and $ZnEt_2O + O = ZnEtO_3$. With stannic chloride it forms stannic ethyde, thus:—$SnCl_4 + 2ZnEt_2 = SnEt_4 + 2ZnCl_2$.

With silicic chloride it forms silicic ethide, thus:—$SnCl_4 + 2ZnEt_2 = SiEt_4 + 2ZnCl_2$. It forms a phosphine with phosphorous trichloride, thus:—$2PCl_3 + 3ZnEt_2 = 3ZnCl_2 + 2PEt_3$.

Zinc ethide and ammonia form an amide and hydride, thus:—$ZnEt_2 + 2NH_3 = 2EtH + Zn(NH_2)_2$.

When zinc ethide and ethylic oxalate are heated, and water added, ethylic diethoxalate is formed, thus:—$ZnEt_2 + (COEtO)_2 + 2OH_2 = CEt_3OCOHO + EtHO + ZnHO_2$.

It forms with nitric oxide zinc dinitro-ethylate, thus: $ZnEt_2 + 2N_2O_2 = (N_2OEt)_2ZnO''$. With chlorether and ethylchlorether it forms zinc chloride, with ethylochlorether and diethylated ethylic ether, thus: $2(C_2H_4Cl)_2O + ZnEt_2 = 2(C_2H_4)EtC.O + ZnCl_2$ and $2(C_2H_4)_2EtClO + ZnEt_2 = 2(C_2H_4Et)_2O + ZnCl_2$.

Mercury ethide $HgEt_2$ may be obtained by the action of mercuric chloride, $HgCl_2$, on zinc ethide, thus: $ZnEt_2 + HgCl_2 = HgEt_2 + ZnCl_2$, or by the action of zinc ethide on mercuric ethiodide, thus: $ZnEt_2 + 2HgEtI = ZnI_2 + 2HgEt_2$. The mercuric ethiodide is obtained by the action of sunlight on ethylic iodide and mercury, thus: $EtI + Hg = HgEtI$.

Mercury ethide is a colourless, transparent, heavy, inflammable liquid. Its molecular weight is 258, and one litre of the vapour weighs 129 criths. It boils at 160°C. The halogens and acids cause it to lose one-half of its ethyl, thus: $HgEt_2 + HCl = HgEtCl + EtH$.

The following are some of the organic metallic compounds that have been prepared—viz., lithio-mercuric iodide $LiHgEt_3$, lithic-zincic ethide $LiZnEt_3$, sodic zincic ethide $NaZnEt_3$, potassic zincic methide and ethide $KZnMe_3$ and $KZnEt_3$, magnesic ethide $MgEt_2$, zincic methide $ZnMe_2$, zincic ethide $ZnEt_2$, zincic amylide $ZnAy_2$, zincic ethylate $CnEto_2$, mercuric methide $HgMe_2$, mercuric methiodide $HgMeI$, mercuric methchloride $HgMeCl$, mercuric ethide $HgEt_2$, mercuric ethiodide $HgEtI$, mercuric ethchloride $HgEtCl$, mercuric ethnitrate $HgEt(NO_3)$, mercuric amylide $HgAy_2$, mercuric amychloride $HgAyCl$, mercuric amyiodide $HgAyI$, telluric methide $TeMe_2$, stannous methide $SnEt_2$, trimethyl arsine $AsMe_3$, triethyl arsine $AsEt_3$, triethyl phosphine PEt_3, methyl phosphine $PMeH_2$, dimethyl phosphine PMe_2H, ethyl phosphine $PEtH_2$, diethyl phosphine PEt_2H, trimethyl phosphine PMe_3, trimethyl stibine $SbMe_3$, triethyl stibine $SbEt_3$, triamyl stibine $SbAy_3$, triethyl bismuthine $BiEt_3$, cacodylic chloride $ASMe_2Cl$, stannic methide $SnMe_4$, stannic iododrimethide $SnMe_2I_2$, stannic iodotrimethide $SnMe_3I$, hypostannic ethide Sn_2Et_6, stannic ethide $SnEt_4$, stannic diethodimethide $SnEt_2Me_2$, stannic ethodichloride $SnEt_2Cl_2$, stannic ethodiodide $SnEt_2I_2$, stannic triethobromide $SnEt_3Br$, distannic iodo-diethide Sn_2Et_2I, stannic phenyl triethide $SnPhEt_3$, stannic phenoethyldichloride $SnPhEtCl_2$, distannic ethodiiodide $SnEt_4I_2$, plumbic ethide $PbEt_4$, plumbic chlortriethide $PbEt_3Cl$, ethyl phosphoric iodide $PEtH_3I$, diethyl phosphoric zincic iodide $PEt_2H(ZnI)I$, triethyl phosphoric iodide PEt_3HI, tetrethylarsenic chloride $AsEt_4Cl$, triethyl arsenic dichloride $AsEt_3Cl_2$, dimethyl arsenic trichloride $AsMe_2Cl_3$, methyl arsenic tetrachloride $AsMeCl_4$, tetrethyl antimonic hydrate $SbEt_4HO$, antimonic triethoxide $SbEt_3O$, &c. **Hugh Clements.**

GAS ENGINES.

(*Continued from page* 316.)

[14475.]—No. 819 (1877), Richard Hallewell, Blackburn, "Improvements in Gas Motor Engines, and in the Valves of such Engines."—"This invention relates to that class of engines in which there are two pistons and piston rods working in connection with one cylinder, and the invention comprises—firstly, an improved apparatus for momentarily holding or suspending the 'loose' piston and piston-rod in position during the effective or in-stroke of the working piston, which latter is connected by piston-rod to the crank; secondly, to an improved combination and arrangement of shafts and gearing for transmitting the motion from the crank shaft; thirdly, to an improved construction of valve to be used in connection with the gas motor engine referred to, or any other gas motor engine. The rod of the loose piston is taper or wedge-shaped on one side, forming an inclined plane in the direction of the engine. The cylinder is open at the top, and spanned by a bridge-piece, through which the piston-rod works, the aperture in the bridge being of form similar to the shape of the piston-rod. A sliding block-piece mounted on the bridge is actuated so as to wedge and hold the piston-rod, when required, by means of an inclined piece mounted upon a rod worked from the crank shaft of the engine. When the loose piston and rod are to be released the rod and inclined piece are raised by a cam acting upon and lifting the said rod and incline clear of the sliding block above referred to. Motion from the crank shaft is transmitted by gear to a second shaft, on which is the fly or balance-wheel and driving pulley. This arrangement admits of an increased speed, by reason of difference of diameter of the gear wheels, being imparted to the second or driving shaft of the engine. The valve I employ comprises a disc valve seal, communicating with the cylinder, and on the sealing is a disc, having a series of inclined air or gas warp or 'conductors' for supplying air and gas, and for exploding the same, the inclines being formed around the periphery of the disc, on which is the ordinary cover, the latter being held in position by means of a crank and lever, or weight, or spring, an eccentric hand lever being employed for raising the lever, so as to liberate the valve cover, when requisite to remove the latter, the necessity of adjusting and readjusting screws being obviated—the supply of gas to the engine being regulated by governor, as ordinary." The foregoing description applies exclusively to improvements on the Wenham or two-piston atmospheric engine, and seem well calculated to effect the purposes for which they are designed.

No. 1063 (1877), W. R. Lake, "Improvements in Gas Motor Engines," communicated by Joseph Wertheim, of Bornheim, Frankfort-on-the-Main, Germany.—"This invention relates to improvements in gas engines, more especially to further improvements in the engines or machines described in the specification of my former patent, No. 3144 (1876). I have now improved my engine in the following manner. (1.) Instead of setting the communicating pipes in a slanting or inclined position, I dispose them vertically, and thus give the machine a better appearance, and make it more compact and convenient than heretofore. (2.) Instead of the former paddle-wheel used as a power receiver, I apply in this new machine a one simple oscillating paddle. (3.) The power is transmitted to the flywheel through two entirely new arrangements of mechanism—namely, by toothed wheels or gearing and ratchet wheels, or by a spring alternately bent and released, and one ratchet wheel. (4.) Instead of the former arrangement for the expulsion of the combustion waste I use another much simpler construction. (5.) The explosion dome of this new engine is surrounded by a water jacket, and provided with a cooling vessel. (6.) The slide-valve has improvements allowing a more favourable distribution of air and gas at the igniting point of the dome. (7.) The construction of the disc moving the slide-valve is so modified that the working may be noiseless. (8.) The ignitor is modified, especially in the parts for feeding the air. (9.) The regulator is the same as in the former specification, except that the connecting parts are somewhat changed. (10.) The reservoir of this new engine consists of a cylindrical tube, fitted at its end with a cap to prevent the spouting of the water. In my former engine the siphon-like tube is fitted at its bending point with a paddle-wheel inclosed in a case; one part of the siphon supports a small open reservoir—the other supports the explosion dome. The whole apparatus is filled with water. Air and gas mixed in the proper proportion enter the explosion dome; this entrance is regulated by the slide-valve. This mixture is ignited, explodes, and forces the liquid downwards through the paddle-wheel on the other part of the siphon and its reservoir. The *vis viva* of the water is taken up by the paddle-wheel, and transmitted to the main shaft. In one part of the siphon the liquid is carried away by the explosion. By this action, and the following contraction of the combustion, a vacuum is produced. This vacuum causes the water contained in the reservoir to flow back into the explosion dome. The combustion waste reduced to atmospheric pressure does not prevent the ascent of the returning liquid above the level of the water, because, at the proper time, the waste gases are expelled. The rapidly-returning liquid, by means of peculiar mechanism, drives the paddle-wheel. The action above described also takes place in my new engine. The two tubes of the siphon are placed vertically and parallel upon the case containing the oscillating paddle. One of the tubes represents the reservoir, and the other supports the explosion dome. This arrangement is designed to give the machine more stability, and to make it more compendious. Instead of the paddle-wheel used in the former engine, I now only employ one oscillating paddle for receiving and transmitting the power. Upon the box or case the two parallel tubes are screwed. One tube supports the explosion dome, and the other tube forms the reservoir. Both tubes communicate through a suitable channel in the case. The paddle turns around its axle, and nearly closes the channel. The said paddle has two openings; these openings are covered above by a valve, and below by another valve. The first valve is held open by a spring, and pressed against its seal. When the second valve is open the mixed gas enters the dome, a valve in the box is opened by the weight of the liquid, and the latter escapes through the first valve, which is held open by the spring. The following explosion presses the said valve strongly against its seal, the paddle closes the channel, and is moved by the pressure of the explosion gas. When the vacuum in the dome and in the tube is produced the second valve is closed by the atmospheric pressure, and the paddle returns to its first position." The other details of this invention are simply modifications of those described previously in No. 3144 (1876), and the remarks made on that invention apply with equal force to this. Its extreme height and cumbrousness are obvious and heavy disadvantages.

No. 1470 (1877), C. Linford, Abbey Iron Works, Leicester, "Improvements connected with Gas Engines."—"This invention relates to inventions connected with gas engines, and consists, firstly, of an improved design and arrangement of parts for atmospheric gas engines. I use a cylinder wherein are two pistons connected together by suitable rods. In the centre of the cylinder I form a large opening for the admission of air; in this opening I place a crank with a connecting-rod connected to one of the pistons; the pistons are connected together by two suitable rods in any convenient manner. On the crank shaft I fix a flywheel and cams for working the valves for the admission and eduction of the gases, the object being to obtain great power in proportion to the quantity of gas consumed. The cylinder is closed at both ends, but has a large opening in the centre. At the closed end of the cylinder I fix a valve for the escape of the unconsumed gases. This is simply two single-acting cylinders placed opposite each other; the only novelty about it being placing the crank in the centre, the whole arrangement forming a double-acting explosive engine, equivalent in its action and results to the Hugon or Lenoir engines, with the added disadvantage that two cylinders and two pistons are employed to do the work which can be done better in one, as well as a double set of valves and their connections. Secondly, of an improved system of bellows piston for drawing in and expelling the charge. This I do in the following manner: In single-acting atmospheric gas engines where an explosion chamber is used, wherein the working piston does not go, I use a block or piston, attached to which on the under side I fix an indiarubber corrugated ring, which is capable of being closed or distended as may be required. One end of the ring is connected to the bottom side of the block or piston, the other end to base of explosion chamber. The interior of the ring is exposed to water supplied to the explosion chamber. Thirdly, of an improved system of arranging and working the exhaust valves of such engines. They are so arranged that they may be opened at any part of the instroke of atmospheric, and are always closed when the pistons are drawing in an explosive charge. I use a valve generally known as a ventilator, but of peculiar construction. It can be worked by ratchet, pawl, eccentric, or cam. Fourthly, obtaining a vacuum in gas engines. Instead of an air-pump I use a corrugated cylinder of indiarubber, and work it by cam, lever, or eccentric, and thus I obtain a better speed than by an ordinary air-pump without loss by friction or leakage. Fifthly, system of governing. For this purpose I use an ordinary steam-engine governor, acting upon a link arrangement in the connecting-rod of the slide-valve. By the action of the governor upon the link the rod is shortened, but the stroke of the valve remains the same, the position of the valve being altered, so that a less charge of explosive mixture is admitted into the cylinder, the position of firing the charge is much sooner, thereby reducing force of the explosion and decreasing speed of piston, at the same time the governor acts upon a small gasometer in which a definite charge of gas is regulated for supplying the cylinder according to the speed of the engine. Sixth, of an improved piston for gas engines, the object being to prevent leakage in atmospheric engines. I use on the outside of the piston—that is, the part exposed to atmospheric pressure—a hollow indiarubber packing filled with air, and of such a diameter as to fill the cylinder without pressing hard against the sides on the return or inward stroke of the piston; when there will be a partial vacuum behind the piston, the pressure of the atmosphere will be on the hollow ring. The ring will be compressed against the sides of the cylinder to prevent leakage of air by the piston, thereby giving greater power to the aforesaid engine." I am afraid it would be lively times for the indiarubber when in contact with the grease and heat of the cylinder of a gas engine, and most certainly the stickiness of indiarubber vulcanised or unvulcanised, when acted on by animal oil, would not give greater power to the engine. "Seventh, an improved method of working the valves and pistons of the aforesaid engines, also actuating the cams, eccentrics, and wheels. For working the aforesaid valves I use a friction clutch. The clutch has on its face corrugations turned truly to fit into each other, so that by the pressure of a weight or eccentric aforesaid faces are pressed one into the he motion may be given out by fast and eys. with suitable geared wheels."

82 (1877), F. S. Barff, Professor of Che- Kilburn, Middlesex. "Improvements in [Motive] Power."—This invention relates re economical obtainment of motive power iployment of carbonic oxide and hydrogen utes for steam, and it consists—firstly, in g carbonic acid into carbonic oxide by he same through overheated charcoal, r similar decomposing agents, the same tained, and the decomposition effected. ly-arranged apparatus or in such an as is capable of supporting the desired pressure, and in employing as a motive e carbonic oxide gas thus produced, l be found to have an increased volume to bonic acid originally employed. Secondly, g steam at a pressure of about 400lb. to e inch, through or over heated charcoal, r other similar decomposing agents, so as ts decomposition into carbonic oxide and and in the employment of resulting oxide and hydrogen for the purposes of wer. The carbonic oxide or the carbonic hydrogen may then be made to undergo n, and the heat generated may be em- her for maintaining the temperature of the ng apparatus or for other heating pur- ith due deference to Professor Barff, I il to see the economy of the proposed nt, and cannot but think that, if even on the score of economy, the poisonous of carbonic oxide, even when mixed with a ntity of air, renders its use in the hands of e class usually employed to attend to wer engines in the highest degree danger- ay nothing of the high pressure of the is proposed to decompose. It is very very beautiful in theory, but utterly use- ractical invention.

7 (1877), F. W. and W. J. Crossley, ments in Gas Motor Engines. This exclusively relates to improvements con- th the details of the Otto Silent Gas nd are—First. A method supplying and he combustible charge of a gas motor at is to say, making the greatest part of arge consist of uniformly mixed combus- so diluted that its combustion is of a ive character, and igniting the same by an inflamed charge of stronger or less mbustible fluid, projected from a sepa- ber or passage into it so as to come into contact therewith. Second, in a gas ine, supplied with combustible charge in a ove referred to, making the inlet port of the a long narrow passage projecting centrally ody of the cylinder, so as to effect the lete admixture of the fluids composing charge, and to constitute the chamber the strong charge; third, in a gas motor cting the close contact between the slide ce on which it works by means of the essure of the charge in the cylinder, so lide is relieved of pressure when close con- required. Fourth, in a gas-motor engine compressed combustible charge in the kindled by means of an igniting flame in chamber in the slide, providing a channel from the side of such cavity nearest the rt towards the latter, in order to permit us pressure in the cylinder to be d to the cavity without forcing the flame back up the supply pipe, and ting ignition. Fifth, in a gas-motor herein the gas supply valve is worked acting on the valve lever arranging on such lever to slide on its pin, and con- to the governor, so that the roller is it, either so as to face the cam or so as to y to one side thereof. Sixth, in a gas ine establishing a communication between or of the cylinder, and an enclosed space ack of the valve, so that the gaseous on the former may be transmitted to of the latter. Seventh, in a gas motor onstructing the face on which the slide arate from the cylinder, and with a piston- ection fitting a hole in the cylinder, so gaseous pressure in the cylinder will said loose face against the slide.

(To be continued.)

icrophone.—We have received a number asking us to recommend one of the many microphone advertised in our pages. It is ur rule to recommend the goods of one in preference to those of another, but we willing to notice any novelties which may ng of mention. Mr. W. J. Lancaster has one of his microphones, in which the self-contained, a carbon plate being sepa- a zinc slab by a pad of blotting-paper with the exciting liquid. A pencil of ts in a cavity in the plate, and reclines e carbon block attached to the top of a llar connected to the plate. The whole is on polished box, and is fitted with binding mplete, ready for attachment to the line he apparatus is substantially the same as ibed on page 265, and is the most compact be with [illegible]

REPLIES TO QUERIES.

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*** *In their answers, Correspondents are respectfully requested to mention, in each instance, the title and number of the query asked.*

[31976.]—**Compound v. Ordinary Condensing Engines.**—"J. B. C." writes: "If I were to say that the practical effect of firing off a cannon was (is) to produce a vacuum (!) in the powder chamber, because the gases rushing out of the muzzle tend to draw everything inside the cannon with them, I wonder whether your readers would laugh." I suppose "J. B. C." will be surprised to hear that such a statement would be correct, and that the report made is principally due to the air rushing in to fill the vacuum (of course it is not a perfect vacuum thus formed)?—Assoc. Inst. C. E.

[31976.]—**Compound v. Single-cylinder Engines.**—If "J. B. C.," who wrote on this subject in No. 689, had only read with ordinary care my letter in the previous number, he might have spared his sarcasm and affectation of superiority, which have been misapplied, for knowledge born of experience. For what purpose he introduced the firing of his hypothetical cannon I can't discover, since it has no relevancy to the point for which he thrust it forward. It serves, however, for me to say that if he will prevent the expelled matters from returning to the cannon, as matters are prevented from returning to the air-pump, he will obtain the sort of vacuum the latter creates. What we term the vacuum of the condensing engine is a pressure reduced from 15lb.—the atmospheric limit—down to about 3lb., the practicable limit. What is the difference between this reduction of 12lb. by condensation and a similar reduction from 27lb. to 15lb. by any other process? The two operations only differ in distance from the point of vacuum, but are essentially alike in result. My letter gave "A. B. C." (I beg pardon—I mean "J. B. C.") no reason for arguing as though I believed in a pressure which could act in one direction only; and, further, I am not surprised to be told that pressure forward is about the same as backward. I am, however, surprised to find any reader who could deduce such thoughts from perusing my letter. My point stands good—that the transition of steam from a little cylinder to a big one reduces the pressure very materially; that the steam at such reduced limit loses none of its previous force, because what it loses in pressure is correspondingly gained by increased piston area; and, finally, whatever pressure is lost between one piston and the other is a gain to the first piston, by removing so much of its back pressure.—Robert Langton.

[32230.]—**Sofa Bedstead (U.Q.).**—I should recommend John Brownjohn to write to some bedstead manufacturer for a catalogue, where he will see two or three designs of the sofa bedstead. They are generally about 6ft. long by 2ft. wide, and I believe they are to be had complete for about 65s., with cushions.—Telescope Tele.

[32679.]—**American Organ.**—As I have just effected an alteration of my harmonium keyboard, I can strongly support the recommendation of "Organon" to cut the keyboard instead of removing and altering the pins. The former is by far the easier and better way. If "Amateur" cannot afford the room for a new frame (½in. stuff would do) to be screwed under the old one, he might have some iron clamps made instead, and screw them on. I made two new end-pieces, and joined them to the rail by tenon and mortice. The shifting of the reeds is, of course, a very simple matter; but I had to pay 7s. for the seven new reeds to fill up. If "Amateur" (or any of our readers) has an instrument of more than two rows of vibrators, I should be very glad of permission to inspect the construction of same, as I have an idea that the American organ is open to considerable improvement.—W. H. Gnikrod.

[32740.] — **Purifying Naphtha (U.Q.).** — You cannot dissolve guttaperchа with the coal-tar naphtha—*i.e.*, not to be of much use. It is the spirit of naphtha that you require. Spirit of turps will also dissolve it.—Telescope Tele.

[32746.] — **To Darken Basil Portmanteau (U.Q.).**—Give it two or three coats of olive oil, put on lightly.—Telescope Tele.

[32755.]—**Acetic Acid (U.Q.).**—I had not noticed this query, or I should have answered it before. In this country acetic acid is made by distilling oak and beech wood in retorts similar to those used in the manufacture of coal gas. Crude acetic acid is produced, together with creosote, wood tar, and carbon. It is neutralised with lime, and again with soda, and is then called acetate of soda. This is fused at a high temperature to destroy the impurities which accompany the acid. The acetate of soda is next placed in a retort mixed with three times its weight of sulphuric acid, and concentrated acetic acid is obtained on distillation.—J. Harris.

[32766.]—**Stopwork.**—On page 207 a somewhat lengthy reply to "A Lover of the Art," upon the "sliding click stopwork," by "The Company in Question," appears. The "Company," in addition to detailing the period of its existence, its special superiority over all other manufacturers, and as the only persons with *le savoir faire*, tender more than one compliment to me. But when they state the following:—"We trust that our experience upon the subject will be taken to be of *more value* than that of any gentleman speaking only from a few descriptive sentences in our very brief 'Notes on Stopwork,'" &c., I am compelled to regard such as egotistic. The query, as addressed to me by "A Lover of the Art," was replied to in a practical manner, believing that my remarks were to the point as required by the querist. The "Company's" reply at page 297 does not disprove one word of my reply to the query. I thank the "Company" for their proffered kindness in offering to send the stopwork for my inspection, but I prefer such mysteries to be explained *pro bono publico*, especially as their pamphlet appears to me to be all that is necessary to become acquainted with the sliding-click action, though minus illustration. "Stewart" has stated: "A line of engraving is worth pages of letterpress in the description of machinery."—Seconds' Practical Watchmaker.

[32798.]—**Wheel-Cutting Machine.**—In my sketch of the wheel-cutting machine I did not put the centre of the quadrants high enough to be convenient for cutting "flattish" wheels. I am not up in rules for skew wheels, so must refer "X. X. X. X." to one of the many books on wheels. If he puts the compound slides to the wheel-post, he need not skew his cutter. The cutter must be of best cast steel, turned first to be as exact as possible to shape of tooth, and then cut with a small cutter of an angle of about 45°. If the strap pulley is rounded a good deal, the strap will drive almost anywhere and anyhow. For cutting a wheel 2ft. 6in. in diameter, the cutter-shaft ought to be driven by a train of wheels, and only running slowly.—X. X.

[32800.]—**Aerophone.**—Mr. G. Dashwood says he saw a description of the aërophone in the *Times* of the 20th April, and he asks your readers for a description with diaphragms. Up till this week's number (June 7) no one has replied. I should have been surprised if they had, for I believe the aërophone came to life somewhat in this way. Writers of sensational paragraphs for the newspapers have been talking of the capabilities of the phonograph, and have suggested the possibility of making an engine call out the name of the station it is approaching, and how long it stops. Travelling round the journalistic world the idea has at last taken practical form, and Mr. Edison is credited with another marvellous invention, which however much it may be in *posse* is scarcely in *esse*. Perhaps your correspondent, "Asor," will kindly let us know something of the aërophone.—Essar.

[32812.]—**Induction Coil.**—It is not advisable to make up the wire for a coil by joining a great many different pieces, and the wire should be all of the same size in each portion of the coil. What is worth doing at all is worth doing well.—F. Y.

[32813.]—**Plaster Ornaments.**—"Subscriber" should try "blue" for keeping the plaster white. Perhaps water-glass would do for the cement, but the enamelling on slate is put on by means of heat. The process was very fully described in this paper, I think, some time ago.—J. L. M.

[32829.]—**Edison's Sewing Machine Motor.**—Only applied to a model I believe. The journal named makes some peculiar statements at times, and has a rival now in the shape of the *Electrician*.—Essar.

[32833.] — **Engines of Great Eastern.** — I quote from "Life of I. K. Brunel:"—Paddle engines: Diameter of cylinders, 74in.; stroke, 14ft. Screw engines: diameter of cylinders, 84in.; stroke, 4ft. Four cylinders to each set of engines.—M. S. P.

[32835.] — **Three-Cylinder Engines.** — Does "Mechanic" mean Brotherhood's three-cylinder engine, or Willan's? They are very different in arrangement. The latter was illustrated about two or three volumes back.—J. M.

[32870.]—**Chemical.**—Some time ago I had for analysis a mixture of sulphates of calcium and barium. I wished, from the quantity SO_3 found, to determine the percentage of each. I consulted all the books I could find but none gave me the necessary information for making the calculation. It then occurred to me that, by using algebra, the difficulty might be overcome. The method is generally applicable to any mixture of two salts containing one radical common to both (either positive or negative), which is capable of being readily estimated. Let x = the weight of NaCl in the mixture and y = the weight of KCl; then $x + y = a$ (1), where a equals the weight of the mixture taken for analysis. The weight of chlorine combined with Na will be $\frac{35{\cdot}5}{58{\cdot}5}x$, and that combined with n will be $\frac{35{\cdot}5}{74{\cdot}5}y$. Therefore $\frac{35{\cdot}5}{58{\cdot}5}x + \frac{35{\cdot}5}{74{\cdot}5}y = b$ (2), where b equals the weight of chlorine found. Now, multiplying (1) by $\frac{35{\cdot}5}{58{\cdot}5}$ we get $\frac{35{\cdot}5}{58{\cdot}5}x + \frac{35{\cdot}5}{58{\cdot}5}y = \frac{35{\cdot}5}{58{\cdot}5}a$. (3.) And subtracting (2) from (3) $\frac{35{\cdot}5}{58{\cdot}5}x - \frac{35{\cdot}5}{58{\cdot}5}x + \frac{35{\cdot}5}{58{\cdot}5}y - \frac{35{\cdot}5}{74{\cdot}5}y = \frac{35{\cdot}5}{58{\cdot}5}a - b$. That is $\frac{35{\cdot}5}{58{\cdot}5} - \frac{35{\cdot}5}{74{\cdot}5}y = \frac{35{\cdot}5}{58{\cdot}5}a - b$. Now, $\frac{35{\cdot}5}{58{\cdot}5} = 0{\cdot}6068376$, and $\frac{35{\cdot}5}{74{\cdot}5} = 0{\cdot}47651$; therefore $0{\cdot}1303276\,y = 0{\cdot}6068376\,a - b$, and

$$y = \frac{0{\cdot}6068376}{0{\cdot}1303276} - \frac{b}{0{\cdot}1303276}.$$

Also $\dfrac{0{\cdot}6068376}{0{\cdot}1303276} = 4{\cdot}6562.$

Therefore, $y = 4{\cdot}6562 - \dfrac{b}{0{\cdot}1303276}.$

Briefly, divide the weight of chlorine found by 0·1303276 and subtract the quotient from the product obtained by multiplying the weight taken for analysis by 4·6562. This gives the weight of KCl in the mixture. I give an example:—Two grammes of the mixed chlorides are found to give 1·1 gramme of chlorine, $2 \times 4{\cdot}6562 - \dfrac{1{\cdot}1}{0{\cdot}1303276}$: that is, $9{\cdot}3124 - 8{\cdot}4402 = 0{\cdot}8722$ = the weight of KCl; and $2 - 0{\cdot}8722 = 1{\cdot}1278$ = the weight of NaCl. If the quantity of chlorine in these quantities of NaCl and KCl be calculated it will be found to be just equal to 1·1 gramme.—Edward Jackson.

[32881.]—**Gas-Holder.**—I presume "Os" made a great error in answering this query, as all answers to this valuable journal should be authentic, and from sound practical knowledge. I still maintain what I said respecting zinc gas-holders, from the various acids, salts, and ammonia produced in the manufacture of coal gas. "Os" also must bear in mind there are many qualities of sheet tin manufactured. As a proof of the durability of this metal, Mr. Malam, of Hull, fixed one of his patent gas governors at the Huddersfield Gasworks. The holder was 4ft. × 2ft. This holder to my knowledge (having been apprenticed to the said company) was in use eighteen years without ever being replaced. If "An Amateur" wishes to manufacture gas for illuminating purposes, balloons, &c., he must go to a little expense in procuring a breeze condenser, washing vessel, and purifier. Again, "Os" never informed "F. A. B. J." how he was to obtain his gas from the gas-holder with only one pipe. He could do so by the means of a T-pipe put in his inlet under the tank with two stop-taps, one to shut off the gas from the gas-holder to the hydraulic main during repairs, and the second one to the main leading to burners. "Os" informs us some holders are made with cores. This he means the tank for the gas-holder to work in. With regard to a larger pipe being attached to a small one for a better supply of gas, this is well known could not deliver more gas than the small one does at the delivery end. A pressure-gauge is essential to work by. "F. A. B. J." must make himself a conical regulator with a balance or screw, and then he can work his pressure to a hair's breadth, as no large vessel or cylinder would do that if placed between the gas-holder and burners.—F. R. Waite.

[32897.]—**Japanning.**—Use Brunswick black or black japan made thin with turpentine; put it on in thin coats.—Telescope Tele.

[32911.]—**Fuller's Battery.**—I do not like to answer the particulars asked for, p. 321, because I have no personal acquaintance with the battery, and have no special data concerning it. I do not think that a two-fluid battery can be relied on for prolonged use. Carbon fragments would advantageously enlarge the negative surface, but they would also reduce the capacity of the vessel for containing the liquid charge. To ascertain the number of cells required more information is needed than the length of wire used; the internal resistance of the cells and that of the bell itself must be given; and even then the result of calculation is indefinite, because the mechanical resistance of the bells varies, and we need to know the power of current which is capable of acting on the spring and so actuating the bell.—Sigma.

[32930.]—**Pipe Angles.**—To "B. G."—I am much obliged for your answer to my query. I can understand the water method for pipes already made, and with some care and trouble it might answer. But what I want to know is this:—I have 2 pieces of flat zinc of the proper width to form the size pipe I need—I want to know how to cut the end of each piece, so that when I roll them up round they will form, when soldered together, the pipe with the exact bend I require. I have tried many times, but always get a vacancy either at inside or outside of the angle.—John.

[32933.]—**Legal Question—Tithes.**—The reply on p. 299 is hardly correct. Sec. 29 of the 24 Vic., cap. 93, runs:—"If a rent charge shall at any time be in arrear and unpaid, and, in order to enforce payment thereof, it shall become necessary for the person entitled to the same to give notice of his intention to distrain upon the lands liable to the payment thereof for the arrears of the said rent charge, according to the provisions of the said recited Acts, the owner of the rent charge shall in all cases be entitled to 2s. 6d. for and in respect of each notice which shall have been so issued," &c., &c.—H. E. Lansdowne, Sidmouth.

[32968].—**Steam.**—Is it possible that "E. B. F." can substantiate his reply to the above query when he asserts that a steam-engine cannot propel a 20ft. yawl as fast as four oars can, and further states scarcely half the speed is obtainable from screw or paddle in comparison to four oars. This assertion I must respectfully deny, and universal experience teaches contrary. My own boat, which is 22ft. on keel, can be propelled with ease at 10 knots per hour 50lb. pressure, and I have obtained 12 with a pressure of 80lb. This leaves a very wide difference from the statement of "E. B. F." I might add my boat before conversion to a screw launch was originally a four-oared one, and I shall be happy to give "Steam" any suggestion that would assist him. —Black Witch.

[32993.]—**Musical Box.**—I think "Discord" will find that by slightly increasing the distance between the comb and barrel he will at least mitigate, even if he does not entirely cure, the jar complained of. "Discord" is right in supposing the cause to be a too great amplitude in the swing of the tongue, caused, most likely, by the pin depressing it too much. By taking the comb a little further back the tongue will be sooner released, and, consequently, its vibration will be less violent. I hardly understand what is meant by "restoring the original temper of the comb." Has it been in the fire? or does "Discord" suppose that, like us poor humans, the temper does not improve with age? The temper of music steel—such as tuning-forks, rods, &c.—is considerably less hard than spring steel, and to harden it, or alter it in any way, would be to deteriorate the quality of tone, as well as to put it very much out of tune.—W. H. Davies.

[33004.]—**Photography.**—My first camera had a single convex lens. I took some good pictures with it. I should advise you to get "Photography Made Easy" (advertised on front page). I learned through its instructions four years ago. It gives full instructions for arranging camera, &c., and mixing solutions, and I should also advise you to get a proper lens, as single lenses are awkward to focus with.—Torpedogo.

[33017.]—**Tuning the Violin.**—I am obliged to "Fiddler" and "W. H. Davies" for their replies to my question. Previously to their appearing, however, I had evolved a test by which I proved whether my violin was in tune or not. I found that, if in playing the minor scales upon any two of the contiguous strings, as the scale of G minor on the strings G and D, D minor on those of D and A, A minor on those of A and E, ascending and descending, stopping in the usual manner, the impression produced on my ear was satisfactory; also on drawing my bow across any two of the open strings, a satisfactory sonorous harmonic vibration of 5ths was produced, proving that the violin was in tune. In playing major scales I found that the test was not so satisfactory, although, after testing with the minor scales, the major scales necessarily confirmed my judgement. This, as I take it, seems to prove the proposition that the minor 3rd is the first harmonic consonance in music, and that, to improve what is termed the musical ear, or promote the development of the organ of tune, so as to attain the power of appreciating nice and subtle variations of musical tone, it would seem that the neophyte should study principally in the minor mode.—Tyro.

[33018.]—**Excavating.**—To "Excavator."—There is a misprint in my table of contents on page 323. The content of the 8th foot should be 147,595 cubic feet. Otherwise the figures are correct.—H. E. H.

[33027.]—**From "Incog."**—From the symptoms described by "A. S." and the cause, I have no hesitation in saying that he is suffering from some tumefactive congestion in the lumbar region or its muscles, which were weakened and irritated by the "severe walking on an empty stomach," and thus made a focus of attraction for the deposit of the effete matter generally loosely stirred up in the body. Once aggregated in this way, such congestive formations are constantly manifesting reactionary symptoms, the most prominent being the absorption of the heat necessary for that resolution or inflammation, before being taken up and expelled from the body in some form and manner, the phases of which form the many diseases which "flesh is heir to." It is this absorption of heat which constitutes the phenomena of "pain," the revitalisation of a torpid part. Thus when "A. S." used his hip baths, he simply abstracted the latent heat, and so temporarily (fortunately) numbed or deadened the parts. When removed from the water they re-absorbed from the body the heat required to bring them to their former condition of passive life. The process made the pain. I should not advise the repetition of such treatment, as each repetition will so weaken the powers of re-action that it will finally cease, and paralysis of the extremities supervene. Moreover, it must be remembered that the heat of re-action is obtained at the expense of the de-animation of the body and brain—hence the "intense morbid mental condition, depression, and hypochondriasis." It is "robbing Peter to pay Paul." The remedies required for such a condition are such as would raise the thermal forces to a considerable degree, in combination with "alteratives" (solutives), which would combine with the congestive deposit, and (like salt with snow) render it soluble at a lower temperature, and thus preserve the natural energies from that excessive drain, which debilitates the body and suspends its functions. The astringents he has used act, and have acted, just like the cold water, evolving the latent heat by condensing the tissue. The thermals have all been too weak for the work. Of alteratives I see no indication. The "sheet-anchor" of this class are the bromide and the iodide of potassium; I hope they have been "conspicuous by their absence," or much of the hypochondriasis would be well accounted for. From the valerian and carbonate of ammonia I am afraid he would fail to obtain any sensible relief, as any thermal force obtained from the valerian would be too easily decomposed and expelled by the volatile alkali, though it might serve to counteract the after-depression often experienced from the too free evaporation of heat by the diffusive stimulus of the ammonia. The gelseminum and lupulin are the "concentrated remedies" of the hygeian system of medicine, the concentration being the extract of the mineral alkaloidal salt, or vegetable principle, of the plant—like quinine, having no alterative quality than that flowing from their astringency and stimulation, and too weak for the work. "A. S." can, however, give either recommendation a trial. They might fail, but would produce no organic mischief, like many others. I am gratified with the confidence which makes him "grateful for any help;" but he must pardon me for saying that I have had so much experience in the treatment of disease, and the many important and sudden changes that take place, that I look with little favour upon practice carried out through a periodical, where patient and adviser can only have intercourse at irregular and prolonged intervals. Moreover, I am very singular in my conclusion as to the nature and "uses" of disease, and have had to adapt my remedies, so that they do not number far in the "plural," and I mostly prepare and combine them myself. All the safe drugs are weak; those of the greatest power mostly poisons, which should not be lightly touched by 'prentice hands. And I have never been able to find the natural and efficient alterative in the pharmacopœia. They have the injurious tendency of breaking up the body and dissipating its forces, without the power of creating appetite, and digesting food to create new energies. Thirty years ago I ran the gauntlet of "tonic" druggery like "A. S.," and with the same results—*nil*; hence my reason for safe experiment and research, and my success therein. When the discussion on the Cuca arose in "ours," I thought I observed all the characters of a "life" generator, powerful as that of any of the poisons, without the danger of their use. But in obscure and chronic diseases I also found that these powers had more than the general effect of most life-generators in maturing and developing the matters into an active form, which, though necessary, requires to be known and harmonised with to obtain a good result. To counteract this tendency I have been experimenting, and succeeded in obtaining a compound extract, which seems of great value in chronic disease, and which only requires dilution to be immediately applicable. After self-experiment I used it in the cases of two females—one whom I had on previous occasions relieved of attacks of bronchitis, and whom I had again been observing, while falling into a condition of uterine dropsy, with a face glowing with the internal chronic inflammation, the feeder of the occasional bronchitis. In 48 hours I was surprised to observe the decrease of the inflammation, and the air of vivacity and animation by which it had been superseded. I continued the remedy for 3 weeks, and now 2 months' interval shows no signs of relapse. The other case was that of her sister, long a partial invalid from a fractured knee-pan, and then suffering from pulmonary congestion and incipient pleurisy. These the remedy soon dispersed, and there has also been no relapse. Well, then, I can help "A. S." so far that, if he likes to give this a trial, with sufficient confidence in my knowledge of what it will and will not do, and will publish his address (and occupation) in the usual column, I will forward some to his initials. If the disease be of the nature I suppose, at present we can only arrest its further progress, palliate its evils, and restore the functional activity and integrity, leaving to time and nature the removal of the disease itself. But I may be wrong, and the disorder no more than tic-doloreux, and so give speedy relief, while the worst effects will be no more than catching a good appetite. I give this assurance because I do not wish to bring the reproach of quackery upon myself or the journal in which I write, to which, and correspondents, I must remain—Incog.

[33035.]—**Logarithms.**—Apply the geometrical series, 1, 10, 100, 1,000, &c., to the arithmetical series, 0, 1, 2, 3, &c. Then find a geometric mean between 1 and 10, 10 and 100, and so on—*i.e.*, between any two adjacent terms of the series between which the proposed number lies. Between the mean thus found and the nearest extreme find another geometrical mean, as before, and thus proceed until you find the proposed limit of the number whose logarithm is required. Next find as many arithmetical means between the corresponding terms of the other series, 0, 1, 2, 3, &c., in the same order as the geometrical means were found, and the last of these will be the logarithm corresponding with the natural number required. As an example, I shall give "A. I." part of the solution of a problem already worked out, and which will answer his purpose in every sense as well as if I worked out in full the logarithm of 13, &c. Let it be proposed to find the logarithm of 9. First, the number 9 lies between 1 and 10. Now, the log. of 10 is 1, and the log. of 1 = 0. Therefore, $\sqrt{(10 \times 1)} = 3{\cdot}1622777$ = geometrical mean, and $\dfrac{1 + 0}{2} = {\cdot}5$ = arithmetical mean. Therefore log. of 3·1622777 = ·5. Second, log. of 10 = 1, and log. of 3·1622777 = ·5; $\therefore \sqrt{(10 \times 3{\cdot}1622777)} = 5{\cdot}6234132$ = geometrical mean, and $\dfrac{1 + {\cdot}5}{2} = {\cdot}75$ = arithmetical mean; therefore log. of 5·6234132 = ·75. Third, log. of 10 is 1, and log. of 5·6234132 = ·75; $\therefore \sqrt{(10 \times 5{\cdot}6234132)} = 7{\cdot}4989422$ = geometrical mean, and $\dfrac{1 + {\cdot}75}{2} = {\cdot}875$ = arithmetical mean. Hence log. of 7·4989422 =

By proceeding in this manner for 22 extrac- more—that is, from the last one—it will be that the log. of 8·9999998 = ·9542425, which e taken for the log. of 9.—**Bernard McGuire**, pool.

.35.]—Logarithms.—From tables of loga- s find the natural numbers which correspond logarithmic decimals only, and the answers onsist of those natural numbers containing teger figure more than the positive character- or whole number, of logarithms indicated. for

·4771213 the nat. tab. No. for ·4771213 being 3;
69897 do. do. ·69897 5;
·4342495 do. do. ·4342495 2718;

rst answer 30, and last answer 27·18, each ning two integers because the characteristic of their logarithms is 1; while the second is 5 (consisting of an integer) because the teristic 0.—**Buttershaw**, near Bradford.

36.]—Mensuration.—Let a equal the area of rt to be cut off; then by similar triangles $\mathrm{BC} :: \mathrm{A}x : xy = \frac{\mathrm{BC} \times \mathrm{A}x}{\mathrm{AB}}$. But A$x$ × areas of triangles Axy and Dws; therefore, $\frac{\mathrm{A}x}{} \times \mathrm{A}x = \frac{\mathrm{BC} \times \mathrm{A}x^2}{\mathrm{AB}}$ = sum of areas of es Axy and Dws. Now, the rectangle, with the adjacent triangles, is = a; there- have $\frac{\mathrm{BC} \times \mathrm{A}x^2}{\mathrm{AB}} + \mathrm{AD} \times \mathrm{A}x = a$, a quad- quation, which, solved, gives $\mathrm{A}x = \frac{1}{2\mathrm{BC}}$ $\mathrm{AD}^2 + 4\,\mathrm{BC} \times \mathrm{AB} \times a)^{\frac{1}{2}} - \mathrm{AB} \times \mathrm{AD}$. $16)^2 = 21{,}233{,}664$, and $(288 \times 8 \times 2{,}880)\,2$ = 040, sum of both results = 34,504,704, and the root of this sum is 5,874·07. From this we 308 (= 288 × 16), and we have 1,266·07, which, by the difference of the ends (8in.), gives nches = the distance from the narrow end, the board must be cut, or 129·74 inches from ad end. Now, to find the width of board at int, say, as 288 : 129·74 :: 8 : 3·6, and 24 − 3·6 n., the width of board 129·74in. from the end. The following rule will be very con- for "Omicron," being applicable to the a of problems similar to this one, being, in rived from the above:—To the square of the t of the length and narrow end add twice the al product of the length, the difference the breadths of the ends, and the area of t required to be cut off, and extract the square the sum; from the result deduct the product length and narrow end, and divide the der by the difference between the breadths of s.—**Bernard McGuire**, Liverpool.

6.]—Mensuration.—In reply to "Omicron," ng the sides of taper board (represented by C) continued to centre line, EG.

$$\frac{\mathrm{D} + \mathrm{BC}}{2} \times \mathrm{EF}, \text{ or } \frac{24'' + 16''}{2} \times 24\text{ft.} =$$

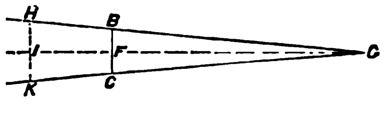
square feet for area of board, ABCD; half area of ditto being = 20 sq. ft.

$$\text{As } \mathrm{AD} - \mathrm{BC} : \mathrm{EF} :: \mathrm{AD} : \mathrm{EG};$$

$$\text{Or } 8'' : 24\text{ft.} :: 24'' : 72\text{ft.}$$

$$\frac{\mathrm{G} \times \mathrm{AD}}{2}, \text{ or } \frac{72 \times 2}{2} = 72 \text{ sq. ft.}$$

a of triangle, AGD. 72 − 20 = 52 sq. ft. area of triangle, HGK, whose base, HK,



its answer, and whose length, IG, in pro- to HK (like that of EG to AD) is $\frac{72}{2}$ = 4th. Assuming x = HK, then $36x$ = IG, cording to the question, $\frac{\mathrm{IG} \times \mathrm{HK}}{2}$, or , or $18x^2 = 52$. And $x = \sqrt{\frac{52}{18}}$, or $\sqrt{\frac{26}{9}}$ =

Or, by slide rule:—

n slide $\frac{\mathrm{B}}{\mathrm{C}}$ set opposite 26 on A;

n slide $\frac{\mathrm{B}}{\mathrm{C}}$ is ans. on line D very nearly 1·7ft.

ershaw, near Bradford.

.]—Clarionet.—"Diatonic" wishes to know nasal" tone can be altered by any means on ionet. I have never produced such a tone do it as an experiment, to show the diffe- tween the pure tone, which is most singu- eet, and the goosey tone, so much heard e clarionet is played by amateurs). I recom- Diatonic" to practise holding notes for a hours every day without any intermission has fully conquered the difficulty, and I am hat he will be well rewarded for his pains. ng playing duets with the pianoforte, I have t of number played with the pianoforte, and s well. If "Diatonic" has any execution urchase some very fine solos, written by Mr. with pianoforte accompaniments. The t is about the most difficult of all reed nts, but when played properly it has most tones, which approach the nearest to a lady's d singing voice. — **Edwin Morgan**,

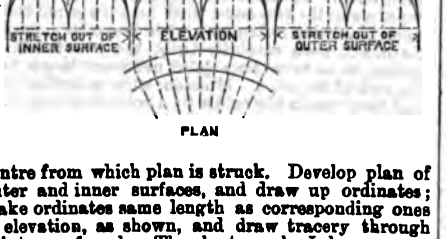
[33038.]—**Legal.**—1. If she wish to retain it for her separate use she can do so by virtue of the Married Woman's Property Act, 1870, by investing it in the "Funds," or in fully paid-up shares or debentures, or debenture stock, or stock to which no liability is attached if a joint-stock or incorporated company, and by applying when she is about to be married that the "funds," stocks, or shares may be registered in her name as a married woman entitled thereto for her separate use; or she may purchase a Government annuity from the National Debt Commissioners, and this will be treated as her separate property. 2. The duty will be at the rate of £10 per cent. If "Bob" means by "£500 in houses and land" houses and land of the value of £500, the duty will be succession duty, not legacy duty.—**Sperans.**

[33044.]—**Parrots.**—I had a pet of the same kind, and kept it for 30 years, and then did not know how old it was. It talked well, and very plainly. I am afraid you have given yours meat, or something salt. Sugar is a very bad thing, and would cause what you speak of. Give sopped bread, a little warm, and Indian corn soaked. I never allowed mine water, as I think it a bad thing. A few chillies in the sop occasionally are good.—E. B. M.

[33046.]—**Brown Head to Stout.**—It is quite impossible to obtain brown heads on stout unless we employ a judicious mixture of grist, coupled with soft water for mashing. White heads result from a deficiency of a peculiar proximate constituent of malt, which can alone be extracted by the use of soft water; although, if the brewing water be hard, it is quite easy to soften it before using it. Waters are hard through holding in solution various salts such as bicarbonates of lime and magnesia, which can be removed by boiling, and such hardness we term temporary hardness. On the other hand waters are also hard through containing in solution certain salts which are not affected by boiling, and, therefore, the hardness resulting from their presence is termed permanent hardness. The salts which chiefly cause permanent hardness are the sulphates and chlorides of lime and magnesia, and these may be removed by the addition of another salt, which can set up a mutual decomposition of the constituents of the water, and thus produce a resulting substance, which is either insoluble in the water, or else can communicate no character of hardness to it. Dr. Clarke's lime process is of value in this case, or we may use soda or its carbonate as a softening medium. H. P. **Harris**, Rotherham.

[33049.]—**Boring Sticks.**—Make or get a tool the size that you want, like half round engineer's boring bit.—**Telescope Tele.**

[33050.] — **Centres of Circular Tracery Windows.**—The elevation only of the windows can be struck from centres, but the correct form required for working can be obtained by ordinates. Draw vertical ordinates across elevation to touch plan, as in the figure, join points of contact with centre from which plan is struck. Develop plan of outer and inner surfaces, and draw up ordinates; make ordinates same length as corresponding ones in elevation, as shown, and draw tracery through points so found. The best work I know upon "circle upon circle and circle upon rake" work is Newland's "Carpenter and Joiner's Assistant;" but the handrailing given in it is inferior to Riddell's system.—F. O. **Cresswell.**



[33054.]—**Sulphuretted Hydrogen.**—There are two methods by which sulphuretted hydrogen may be prepared—namely, by the action of dilute sulphuric acid on sulphide of iron, and by decomposing sulphide of antimony by hydrochloric acid. The first method yields the gas more easily, but the second in a far purer state. To prepare it by the first plan a few lumps of sulphide of iron are placed in a flask provided with a doubly-perforated cork, through which two tubes pass—one being a "thistle-head" funnel, the end of which nearly touches the bottom of the flask, and the other a bent tube connected with a second and smaller flask, nearly filled with water, below the surface of which the tube dips. Another long bent tube in the cork of the second flask, and projecting only just below the cork, conducts the gas under the surface of some warm water, over which the gas is collected. A little dilute sulphuric acid is now poured in the funnel, when a copious disengagement of the gas takes place, which is washed by passing through the water in the second flask. It is important that the sulphuric acid be not too strong, as, if this be the case, a violent disengagement of gas takes place for a few minutes, and then suddenly ceases altogether. By the second method, sulphide of antimony, powdered as finely as possible, is put into the apparatus as before, and strong hydrochloric acid poured on it through the "thistle-head" funnel, and the gas collected in the above manner.—L. **Briant.**

[33055.]—**Sticking Paper Labels to Cloth.**—The preparation with which ordinary sticking-plaster is coated might answer. It can, I believe, be procured in sticks or rolls, and spread on the paper with a heated spatula.—J. **Brown**, Belfast.

[33060.]—**Differential and Integral Calculus.**—Begin without troubling as yet about the theory of equations. Absolutely necessary is a rudimentary knowledge not only of plane but also of solid coordinate geometry. The best book on these branches is Lefebure de Fourcy's "Géométrie Analytique;" but, if you prefer English, read, after Todhunter's "Conics," Frost's "Solid Geometry." By far the most valuable elementary treatise on the differential calculus is Williamson's. I would caution you against reading Todhunter's, because of his ridiculous interdict against differentials. The guide I have found to be most trustworthy of all is Schloemilch's "Compendium der höheren Analysis."—**Leidhold.**

[33062.] — **Zincography.** — "Paper Cutter" is very much at sea on this subject. His distinction of the purposes for which zincography and the anastatic process are employed is altogether fanciful. And where he speaks of a zinc plate being printed "in litho press in ordinary litho manner," I should like to know in what is that so-called anastatic process different from zincography. In my experience I have never before heard of or seen that "the drawing done with anastatic ink (ordinary litho ink) is transferred between steel rollers!"—**D'Evlynn.**

[33062.]—**Zincography.**—I think "Paper Cutter" must have forgotten that zincography need not be used for letter-press work alone, but that it can be used as easily as stone (at least, that is my experience), for surface printing.—A. **Pumphrey.**

[33062.]—**Zincography.**—In reply to "D'Evlyn" I have in preparation a supplement to my instructions in collegraphy which will explain the method of making a transfer from ordinary writing, which can be printed on a sheet of zinc, and retained for use any length of time.—A. **Pumphrey.**

[33068.]—**The Microphone and the Violin.**—This query being addressed to Mr. Bidwell ought not to be answered by any one else, and I feel diffident in stating that the microphone is not an instrument to be applied to ordinary sounds to make them louder, but it is especially an instrument to render audible sounds of which prior to its introduction we knew nothing.—W. J. **Lancaster.**

[33068.]—**The Microphone and the Violin.**—I have not had an opportunity of making the experiment suggested by "Fiddler," but I have little doubt that the vibrations would not be so strong as to cause the carbons to "make and break" contact. This, of course, would be fatal. "Fiddler" probably knows that the sounds would not in any case be rendered more audible to persons who were not listening with a telephone.—**Shelford Bidwell.**

[33069.]—**Cleaning Carpets.**—For carpets when down sprinkle with damp tea-leaves, and then get a good bass broom and sweep towards fireplace or door. When up hang out on a line for a little while in the sun with the back outwards, give a good beating, and after a good brushing, and then lay brown paper down before putting carpet down to keep away moths, &c.—**Telescope Tele.**

[33073.]—**House Agent.**—The Act 24 and 25 Vic., cap. 21, sec. 10, states that every person who, as an agent for any other person, shall for, or in expectation of fee, gain, or reward of any kind, agree to let or sell, or shall let or sell any furnished house or part of a furnished house, shall be licensed as a house-agent. But no licence is required if the annual rent or value is not over £25. An agent employed in the management of landed estates, or any attorney, solicitor, proctor, writer to the signet, agent, or procurator in any court of law, conveyancer, auctioneer, or appraiser, is not required to take out a licence.—**Excise.**

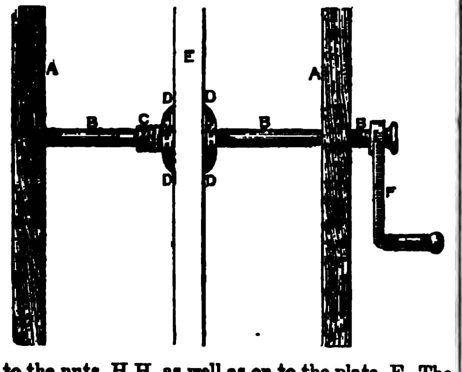
[33075.]—**The Microphone.**—The results obtainable with an ordinary telephone connected to the microphone are so much superior to those produced by a small electro-magnet, and the trouble of making the two instruments being about the same, I should strongly advise intending experimenters to make up a telephone proper at once. The microphone is capable of much improvement, and I have just completed a very simple and almost too sensitive instrument, which I will describe more fully in a "letter." In using the electro-magnet as a receiver, you must, of course, have a vibrating plate, and this, I believe (although open to correction), is a part of Bell's patent; and although the instrument is not in reality Bell's, still, by using several of the parts I believe it to be an infringement, but then this point is of no moment to amateurs or others who use the instrument as a source of amusement and instruction only. It is when any one uses the instruments for profit that the line is overstepped.—W. J. **Lancaster.**

[33083.]—**Estimating Power of Falling Bodies.**—In one of Cassell's technical manuals, called "Applied Mechanics," by Robert Stawell Ball, LL.D., page 52, an example is given wherein a massive iron weight of 500lb. raised to a height of

20 feet, or 240 inches, and then allowed to fall on a pile which is only driven 1 inch into the ground by the blow, the pile is urged downwards by a pressure of $\frac{500 \times 240}{1}$ = 120,000lb., and, as from the preceding remarks in "Manual," if by the same blow the pile had only gone into the ground ½in. the pressure would have been = 240,000lb.; or ⅛in. the pressure would have been = 960,000lb., and so on, so accurate answers to such questions as:—What is the dead weight (that is the weight without motion) which represents the "force of a blow"? cannot be given by calculation with certainty.—BUTTERSHAW, near Bradford.

[33086.]—**Plate Glass Electric Machine.**—The hole in the plate should be either square or triangular, or shaped in some way, and the spindle should fit it pretty tight. A round hole in the plate is a difficult thing to manage.—A VERY NEW SUBSCRIBER.

[33086.]—**Plate-Glass Electric Machine.**—I think that the accompanying sketch and instructions will assist W. Wait. In reference to the sketch, the letters on it correspond to the following description:—A A are the supports of the spindle, B B, which has a screw thread, C, cut in it between the nuts, H H, and the glass plate, E. There are two pieces of thin leather, D D D D, cemented both on to the nuts, H H, as well as on to the plate, E. The nut, H, is screwed tightly up against the plate, E; the spindle, B B, is continued through the support, A, and terminates in the handle, F. The pieces of leather being cemented to the nuts, as well as the plate, keeps the plate from slipping. The nut must be screwed against the plate while the cement is moist, or else the leather will not adhere to the nut.—HOSNIKOS.



[33086.]—**Plate-Glass Electric Machine.**—Put an indiarubber washer on each side of the plate between the nut and the glass, and if the nuts are large enough in diameter they ought to hold fast. See No. 626, page 40, for replies to a similar query.—J. BROWN, Belfast.

[33086.]—**Plate-Glass Electric Machine.**—I have repeatedly stated in these columns that the hole in a plate for machine must be at least 1in. diameter, so that you can have a strong axle and good clamp on both sides of glass. The hole through glass is best quite round and roughed for a quarter of an inch round hole on both sides.—W. J. LANCASTER.

[33087.]—**Making Pure HCl for Laboratory Use.**—I think commercial salt is sufficiently pure. If you wish to purify, if possible, still more, you should put it in its own volume of water for a few minutes, its slight solubility will free it from more soluble salts. As to getting NA_2SO_4, I do not think it is safe for your apparatus to try it. I have tried it twice, and have got two retorts broken over the head of it. Water will absorb 480 times its volume, but you must prepare much more, as there is loss from imperfect absorption of the bubbles. Cool your gas as much as possible, as much heat is given out in solution.—FOSSIL.

[33090.]—**Arithmetical Rule Wanted.**—A 12in. crank will describe a circle 2ft. diameter; this multiplied by 3·1416 will give the answer. Thus, 2ft. × 3·1416 = 6·2832ft., the distance travelled in one revolution.—J. R. W., Mapplewell.

[33091.]—**Raising Water.**—In reply to L. Gilbert I may say that I have a pump at work which raises more than the quantity of water he mentions (250 gallons per minute) to a height of 50ft. It is a small Cameron pump, made by Tanjye, of Birmingham, and is attached to a vertical boiler 7ft. high. The whole arrangement, including pipes, fixing, injector for feed, &c., cost less than £150, and it will work very well on 2cwt. of coal in 8 hours, requiring very little attention. Of course this is not a high "duty," even for a small engine, but as it includes getting up steam and a good deal of radiated heat from a boiler only partially inclosed, and as there is no condenser, the duty is not bad.—J. H. COLLINS.

[33092.]—**Telescope.**—The O.-G., if a good one will do well for detecting bullet-marks at 1,000yds. The longer eyepiece of the two will be best, but you should have the eyepiece made into a pancratic one, so that on bright days you could increase the power, and on dull days *vice versâ*. This can be done by getting a piece of brass tube to fit tightly over present eyepiece, and about same length. Then cut present eyepiece into two, about 1in. from bottom-end; solder this end into one end of new tube, and let the long part slide into other end. Having gone so far rightly you can then try its effects. The lowest power you will find is when the tube is down to the bottom, and of course highest power when the tube is drawn out as far as it can be to remain rigid. If the missing lens in large eyepiece is the one nearest to the eye, I have no doubt it should be 1½in. focus. You may easily find out its focus by measuring distance from top of tube, which should contain it down to diaphragm. This distance will be focus of lens required.—W. J. LANCASTER.

[33094.]—**Cleaning Bicycles.**—A mixture of oil and turps, applied with a piece of cotton waste, and plenty of "elbow-grease," will clean E. Hornsby's bicycle. After wiping off dry, use a steel burnisher (can be obtained from any harness-maker), and the machine will look like new.—56IN. (ALLBRIGHT) SPECIAL CHALLENGE.

[33095.]—**Eyepiece.**—Measure focus of O.-G., then send with the measurement to an optician the draw tube, tell him power you want, and the eyepiece would in due time be in your hands. I would, however, suggest that you have a lower power, as a high power like 200 would be ineffectual in any but experienced hands.—W. J. LANCASTER.

[33096.]—**Cylinder for Phonograph.**—I believe that a hard wooden cylinder, if accurately turned, would do nearly as well as a brass one. If the bulge in the ferrotype plate is permanent, remaining after it has cooled, you will never get good results with it. Try again, using less heat and no pressure. You may be satisfied with the paper drum if it is tolerably tight before it is connected with the spring. Tinfoil of half the thickness recommended will answer, but not so well, and it will not bear many repetitions.—SHELFORD BIDWELL.

[33097.]—**Indiarubber Binding for Books.**—Take your sheets and knock them up evenly on the back—if they are single sheets it will be as well to take a slight trim off. Then screw up tight in laying press (if you have one), leaving the backs about an inch out; if you have no press, place on the edge of the table and place a piece of board on the top, flush with the back, and press tightly with the hand. Then with a brush dipped in the solution go lightly over; lay in a cool place to dry, and repeat process about three times; when the last coating has been put on, lay wide tape on same width apart as sewn books, and let dry in. You can then bind as usual. I have seen indiarubber-bound books that have been knocking about the shop for a number of years, and they certainly have not deteriorated.—PAPER-CUTTER.

[33100.]—**Green Writing Ink.**—The following recipe is given in the ENGLISH MECHANIC, No. 506, Dec. 4, 1874:—"2 parts acetate of copper, 1 part carbonate of potash, and 8 parts of water. Boil till half is evaporatod, and filter.—A SIGNALMAN.

[33100.]—**Permanent Green Writing Ink.**—A sixpenny bottle of Judson's green dye in a pint of hot water would make a first-rate ink.—J. HARRIS.

[33102.]—**Wire Joints.**—The solder is that used by tinmen. The simplest way to make joints is to taper away the two ends, then heat them red hot in a gas burner to soften, rub with fine emery cloth to clean, and then carefully twist the two firmly together, so as to make a joint not much larger than the rest of the wire. Moisten with soldering flux, and then run in the solder by a soldering iron, composed of a piece of thick copper wire tinned at the end, and fixed in a handle, and heated by being put across a gas flame, so that the joint can be brought up to it. The wire should be washed with wet rag afterwards to remove the flux; it can then be covered with silk or folded in a piece of paper as it is wound on, or the wire can be warmed and rubbed over with a solution of shellac, preferably with a little indiarubber solution added to it. See also reply to 33109.—SIGMA.

[33104.]—**Bicycle Query.**—The best thing "Alpha Beta" can do is to get a second step fitted by a clamp, if possible. I should advise him not to make any holes in the backbone.—TRANSIENT.

[33104.]—**Bicycle Query.**—I presume "Alpha-Beta" has only one step to his machine. If this is so, I should advise him to get an adjustable step, and fix on the opposite side about 2½in. or 3in. (or more, if desired) higher up the backbone. I think this will prevent him "going over the handles," as it did—56IN. SPECIAL CHALLENGE.

[33105.]—**Phonograph.**—The style should be pointed with a ruby well pointed by a lapidary, and should be so adjusted as to make only a small depression, about 1·50in. If it goes deeper than this, remove it further from the cylinder or have a weaker spring.—W. J. LANCASTER.

[33105.]—**Phonograph.**—Indiarubber will not stop the scratching. See that your point is not too sharp, and is well polished. See also that the tinfoil is perfectly smooth and laid on tight. Rough tinfoil is always very noisy.—SHELFORD BIDWELL.

[33107.]—**Phonograph.**—The indentations on the tinfoil ought to be very conspicuous—even when you do not speak at all loudly. Perhaps your iron plate is too thick, or is bulged in the middle; or perhaps you make the point press too hard upon the tinfoil. There is no difficulty whatever in setting the second point to the required depth; I can do it in
the dark in less than three seconds. If t
smooth, and the end of the point wel
there will be little of the scraping noise.
note-paper or vegetable parchment in t
the will-parchment.—SHELFORD BIDWE

[33109.]—**Soldering Wires of Elect
ratus.**—Solder forms, of course, an alloy
copper, and this alloy has its own mech
perties. If a copper wire with solder on i
red hot, the copper is eaten away, no dou
a readily fusible alloy forms. Wires,
German silver, become very often bri
soldered, while other joists remain quite
reason for this probably lies in the heat u
dering, and I should say that only just b
to cause the solder to run into the interst
to be employed. Anything beyond this t
up the conditions of brittleness.—SIGMA.

[33109.]—**Soldering Wires of
Apparatus.**—A galvanic action set up i
by the tin and lead of the ordinary sold
silver acting on the copper wire, is the ca
rottenness observed by "Reader."—J. H

[33111.]—**The Spider and the Fly**
noticed the same thing over and over agai
as the fly is not on the web, the spider w
tempt to take him; and if you merel
spider's leg with a hair he immediately
self-control and makes for home with th
despatch. From long observation of th
the spider, I am almost definite on the f
viz., that the spider cannot see the fly in any
secondly, that the spider takes a fly by fe
The spider sits immediately under cover, h
central fibre, leading from web to his do
immediately this web is disturbed in any
pulls the fibre tighter, and if the vibrati
tinued he runs down to the cord and feels
front feet, two fibres at a time until he fin
giving evidence of most vibration, down th
until he comes up with the invader fly; coi
the fly numerous layers of web he succe
tangling his victim, and carries him, sub
to his nest. Now, I have laid upon a web
of every conceivable subtance, generally a
a thin thread. I have in this manner broug
spider and kept him at hard battle for som
then suddenly, losing the thread, the spid
has been very much mistaken, and, after
round the piece of paper, he goes to work
the fibres attached to the paper and then
up, carries it to the edge of the web and th
fall. All this, I hold, is due to feeling,
any way due to sight, although they have
to hearing, although some naturalists
spiders do hear. Another queer thing
spider is, how surely, when he gets unde
tim, does he probe his thorax with the f
mandible through a minute orifice in which
his poison into the fly. Flies once th
always die.—W. J. LANCASLER.

[33113.]—**Phonograph.**—See my reply t
ner" (33107). The indentations which cau
musical note probably result from the vib
the spring, caused by its dragging over t
To remedy this, make the point turn up s
as to meet the tinfoil. It is not necessar
points should be exactly on a level with th
the cylinder, provided that their direction
A straight line drawn in the direction of
point should pass through the axis of the
one drawn in the direction of the second po
pass slightly above the axis. Make the
smooth as possible by laying it on a shee
glass and passing a roller over it. It i
that your steel spring is too stiff.—S
BIDWELL.

[33114.]—**Electric Bells.**—Electric be
rule, are made with electro-magnets, an
magnets are always capable of produc
highest power in proportion to the str
current; it is, I suppose, a fault in the
needs attention. If your bell has been
twelve months it is almost time you re-ch
cells. This you can either do yourself or
to the maker. When re-charged, they
good as at first, and will work anoth
months without troubling you.—W. J. LA

[33115.]—**Black Board.**—The desider
black board for chalk-writing are an inten
without the least gloss, or the writing
seen in all positions—and a slight rough
the "grain" on paper for water-colour
No paint will do, even if containing mu
and as to enamel, whatever that may be,
doubtless make a smooth surface; but
surely cannot desire a surface like glass fo
upon? I don't know how the makers bl
when new; but in schools the surfaces ar
renovated by Vago's "black art" prepar
H. Frankie's "improved composition"
boards, each of which is 2s. 6d. and 5s. a b
smaller size is enough to black half a do
boards on both sides; and it is most econ
do a number at once, if you have then
recommend the "black art" from pract
rience, and wish I could tell "Nero" how
it. It seems to be a solution or suspensi
black in alcohol. Any large school statio
get it for you.—DAGHBERT.

[33115.]—**Black Board.**—Is it a stain
require? Here is a very effective one:

broken into small pieces, put into nearly
at of vinegar, which must be in an open
Let it stand for half an hour, and then add
teel filings, when it will commence effer-
Cover it up, but not sufficiently to exclude
et it stand for 2½ hours, and it will then
use. Apply with a brush, and, if not black
give two or three more coats. If you
a paint, have it made up without any
a it.—TELESCOPE TELE.

]—**Equatorial and Lightning.**—The
is are decidedly dangerous, but the danger
ercome easily enough. All that is needed
ure a good electrical connection of the
the pillar to earth. A stout copper rod
secured to the iron, and led down into a
of moist earth, terminating in a large
ate or a sack of coke.—SIGMA.

—**Equatorial and Lightning.**—There is
danger of your iron pillar ever suffering;
ou have it contained in an observatory I
ise you to have a copper strand from top
ig into earth, and connected to a large
on in a damp earth. A piece of the same
ld connect the iron pillar to the conductor,
course. On the top of the observatory
usual pointed terminals.—W. J. LAN-

—**Brewing.**—In a small brewery, with a
plant, it would not be advisable on the
onomy to fix a steam boiler; neither would
y advantage. With regard to the employ-
on for boiling tanks and other utensils, no
s can happen, provided that the ferment-
s are not made of the metal. After the
been brewed in about two or three times,
y to rust remains, and consequently just
can be produced as if no iron was used.
may state from personal experience that I
pale an article as can be bought, although
sels are made of iron excepting the fer-
quares. I can answer for it that out of
ired vessels now erected, ninety of them
of iron.—H. P. HARRIS, Rotherham.

—**Violin Varnish.**—The best would be
ould dry as hard as the wood itself, and
ly, so that the pores be as little choked as
The varnish that best answers these re-
s is shellac, dissolved in methylated spirit.
sizing the soundboard of a piano before
increases its resonance—so, conclude it
re the same effect on a violin.—W. H.

—**Mineralogy.**—I send the following ex-
n Dana:—"Roselite: related to, if not
rith, cobalt bloom, composition of which is
balt, 39·2; arsenic acid, 37·9; water 22·9;
h ores of lead and silver in Saxony, Corn-
berland, and United States. Euchroite:
f copper from Hungary contains 33 per cent.
id, 48 oxide of copper; of little use in the
ar, emerald green. Erinite: arseniate of
3·8 arsenic acid; 59·4 oxide of copper;
colour, emerald green. Margarite: pearl
icate of alumina; Tyrol. Minium: oxide
d lead; used as a dryer in varnishes, and
nt usually prepared artificially. Fluellite:
f alumina from Cornwall, contains fluorine
nium."—C. J. B. F.

and 33123.]—**Mineralogy.**—Your corre-
"A Would-be Mineralist (? Mineralogist),
rtain information, which I am glad to be
pply. *Roselite* is a hydrated arseniate of
e, and magnesia, found at Schneeberg, in
It is of deep rose-red colour, but is named
of the celebrated chemist, Gustav Rose.
imes described as a variety of *Erythrite*,
af has lately shown that it is a triclinic,
thrite is oblique. Its H is about 3·5 and
738. On heating to 100° C. the crystals
fragments and turn blue. It must not
ded with *Rosite*, which is a pink mineral
ite group. *Euchroite:* This is a hydrated
f copper, found in quartzose mica slate,
a, Hungary. It is of bright emerald or
colour. H = 3·5 – 4, G = 3·389.
tion, rhombic. *Erinite:* This name has
d to a hydrated arseniate of copper which
and in old collections of Cornish minerals,
ocality not being known. It occurs in
d aggregations, which occasionally
stalline facets. Colour, fine emerald-
rass-green. H = 4·5 – 5, G = 4·043.
name has been applied to a greenish,
ineral, which occurs as a constituent
rocks in the neighbourhood of
Causeway, Ireland. It is a highly
licate alumina and peroxide of iron.
(not margyrite) is an anhydrous sulph-
of silver, containing, when pure, about
of silver. It is of iron black colour, but
nd streak are dark red, and thin splin-
p blood-red and translucent. Its H = 2
– 5·4. It is found at Braunsdorf, in
ribram, in Bohemia, and a great many
both in Europe and in Mexico and Peru.
ion oblique. *Minium.*—This name has
d to vermilion (native sulphide of mer-
e red oxide of lead. It is more properly
the latter, which occurs in small quan-
eadhills, in Scotland, in the island of
and at a great many localities at home
, in association with galena and other
lead ores, of which it seems to be a decomposition product. Its H varies from 0 to 3, and its G is about 4·6. *Fayalite* is an anhydrous silicate of protoxide of iron, formula $2FeO, SiO_2$. It is very dark green, dark brown, or black, somewhat resinous or sub-metallic in fresh fracture H = 6·5, G = 4 to 4·2. It occurs at Fayal in the Azores, the Mourne Mountains, Ireland, and other localities, generally with volcanic rocks. It may be regarded as a natural slag. Crystals indistinct. *Fluellite:* This mineral formerly occurred in minute colourless or white rhombic pyramids, with truncated summits, at Stenna Gwynn, in Cornwall. It was partially analysed by Wollaston, who found that it contained fluorine and aluminium. H = 3; G not determined. As to the uses of the above minerals, they are all such rarities that they are of considerable value as scientific specimens for study. Only *Miargyrite* ever occurs in such quantities as to be of use in metallurgy as an ore of silver, and even this is rare. BROWN COAL (33123): This is a synonym for the coal termed lignite. It is frequently used as fuel, but is generally inferior to true coal on account of its large proportion of moisture and ash. It occurs in beds more recent than the carboniferous period, although many post-carboniferous beds yield true coal. The best-known deposit of lignite or brown coal in the British Islands is that of Bovey Tracey, in Devon. This occurs in numerous thin beds, interstratified with clay derived from the decomposed granite of the vicinity, and is shown by the character of its undecomposed leaves, &c., to be of miocene age. It has been used locally for burning coarse pottery, but its calorific value is considerably below that of average coal from the coal measures, and it burns with a bad smell, owing to the presence of sulphur and certain nitrogenous compounds. It may generally be distinguished from true coal by its more-fibrous and less-lustrous character. Sometimes it is even foliated, and closely resembles a mass of dried leafy matter, closely compressed, and so far altered as to have lost most of its structure. Lignite, or brown coal, also occurs at Brora, in Sutherlandshire (oolitic); at Dax, in France; Hesse Cassel; Oedenburg, in Hungary; Merssen, in Saxony, Richmond, Virginia, and a great many other localities.—J. H. COLLINS, 57, Lemon-street, Truro.

[33123.]—**Brown Coal.**—Brown coal is a less perfect variety of bituminous coal, and of more recent origin, burning with an empyreumatic odour. It often has the structure of the original wood, of a brownish-black colour, A tertiary formation.—C. J. B. F.

[33123.]—**Brown Coal.**—Brown coal or lignite is found in many part of Germany in the tertiary formation. It is either compact or earthly—is in fact imperfect-coal. It burns slowly, leaves much ash, and emits a strong sulphurous smell. Where low continuous heat is required, it may be used advantageously. A strong draught is needed. From brown coal paraffin and mineral oils are manufactured (sola-oil, photogen, and hydrocarbon.—N. SIRCH.

[33126.]—**Microphone Construction.**—Make a microphone, as described in letter 14422, merely correcting E by placing in letter-press F, thus the piece in "Wiseaf's" sketch (which I may add is fairly accurate) marked F should be about 2½in. to 3in. long, and about 1¼in. wide, and the upright E should be more upright for delicate sounds; the other points you may follow. I am sending an article to "ours" on my pile microphone, and experiments to be made with it.—W. J. LANCASTER.

[33128.]—**Photographic.**—Why not at once use the Liverpool company emulsion? This is already prepared, and requires merely pouring on to a plate, and the whole thing is done. Plate may be exposed either in a day or twelve months.—W. J. LANCASTER.

[33128.]—**Photographic.**—"Photo" asks for information on Chardon's "Bromide Emulsion" process, for which I would refer him to either of the photographic almanacs, where, I believe, full instructions are given. It is, however, neither more nor less than an emulsion process (collodion not gelatine), in which the sensitive salts and guncotton have been precipitated, and then washed and dried ready for again being dissolved in alcohol and ether. It is a more sensitive process than "wet plate," but requires alkaline development, when it gives a very detailed but rather thin image, I believe. It can be obtained from Solomon, of Red Lion-square; but I should certainly recommend in preference Kennett's "Gelatine Emulsion" process, which is more rapid, gives as fine, if not finer detail, requires the same kind of developement, but instead of alcohol and ether and their accompanying trouble, &c., needs only water for solution. If "Photo" is not acquainted with it, and you are willing to insert, I will give him an outline of a gelatine process I have been experimenting in for some four or five years, and which so far as I have been able to test it, is the most rapid, the simplest, and the cheapest process known.—FINEM RESPICE.

[33130.]—**Lightning Conductors.**—Only one instruction is requisite—do not use any insulators; secure the conductor, which is best made of copper wire rope at least ⅜in. thick, to staples driven into the brickwork, or to any bands round the chimney. The point to be most carefully attended to is the securing a good earth-connection, and the best of all is to lead the conductor to the gas and water mains, if there are any—otherwise it must be taken to a stratum of moist earth, wet ditch, or pond.—SIGMA.

[33133.]—**Bicycling.**—It is possible to get a good second-hand bicycle. "Pegasus" should get a paper called the *Exchange and Mart*, and select one of the bicycles advertised in it—such as a "Challenge" or other heavy machine—and give about £10 for it. Those advertised at much less are either worn out or broken or defective machines. (1) Do not select a light machine to learn on. I bought a light new one to learn with, and knocked it all to pieces. When "Pegasus" has ridden 2,000 or 3,000 miles it will be time for him to think of getting a new one. (2) Beware of the so-called cheap bicycles; they are a delusion and a snare. A bicycle requires very careful workmanship in making and good materials, and this cannot be done for £7 or £8. (3) All the wearing parts. (The state of the paint and cuts in the tire are of little consequence, as they can be repaired with very little trouble.) (4) It is not at all necessary to learn on a "body jolter." In fact, I think you cannot learn on one.—TRANSIENT.

[33133.]—**Bicyling.**—"Pegasus" would do wel to avoid second-hand bicycles; they are generally damaged, antiquated machines, which are being cast on one side by riders who want a more elegant and modern steed; there are cases where circumstances compel a bicyclist to dispose of a good machine, but they are rare. As a seller, I find it to pay the best to sell a machine after having ridden it one or two seasons; the loss is only a few pounds, and to keep it there is the drawback of riding an old-fashioned bicycle, constant repairs, and the end being a general collapse and a dead loss of the whole. Cheap bicycles are as much to be avoided as second-hand ones. They are badly constructed, are of common material, and consequently very heavy, and they will cost nearly the value of a good machine in constant repairs; and to ride them is to handicap yourself to the tune of from ten to fifteen pounds in weight, and the pleasure derived is what you might reasonably expect from an intimate acquaintance with the treadmill. This class of machine may be had "all bright," without extra cost; or they are gaudily painted, or perhaps profusely gilt, and no end of extras given in. A beginner would not understand the different parts: the best course for him to take is to purchase from a good maker, such as Hamber, Cower, Green (B'ham), Coventry Machinist, Surrey Machinist, &c., &c. If you have rough roads, ask for a "roadster;" if good roads, a "light roadster;" give length of leg and your weight. Ball bearings are considered to run the easiest and to last the longest; parallel bearings (in my opinion), come next. It is possible to learn on a spider, but it is more difficult, and also dangerous to rider and machine, A bone-shaker is far the best and safest.—CAPTAIN, V.A.B.C.

[33136.]—**Siphon.**—The best arrangement you can have is to take the pipe direct from tank to ferncase. You can gain nothing by making a siphon, addition with the exception of innumerable difficulties.—W. J. LANCASTER.

[33139.]—**Power of Astro Eyepiece.**—Obtain focus of O.G. Let us suppose it to be 50in.; then obtain equivalent focus of eyepiece—suppose this to be ½in.; then in 50in. there will be 100 ½in., and 100 will be the power of the eyepiece on the lens named, roughly. You may get focus of O.G.; of course I mean solar focus, and also focus of eyelens in eyepiece. Then ascertain how many times focus of eyelens will go into focus of object-lens, and divide the quotient by ¾; thus: 50in. O.G.; ¼in. eyelens gives 200; then, 200 × 3 ÷ 4 = 150.—W. J. LANCASTER.

[33150.]—**Eruptions and Earthquakes.**—To JOHN S. LAKE.—"Naturforscher" for 20th April, 1878.—A. B. M.

[33152.]—**Carbon—Bisulphide Prism.**—I have found Kay's coaguline—which, I suppose, is a preparation of isinglass—do the work very well indeed. See that the surfaces are quite flat before cementing them, and have them quite clean, without any finger marks. You will be able, with care, to make a good prism.—W. J. LANCASTER.

[33155.]—**Bicycle Brake Cord.**—The lion leather brake cord will not, I find, break or cut through. I always use an oiled rag to rub down the spokes of my machine, which keeps them from rubbing—*A. N.*

[33155.]—**Bicycle Brake Cord.**—As I have for a long time been in the habit of covering catgut with No. 25 copper wire for several bicycle firms, I presume they find this to answer best for the purpose. The gut is first twisted very tight, and while in that condition wrapped round with the wire, so that it has the double effect of strengthening the gut and preventing its wearing out. I remember thinking they were violoncello strings, and marvelled where such a lot of those instruments went to—W. H. DAVIES.

[33168.]—**Zincography and Anastatic Printing.**—The two processes are quite distinct—in the former the drawing is either made on the transfer paper, or upon the zinc; in the latter (the anastatic) upon plain paper. But the results do not compare favourably. I should be glad to send D'Evlyn some trials of mine drawn upon plain paper—a transfer produced by collography or "gelatine surface," and transferred to zinc to print long numbers.—A. PUMPHREY.

UNANSWERED QUERIES.

The numbers and titles of queries which remain unanswered for five weeks are inserted in this list, and if still unanswered are repeated four weeks afterwards. We trust our readers will look over the list, and send what information they can for the benefit of their fellow-contributors.

Since our last "Telescope Tele" has answered 32230, 32740, 32746; J. Harris, 32755.

32300. Soap Substitute, p. 635.
32307. Induction Coil, 635.
32309. Dissolving Tap.—To Mr. Pumphrey, 635.
32310. Organ Pipes, 636.
32313. Microscopical.—To Mr. Allen, 636.
32316. Gold Shell, 636.
32323. Herapathite, 636.
32326. Pigments, 636.
32350. Traction Engines, 637.
32354. Colouring Fern Leaves, 637.
32357. Paste Blue, 637.
32358. Coal Tar and Chemicals, 637.

32799. London University Matriculation, p. 201.
32810. Grinding Dry Soap, 201.
32811. Basso, 201.
32814. Emery Stones, 201.
32820. Electrometer, 201.
32831. Toy Balloons, 202.
32832. Exhaustion Valves, 202.
32834. Disconnecting Compound Engines, 202.
32841. Tapper Bells, 202.
32849. Matt Size, 202.
32853. First B. A., London, 202.
32858. Steam Boilers, 202.

QUERIES.

[33159.]—**Locomotive.**—Can any of the readers of the Mechanic give some dimensions and result of working a loco., with the driving axle over the boiler? Where could I obtain a diaphragm of one, and also the engine with two pairs of cylinders and two smoke-boxes, and two funnels? I have seen one of these engines once in South Wales, belonging to the M. R. and C. Co.—W. H. Salford, Engine-driver.

[33160.]—**Sheave.**—Will some reader kindly help me? I have a large sheave that a wire rope works on, and there is a hole worn through it in one place, and I want to know is there any way of filling up this hole with some kind of cement or something? Any information would be very thankfully received, as it would save me a great deal of expense and trouble. Perhaps I should have said it is underground in a colliery the sheave is, and more inconvenient to replace than if it was outside; and I think it would last a long time again if I could have the required information.—Underground.

[33161.]—**Electric Bells.**—Would some of our readers kindly inform me whether there is any Léclanché or similar cells or battery specially made for electric bells &c., on board ships, screws, paddle boats, or the sea generally.—W. R. S.

[33162.]—**Soap Bubbles.**.—Can any one tell me the best manner of making a lather for blowing soap bubbles.—F. B. L.

[33163.]—**Works on Chemistry.**—Would Mr. Allen, or some other chemist, kindly say what works he would recommend to one who wishes to get a sound knowledge of chemistry by working at it himself, being unable to attend classes &c.? Has got Roscoe's "Elementary," Bowman's "Practical," and Attfield's "Pharmaceutical Chemistry." The object is to have a good knowledge of analysis.—F. C. F.

[33164.]—**Properties of Matter.**—Is it consistent to say that impenetrability and divisibility are both properties of matter? In their definitions, divisibility refers to aggregations of atoms, and impenetrability to the atoms themselves. In giving definitions to these properties, both definitions should refer either to the atoms, or to aggregations of atoms. If this is followed out, I do not think that matter can be said to be divisible if we speak of atoms; or that it can be impenetrable if we speak of masses.—L. Bergmann.

[33165.]—**Painting Imitation Granite.**—Can any reader inform me how to paint the stone pillars of a window, so as to represent granite? What colours are required, and how is the finishing process accomplished?—Inquirer.

[33166.]—**Asbestos.**—I want to cover tubing with some thin material that will bear being submitted to considerable heat. Asbestos would, I think, answer my purpose, but I am unable to work it up, so as to form it into thin sheets similar to paper. Will any one kindly tell me how to manage this?—Cardinal.

[33167.]—**Steel Watch Chains.**—Could any reader inform me as to the best method of blacking steel watch-chains for a certain purpose? I want to black them over; have tried Brunswick-black, lamp-black, and Berlin-black, but find that neither one will answer, as the black so soon wears off.—W. E. P.

[33168.]—**Foundry Coke.**—Would any correspondent inform me as to the process of making foundry coke, or refer me to some work on it?—J. E. Grandin.

[33169.]—**Renewing Grenet Cells.**—Would Mr. Lancaster or any of your correspondents tell me how to renew some Grenet cells that have been used for electric bells, and are quite exhausted? And the name of the composition for covering tops? and how to use it in covering cell tops? And if it would not be trespasing too much, should feel greatly obliged for a little information as to repairing Léclanché cells also.—J. King.

[33170.]—**Outrigger.**—Will some reader give the size of an outrigger to carry a person weighing 10 stone?—Torpedogo.

[33171.]—**Battery.**—Would some correspondent inform me which battery offers the highest resistance—a Léclanché or a sawdust Daniell?—A Very New Subscriber.

[33172.]—**Anti-Corrosive Oils.**—Perhaps some of our kind readers will inform me how these can be prepared on a small scale?—Cripple.

[33173.]—**Electricity.**—Will some gentleman competent to do so advise me as to the application of electricity for the cure of rheumatism? First, should it be what is called the constant current and from what source? Second, should the current be received direct or through a bath? Third, what direction should the current take through the body? Should be glad for instructions to make a simple and suitable battery, as I find the medical batteries are very expensive.—C. Engineer.

[33174.]—**Olive Oil.**—Can any of our readers give me the exact composition of pure olive oil? I have been told that it contains palmitine (the principal constituent of palm oil), but in "Fownes' Chemistry," last edition, he makes no mention of palmitine in olive oil, only stearine and olein. I would like to know what substances, if any, expand on solidifying besides water and bismuth, and oblige—Gallium.

[33175.]—**Midland Express.**—On Monday, June 3, 1878, a very fast special express left London at 9.15 and only stopped for changing engines. It arrived at Carlisle at 4.27 the following morning. Can any one say why it ran and give the booked speed, compared with the ordinary 9.15 express? Also the booked time of the 10.45 Liverpool to London.—Passenger.

[33176.]—**Midland Lights.**—I see the red lights on the back of many trains in a line. How is this, and why do I see a green light on several goods and express engines? Also at King's-cross (Met.), what does a white board, plain, or with crosses, denote?—Passenger.

[33177.]—**Watch Tools.**—The writer would esteem it a favour if any of our readers could give him the average price of a set of tools (new or second-hand), suitable for general jobbing work in watches and jewellery. A list of them will also be gratefully received.—W. B.

[33178.]—**Restoring Gilded Organ Pipes.**—What can I do with a set of organ pipes that are somewhat battered and have the gilding knocked off in places?—Rango.

[33179.]—**Phonograph.**—Must the cylinder of this instrument be limited to 4½in. in length? This would only suffice for a speech of about 30 seconds. I suppose when the point has once travelled to the end of the cylinder the tinfoil must be renewed. How comes it to pass that the returning point does not indent the tinfoil rather than ride up and down over the indentations already formed? The spring to which the second point is attached seems to be of considerable strength.—Tyro.

[33180.]—**Closing Tubes of Spirit Levels.**—When this is originally done I believe it is by the agency of heat. The other day, wishing to fill one with coloured spirit, I rubbed down one end on a Turkey stone, took out the colourless spirits (spirits of nitre, for the third time in my limited experience), and refilled it with coloured alcohol. My difficulty now is to keep it there. Nothing soluble in alcohol will do, such as resin, &c. Can any of your readers kindly help me?—J. L. H. S.

[33181.]—**Life of a Watch.**—My wife and myself have each of us a Geneva watch. Mine was a most reliable one, and my wife gives a good character to hers. Of late each watch has been under repair more frequently than we care should be so. We keep to the same firm, which has always used us and our watches well. An idea has occured to me. How long should a Geneva watch last with careful usage, its cost when new taking two figures in the pound to state it?—J. L. H. S.

[33182.]—**Valuation.**—A, 21 years of age, is entitled to property on the death of B, 56 years of age, and both are anxious to realise. Can this be done? If so, in what proportion would A and B be entitled to the proceeds?—Beta.

[33183.]—**Purifying Nitrate of Potash.**—Can any chemical correspondent inform me how to purify nitrate of potash?—J. M.

[33184.]—**Raising Water.**—Will any reader kindly mention and describe a plan or a machine whereby I can without loss lift water from an underground cistern to one in the house? It must be self-acting. Height about 40ft. Living in a district wholly dependent on rain water for supply I could not afford to use an hydraulic ram on account of the waste. Would a pulsometer do?—Habitans in Sicco.

[33185.]—**R. A. of Stars.**—Some plain instructions for working the R. A. of the several stars would be very acceptable. I thought that meridian passages might be found by adding to the R. A. the transit of the first point of Aries for the same day; but on comparing my results, after deducting 24 hours, I am out more than a minute in all the reported southings of the stars on the 1st of June in your journal, and if I treat the R. A. of the sun for the meridian passages and check the result with the southings it is five minutes out.—P. Squire.

[33186.]—**Organ.**—Will any contributor on this subject give me his advice as to the most suitable key-action for an organ of 17 sounding stops (great 8, swell 7, pedal 2), compass CC to G in alt.—the size of instrument to be 10ft. 6in. wide by 8ft. deep by 12ft. 6in. high? I should prefer placing the pipes on alternate sides of soundboards with treble pipes in centre and passage-board for tuning, but am doubtful about height being sufficient for roller-boards. If this arrangement is admissible, a sketch of most compact form of roller-board will oblige. I would also venture to request scales for following stops (open diapason being 6¼in. dia.)—viz., stopt diapason, hohlflute, stopt flute, piccolo, pedal bourdon, and violoncello, all of wood.—H. D

[33187.]—**Force Pump.**—I should be glad if "Black Witch" would give me drawings and dimensions of the pump.—Young Engineer.

[33188.]—**Pressure Gauge.**—Could any kind reader give me particulars of "bourdons," as I wish to make one to work up to 80lb., and about 1¼in. in dia.?—Young Engineer.

[33189.]—**Luther's Chorales.**—Will some reader kindly say where I can get the original form of these inimitable compositions? I hardly know two hymn books which give "Ein Feste Burg" alike. If I were also informed of the titles of some of the leading hymn-tune collections of the German Lutheran Church I shall fee under a deep obligation.—George Bell, B.A.

[33190.]—**Piccallili.**—Will any reader of "ours" kindly give a receipt for the above article? Have tried several forms without success, the ingredients separating when left to stand, leaving a thin liquid above and a yellow paste below. The secret appears to be in making a mixture about the thickness of cream, which will be permanent.—Hannah.

[33191.]—**Fumigating Wood.**—Could any reader inform me how to treat soft and other woods, to give it the colour and appearance of old oak? I understand it is done by putting the wood into an airtight box, then filling the box with fumes. What kind of wood and chemicals are used, and how applied?—Cabinet-Maker.

[33192.]—**Keeping Colliery Engine Bright.**—I am a winder at a colliery out of a pit which unfortunately happens to be the upcast, which is only five yard from engine-house. The air when blowing west bein naturally weaker, the furnace is doubly forced to keep u the current through the work, and I, being west from pi unfortunately drop in for a fair share of smoke an sulphur. I would like some one, having had a littl practice, to inform me how I could keep my engine brigh having so much smoke to contend with, which causes th bright work in a few hours to become yellow, and als much impairs my health. I may say I have tried a ru over of paraffin and other oils, but without success.—E. P., Engineer.

[33193.]—**Iron Pianoforte.**—Having ventured m hand at one of these I shall be much obliged if Mr. Davi or any practical reader will afford me a little guidanc In the first place how is the soundboard to be fixed to th back? I notice there are screw-holes in the iron, but n tap to them; so that from that, and the countersinkin of the holes, I presume the thread will have to be in th thin soundboard, and it puzzles me to know how th will hold, as a wooden nut outside the soundboard woul be unsightly; second, should there be any glue or cemen of any kind to bed the soundboard on to the iron? third I see advertised a "reverberating soundboard." I am, o course, ignorant what sort of a soundboard this is, but i it in any way answers to its cognomen it would seem to b a desirable addition, and, as I am wishful to have eve improvement within my reach, I should very much lik if I am not asking too much, a description of this and o its effects. I may say that I have laid out my "scale carefully from instructions lately given, and, being prett handy with my tools (such as they are), and determin to spare no pains, I have every hope of ultimate succe dependent upon such kind advice as I may receive.— Hardisty, Nantwich.

[33194.]—**Mining.**—Will some of "ours" answer th following queries:—First, why are square curbs put in shafts, and how, and when necessary? Second, how a round curbs put in and fastened where the ground, bei sunk through, is sandy or loose? Third, what is th proper name of what colliers call "white damp"? Wh is the meaning of "atomic weights" when speaking o different gases?—Roscoe.

[33195.]—**Dying Intestate.**—A man has died inte tate, leaving a widow and one child (girl under two yea of age). His estate consisted of furniture and the lea of a house, whose term expires 28 years hence, and who net rental is £20 per annum. The widow has no bloo relatives nor any means of support in England, but th relatives of her deceased husband—father, brothers, &c. are in England, and in tolerably easy circumstances. Sh thinks that if she had funds enough to carry her t America, where she was married to deceased, and whe she also has blood relatives, she could get an ea livelihood. In reference to her case, the following quer are made, and information thereon and on other poin pertinent, will greatly oblige. 1st. Must letters o administration be taken out—if so, by whom? 2nd. Ma any part or the whole of the estate be sold by the wido so as to raise capital for starting a business, and thus t provide support for self and child; or even to provid means for carrying them to America with the same vie or to carry the widow only to that country, the gran parents keeping child in her absence? 3rd. Can th father or brothers of deceased claim any part of the esta under any of the circumstances above stated? 4th. Is th father or are the brothers in any way legally liable to sup port the child, if the widow is unable to do so? Will an reader of "ours" give other necessary information on th above subject, and also kindly name any little book on th matter, its price, and where obtainable.—R. J. G.

[33196.]—**Bar Magnet.**—Will Mr. Lancaster, or an other gentleman, inform me the best way of ascertaini when a telephone bar magnet, 5in. long and ¼in. in di meter, is magnetised to saturation?—G. J. C.

[33197.]—**Mathematics and Observation.**— John Herschell, in his outlines of astronomy, says:— sound and sufficient knowledge of mathematics is ne sary for the student who wishes to go beyond t threshold of astronomy." Could "F. R. A. S." indic a mathematical course which would fulfil the ab requirements without going beyond the bounds of w I may call an amateur in astronomy? I should als glad to know which is the best astronomical almanac general observation?—W. S.

[33198.]—**Brakes.**—There is a new brake on Midland which is most disagreeable; the air rushes u chimney, and makes a dreadful noise, and as soon a train stops it recoils about 2 yards. What is it?— senger.

[33199.]—**Rapidly Raising Temperature Water.**—Will some fellow-reader kindly inform m quickest way to raise the temperature of a pail of (containing about 3 gallons) from 50° to 120° F., b aid of gas only? Any patented method or otherwi be gratefully received, as it is for private use o A. C. R.

[33200.]—**Legal.**—Will some of our legal friends me a little information as to the following?—A. B. intestate in London in 1802. The Court of Chanc said to have advertised from time to time for his n kin. How can I obtain particulars as to value o property, &c.? Would property left as above be di among the descendants of A. B., or is it the heir- only who is entitled to it?—R. O.

[33201.]—**Sulphuric Acid.**—Would some sulphuric acid manufacturer or manager kindly give his experience on the following? I find from several years' comparison I have used 21cwt. Scotch coal per ton of o. v. produced. This includes steam boiler for the chambers, and evaporating in the Leach boilers before transferring to the glass retorts, which are of the usual make, rectifying two carboys each. I would gladly give in return my experience for the benefit of our readers of the product of o. v. obtained per ton of Spanish ore:—The cost per ton of o. v. for sulphur; ditto coal; ditto retorts; ditto retort-ts; ditto straw; ditto hampers?—O. V.

[33202.]—**Algebra.**—What is the meaning of a figure placed below a symbol, thus—$x_4 y_6$. I know what they mean when placed thus—$x^4 y^6$.—ROSCOE.

[33203.]—**Civil Service.**—1. What are the duties of the custom officer and clerks in the Custom-house? Also what different stages of appointment are in this branch of the service? 2. What are the duties of the excise officer and clerks in the Excise Office? Also what are the different stages of appointment in this branch of the service? 3. What subjects are candidates going in for the above examined in? Also where and how often are the examinations held? 4. What extra subjects, if any, are candidates examined in for Indian or Colonial service? 5. Are the Government surveys at home and in the colonies included in the Civil Service? I should feel much obliged if some fellow-reader would kindly answer the above or inform me if there is any book which treats of the subject in detail.—R. C.

[33204.]—**The Phonograph.**—To MR. SHELFORD BIDWELL.—I have constructed a phonograph exactly in accordance with the instructions given by Mr. Bidwell, and should be much obliged if he would inform me whether the tearing of the tinfoil, which is my chief obstacle, is due to want of adjustment or to the points being too sharp? The tinfoil is of the thickness recommended by him, but the turn of a hair's breadth too much in the adjusting screw, or even the mouth touching the mouthpiece while speaking, causes the point to tear it. Also I cannot succeed with the paper diaphragm, as Mr. Bidwell seems to have done; but the iron diaphragm reproduces speech with tolerable distinctness. Can Mr. Bidwell give me any idea how to avoid the tearing of the tinfoil? If so I shall be grateful, as I have incurred considerable expense, and the results are not quite what I hoped for.—F. B. S.

[33205.]—**Automatic School Bell.**—I wish to ring a large school bell automatically. Can any one oblige me with information as to the size of electro-magnet required for a hammer of about 2½in. by 1½in.? Details as to automatic arrangements, size of core and wire, and length of wire, as well as kind of battery best applicable, and number of cell, would be very acceptable.—Ph. D.

[33206.]—**Electrical.**—Will "Sigma," or any fellow-subscriber, kindly answer the following queries? 1. If the two carbon points of an electric light were quite free, when in action, to advance upon, or recede from, one another, are there any forces of attraction or repulsion capable of causing them to change the interval between them? 2. What percentage of the carbon lost by the one is transferred to the other?—J. H.

[33207.]—**Capital Investment.**—I trust that, in submitting an inquiry of this nature, I am not trespassing upon forbidden ground, but that as our journal ever readily opens its pages to the requirements of all, this also may be permitted to find an entry. It seems dangerous and difficult for the uninitiated to fix upon a proper investment for savings with a view to its being fairly productive and sufficiently safe. The Government securities whilst unquestionable as to safety, are meagre in the matter of returns, and necessitates a large amount of capital to insure a sufficient income for existence. Deposit banks are but little if anything better in this respect, whilst in other ways a good deal of risk seems connected with investments at 5 per cent. or above. Probably many of our friends may be in a position to give some serviceable hints upon this subject, which might be of use to a number in like circumstances as myself. There may be many who, after years of work, may have accumulated from savings and business, a sufficient amount to lighten the present daily labour if it could be advantageously and safely employed; but who, from ignorance as to outside fields of investment, or from unwarranted timidity, are unable to avail themselves of this assistance. For such, sound advice, such as might be expected through the medium of this journal, would be of great value, and as one would be gratefully accepted by—AN ENGINEER.

[33208.]—**Dynamo-electric Machine.**—Would Mr. Lancaster kindly inform me concerning the size of wire, quantity, and best form for making a model dynamo-electric machine?—CHEMICUS.

[33209.]—**Brewing.**—Could any of "ours" who brew their own ale inform me (1st) what quantity of malt and of hops it takes to brew 18 gallons of a good ale? 2. How could I erect (cheaply) coolers for that quantity? 3. How long would it take to ferment, and how should I know when the fermentation had stopped?—TOBY.

[33210.]—**Mining.**—Would any reader be so kind as to answer the following? 1. Describe the best method of placing the frames of a separation door in a long-wall gateway, the inclination of the seam being 2in. in 36in., with a superincumbent pressure of 258 fathoms; area of goaf, 17,200sq. yard. 2. Which do you consider the best kind of door hinges and crooks to make the door fall to, the hanging stanchions being placed in a vertical position. 3. Is it possible to place the hanging stanchion in a vertical position with the inclination of the seam, and the door to fall to by its own weight?—E. H.

[33211.]—**The Phonograph.**—To MR. SHELFORD BIDWELL.—I have constructed a phonograph according to Mr. Shelford Bidwell's excellent explanation, but am quite unable to make it produce the slightest sound. My cylinder is made of cast brass, the hollow being filled with wood, through the centre of which runs the iron spindle. When cutting the thread (8 to the inch) upon the cylinder, the brass, which was evidently badly cast, broke away at one place in a patch; the remainder, however, came out pretty well, and so two-thirds of the cylinder was fit for use. I therefore mounted it exactly as described. In putting the point on the plate (ferrotype) I caused the plate to bulge a very little just behind the point. I think this can hardly hinder the vibration of the plate in any sensible degree. The parchment paper diaphragm I could not get very tight; it gave sensibly to the touch, but when attached to the spring (clock mainspring, of dimensions as given) it became quite tight. I do not know whether the paper should have been quite tight before attached to the spring. I procured some stout tinfoil (15 sq. ft. per pound) and mounted some on the cylinder, so that it lay quite flat and fitted tight. I joined the edges with gum, which therefore overlapped each other, and also put two indiarubber bands round. I caused the scratches made by each point to coincide exactly, testing it with a magnifying glass. I then screwed up one point till it made a good furrow, spoke into the mouthpiece, turning at the given rate, then loosened one screw and screwed up the other point till it pressed firmly at the bottom of the furrow and turned the handle and, the result was perfect silence. If Mr. Shelford Bidwell could give me any idea as to what is the matter with the instrument I should be exceedingly obliged.—M. WILLIAMS.

[33212.]—**Prussiate of Potash.**—Will some chemical correspondent kindly oblige by giving information respecting the chemical compound known as prussiate of potash (extensively used in the manufacture of blue pulp used by paper-makers)? 1. Its chemical constituents? 2. How manufactured, and from what articles? 3. What is a simple test for strength and purity?—E. ALLEN.

[33213.]—**Aniline Black.**—A subscriber would be glad of information as to the method of producing the rich bloomy black which silk velvets have when new? No aniline black he can get will produce the shade. He would also be glad to hear of an aniline suitable for dyeing skin mats.—GARMENT DYER.

[33214.]—**Brass.**—Will some reader say how I may add some other metal to brass while melting it to make it as stiff and rigid as possible, without being "crapply," and yet not add much to the melting point of the brass?—A SHEFFIELD BLADE.

[33215.]—**Arsenic in Violet Powder.**—Will a correspondent give a simple test by which arsenic in violet powder may be detected? So many ladies and nurses look upon the use of the powder as indispensable that a great favour would be conferred upon the "lords and masters" if they could discover the poison by a simple process. Immense benefit resulted from the publication by the German Government of a simple test for aniline used as colouring for clarets.—N. SIRCH.

[33216.]—**Improvements in Bicycles.**—Will "Alderly Edge" please advise? I have applied to a maker to get a machine to his plan of two small hind wheels 12in. apart. He (the maker) says it is a plan that has been tried and abandoned because unsafe; that it would be impossible to turn a corner without an upset, unless a series of springs and levers were fitted to it; that it runs or would run heavily; and that it has many other objections, and would be as troublesome to learn as a bicycle proper.—B. N.

[33217.]—**Converting Bicycle.**—I have a 42in. Ariel bicycle, hind wheel 24in. Will some one give me instructions and particulars, including probable cost, &c., of converting it into a twin back-wheel machine, as I am a very timid rider?—JUNIUS.

[33218.]—**Leather Composition.**—Will "B.," who has given us something worth knowing for piecing belts, or any other reader, answer the following? I have made a flexible composition for leather, which renders porous and inferior leather waterproof and very strong, and it also improves the best leather; it dries hard and tough in ten minutes. A friend has tried it for belts and says it is valuable for that purpose. Would it be so for belting in the cotton factories and district generally? If so I would advertise it in the ENGLISH MECHANIC.—BARTRAM.

[33219.]—**Electric Light for Workshop.**—How many actual horse-power would be required to light a large workshop, say 60ft. by 30ft., from the roof, by means of a magneto-electric machine; and which kind of machine would be best adapted for the purpose?—RUPESVADUM.

[33220.]—**Muriate of Tin.**—Can scrap tin, &c., be cheaply converted into muriate of tin, and sulphate of iron(so as to be worth the trouble and expense commercially; and if so, how would it be best accomplished, or what profitable use can be made of this waste material?—A. Z. O.

[33221.]—**Analysis of Alum.**—How can I accurately detect and determine quantitatively free sulphuric acid, also iron in commercial alums?—DUNSOBARKY.

[33222.]—**Mining Engineer.**—What constitutes the privileges of a man signing M.E. after his name?—DUNSOBARKY.

[33223.]—**Apprenticeship.**—A boy is bound to a special branch of profession, glass trade, as apprentice for a term of years at a large firm. After about a year all hands receive notice to leave except the apprentices. When the notices have expired some are treated according to notice—others are withdrawn on their accepting certain terms offered—a reduction of wages and longer hours—to work from 6 o'clock a.m. to 6 p.m., overtime accordingly, instead of 6 a.m. to 5 p.m. How does this affect the lad? Is he bound to work the extra time?—W. R. S.

[33224.]—**Channel Islands (Iles Normandes).**—In Vol. XVI., pp. 563 and 585, and Vol. XVII., pp. 18, 72, and 125, I find statements as to cost of living in Guernsey and Jersey, which are very interesting, but there is nothing said about the climate, and if suited to persons suffering from asthmatic and bronchial affections. Jersey, I understand, is somewhat large, and more densely-populated than Guernsey, and possibly, also, the most expensive to select as a permanent residence. Can any of our friends inform me upon the following, in addition to the foregoing?—1. Are the schools good for the higher branches of education? 2. Are doctors' fees as high as in England? 3. Would Jersey or Guernsey be preferable for a family to reside in, taking all things into consideration, and assuming an income of £350? 4. Presuming that a residence near to the sea is preferred, is there any spot on the English coast preferable on the whole to the Channel Islands? 5. I have heard that Jersey is like a great orchard, and Guernsey like an evergreen meadow interwoven with rivulets, and dotted with orchards. Is this general description correct? 6. What is the average elevation of the surface above the sea level, and are the islands exposed to severe gales and storms? 7. What communication exists between England and the islands respectively, and with what English port does the most passenger intercourse take place? The inquirer has been accustomed to residing abroad, so that the mere matter of strangeness would be of no importance.—RESPICE FINEM.

[33225.]—**Halse's Galvanic Battery.**—Will some one who is acquainted with the details of the above mentioned apparatus kindly give me particulars of its construction—*i.e.*, size of battery, plates, and mode of producing the vibrations? From the pamphlet Mr. H. publishes I gather that the battery is a 12-cell Smee, which, of course, would be worked by dilute sulphuric acid; but I do not quite understand the construction of the coil, which apparently consists of only one wire (primary). I have an idea that by the motion of a spindle a current-reverser is brought into operation. Please give the number and length of wire on coil, whether silk or cotton covered, if an iron core is used, how vibrations are produced, and how regulated.—LITTLE HARRY.

[33226.]—**Gelatine.**—How should this be prepared for mounting photos? What proportion of water? Should anything be added as a preservative?—JOHN.

Good Work.—The *Railway Age* asserts, on the strength of considerable correspondence relative to the achievements of locomotives, that the best running on record is that of one of the locomotives of the Western Maryland Railroad. According to the statement of Manager Hood, that engine made the extraordinary run of 59,953 miles in one year, at the low rate for repairs of one and a half cent. per mile run. Can any better results be shown here?

The Corrosion of Iron.—At the Conference of Architects, held last week, Prof. Barff, in replying to some questions, stated, says the *Building News*, that for the chamber at present in use, 5ft. × 2ft. 6in., and 1ft. 6in. high, the outlay on fuel for subjecting the articles within the chambers to superheated steam for 10 hours was 5s. In a manufactory this cost would be greatly reduced. A West Bromwich firm, who were working the patent under a royalty, informed him that the cost would not approach that of galvanising iron, and he supposed it would little exceed that of the periodical three-coat paintings. The increase caused by oxidation could be estimated, and to fit nut and screw for each other allowance must be made for this in casting. As to the treatment of riveted articles, and the danger that the coating film would be removed, he would admit there was some difficulty in this; he supposed boilers would be treated in large chambers when made up. When the rivets were hammered or pressed into the plates the coating was removed, and of course those spots would be attacked by rust. The remainder of the plates might be protected from abrasion; the practical difficulty was to re-oxidise the rivets in situ. To accomplish this he proposed to cover the band of rivets with a porous cap of silicate cotton, and to subsequently re-oxidise that portion. But even if this were not successful the rusting of the rivets would be of little practical injury, as it would take so many years to rust through a rivet, and the corrosion could not spread laterally, on account of the repellent character of the black oxide. As to the pressure of steam in the boiler 40lb. was the extreme; but they were obliged to use considerable force to effect the double object of keeping out atmospheric air and to efficiently oxidise the surfaces treated. The oxidation only proceeded till the pores of the iron were all filled up with black oxide; but with very thin objects great caution had to be taken, lest they should be oxidised through.

The Physical Action of the Microphone.—Professor Hughes read a paper on the above subject before a meeting of the physical Society, held on Saturday afternoon at the Science Schools, South Kensington. The author, in the course of his paper, said that the problem of the microphone being solved, it required only to observe the general considerations to produce an endless variety of microphones, each having a special range for resistance. The tramp of a fly or the cries of insects required little range, but great sensitiveness. For a man's voice the surfaces were under a far greater pressure than for the movements of insects. As yet he had found no such insulator for sound as guttapercha was for electricity. Caoutchouc seemed the best, but he had never been able by its use to prevent the microphone from reporting all it had heard. The question of insulation had become one of necessity. If they could insulate it so as to direct its powers on a single object they would be able to investigate the object desired undisturbed by the pandemonium of sounds which at present the microphone revealed where they thought was complete silence. However simple the microphone might appear at the first glance, it had taken him many months to bring it to its present state. He and Dr. Richardson had been experimenting on lung and heart diseases, and although the application by Sir Henry Thompson was more successful, he did not doubt their ultimate success. There was also hope that deafness might be relieved, and there was hardly a science which would not be benefited where acoustics had some direct or indirect relation. Throughout the whole of his investigations he had used Professor Bell's wonderful sensitive telephone instrument as a receiver. A cordial vote of thanks was passed to Professor Hughes.

CHESS.

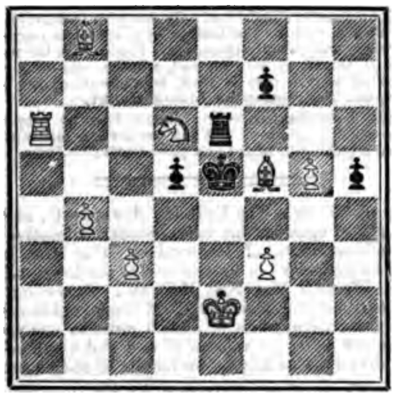
All Communications intended for this department must be addressed to J. Pierce, Copthill House, Bedford.

PROBLEM CCCCXXX.

Motto: "A Poor Thing, Sir, but Mine Own."

(British Chess Problem Association Tourney.)

Black.



White.

White to play and mate in three moves.

Solution to 427.

White.	*Black.*
1. Q to Q Kt 5.	1. Anything.
2. Mates.	

Correct Solutions to 426 by J. J. Amery and W. H. Ferry; to 427 by Agregog and W. H. Ferry.

Agregog.—On looking again at 424 you are clearly right, and 1 Q to Q R 5 is without an effectual answer.

Correct Solution to 427 by W. H. Ferry; if, however, 1. $\overline{\text{B to Kt 7.}}$ 2. P mates.

ANSWERS TO CORRESPONDENTS.

*** *All communications should be addressed to the* Editor *of the* English Mechanic, 31, *Tavistock-street, Covent Garden, W.C.*

HINTS TO CORRESPONDENTS.

1. Write on one side of the paper only, and put drawings for illustrations on separate pieces of paper. 2. Put titles to queries, and when answering queries put the numbers as well as the titles of the queries to which the replies refer. 3. No charge is made for inserting letters, queries, or replies. 4. Commercial letters, or queries, or replies are not inserted. 5. No question asking for education or scientific information is answered through the post. 6. Letters sent to correspondents, under cover to the Editor, are not forwarded; and the names of correspondents are not given to inquirers.

The following are the initials, &c., of letters to hand up to Tuesday evening, June 11, and unacknowledged elsewhere:—

G. F. Lee.—J. H. Sartor.—James Durrant.—Young Farrier.—Telescope Tele.—R. P. G.—A Grocer.—F. J.—Cicester.—Jackson.—Photo Cymraeg.—John.—An Old Reader.—Hortulanus.—A Banker's Clerk.—L. Smith.—B. L. P.—W. H. P.—A Lover of Science.—R. M.—Edmund P. Toy.—T. Jinks.—J. D.—T. Shores.—Morgan J. Evans.—W. F. Hoyle.—J. Carvill.—A Civil Engineer.—Gear.—Never Rust.—One for Croysdale.—Cameron.—Handsworth. — Jasin. — Henricus. — John Earl Clay.—J. G. F.—An Invalid.—H. L.—Richard Temple.—Americus.—C. C. W.—R. S. S.—T. S.—Amateur.—A. A. Watkins. — Smeaton.—A Lover of Perfection.—J. W. S.—L. L.—Plymouth Free Library.—S. Hunt.—B. O. S.—D. Strathearn.—J. E. Floyd.—A Fitter's Apprentice.—H. L. — E. K. Elliott.—F. E. Spiller.—Ellesmere.—Armourer.—Cure.

J. R. Vincent. (The beans you refer to are imported into this country for the feeding of cattle. They are the pods of the carob tree (Ceratonia siliqua), which grows in the East, and particularly in Palestine. They are said to have been the "locusts" on which St. John the Baptist fed in the wilderness. The tree is also found in the Levant and the South of Europe.)—B. J. (Vellum is simply parchment made from the skins of abortive or sucking calves. It has a finer grain and is whiter and smoother than parchment.)—J. T. (We should be glad of the proffered hints on the preparation of chestnut meal. Italian babies—and Italian men too for that matter—thrive well enough on it, and there seems no reason why it should not be more used in this country either by itself or for supplementing wheat flour.)—William Harding. (Thanks for your approval and kind aid.)—Torpedogo. (The First Lord of the Admiralty is the proper person to apply to. If our Government refused to listen to you, of course you would be at liberty to offer your invention to any foreign power. We trust, however, that the immediate course of events may disincline Governments to waste money in such destructive appliances.)—Some One. (We fail to recognise the plant, but its condition is bad, and you have not sent any of the leaves. A local botanist would be the best person to apply to.)—Nose. (Indigestion frequently causes the unpleasant redness complained of.)—Willington. (Yes; but it is a dirty practice, and will inevitably injure the children's hair. People who have the will and the command of soap and water can always ensure freedom from insect pests without having recourse to dangerous poisons and chemicals.)—R. J. G. (It is not true. Any one can prepare such deeds; but only a very clever man—or a fool—would trust himself to do so.)—W. M. S. (The difference in price is caused by difference in size and quality of materials. We have no reason to doubt the honesty of any of the manufacturers alluded to. We expressly stated that Professor Hughes had declined to protect his discovery. Back numbers can be obtained through any bookseller or direct from the publisher.)—J. B. B. Hockley. (To stain brass black take 10oz. muriate of arsenic, two pints of permuriate of iron, and one pint of water. Use by simple immersion and then lacquer off with pale lacquer. Hundreds of receipts for bronzing appear in our back volumes.)—Fly Hater. (Numerous methods of destruction have been advised in back volumes. Have you tried smearing the woodwork of the room with laurel oil?—A Poor Man. (Directions for curing rusty kitchen boilers appeared on pp. 19 and 126, Vol. XXVI.) Clark. (We know of no good book on the subject, but if you were to apply to the Secretary of the Deutscher Turnverein, at King's-cross, you would probably get the information you want.)—A. M. (The value of your invention all depends on the nature of "the other article." Some of the makers of model engines, boats, &c., might purchase your invention. If you think it worth spending ten guineas on, it would be best to get provisional protection for it, and then offer it to a manufacturer.)

J. H. T.—See indices to back vols.

An Old 'un, Goldsmith, F. Ede, G., Chingachgook.—Your queries are advertisements.

W. W., A. Moule, Lossit, and others have replied to queries already similarly answered.

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The English Mechanic
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FRIDAY, JUNE 21, 1878.

ARTICLES.

IS THE MOON INHABITED?

THE writer of these remarks has repeatedly had the above question put to him: in return he would put the following:—What evidence have we of the habitability of the moon? Some writers have indulged in the speculation that, with the large telescopes now in existence, armies of soldiers, troops of elephants and such like may be detected on the march, and others have surmised that buildings might be seen and the styles of architecture ascertained. The ideas such extraordinary statements may induce in the minds of the uneducated render it desirable to examine a little into the probability of obtaining such results. The diameter of the moon is 2,163 miles; but, as it never remains at the same distance from the earth, being sometimes nearer and sometimes farther, it never presents the same *apparent* diameter as seen in the sky. When nearest the earth it is seen under the largest angle, or 33′ 33″·20; but when farthest from the earth it is seen under the smallest angle, or 29′ 23″·65. Now it follows from the relation between the real and apparent diameters of the moon, at its mean distance from the earth, that a second of arc, written thus (1″), is the angle under which a mile and a little more than the tenth of a mile, written thus 1·139, is seen at the centre of the moon's disc; again, as a second is pretty well the *smallest* distance that can be clearly discerned, it follows that a building on the moon to be clearly seen—we may say to be seen at all, must be about a square mile in extent, and then it would be seen only as a spot, light or dark according as the materials of which it was built reflected a larger or smaller quantity of light.

There are some very level plains on the surface of the moon, surrounded by mountains. One such plain has been very carefully examined; it is about 60 miles in diameter. The mountain wall rises to a height of 3,000 feet on the south, 3,200 on the west and north, and 3,800 on the east. On the wall are four lofty pinnacles of rock, three on the west and one on the east. The highest, which is on the east, rises to the height of 7,418 feet above the level interior; the next highest is on the west; its altitude is 7,258 feet; the two lower rocks are respectively 6,296 and 5,128 feet above the interior.

Let us place ourselves, in imagination, within the confines of this mountain-cinctured plain, and view from its centre its girdling rocks at a distance of 30 miles; they would appear from this point under a vertical angle of very little more than one degree, and the highest rock on the east would subtend an angle of less than three. It is believed that no other portion of the moon has undergone so close a scrutiny as this. For three years has its surface or floor been examined, during sunshine upon it, with telescopes able to bring small objects into view, and the results carefully discussed, from which it appears that nowhere on this plain has anything at all approaching the nature of a building or a collection of buildings been detected. At various intervals, as many as 36 small white spots have been seen during the three years, but never the whole together. Ten of these spots have been ascertained to consist of volcanic cones, the bases having an average diameter of about one mile; the base of the largest, near the centre of the plain, certainly does not exceed two miles. With the exception of these natural productions nothing sufficiently elevated above the surface to cast a shadow at sunrise or sunset exists on this plain; there are, indeed, some remarkable variations of brightness upon it: for example, about the middle of the day, when the sun is highest, it appears very dark, almost black, but there is nothing to induce the opinion that a patch of a different tint exists anywhere on this plain, such as might be supposed to arise from a collection of buildings covering a space of four or five miles in extent. From such facts as these, the results of close and unremitting observation, into which conjecture is not permitted to enter, we are forced to the conclusion that the evidence we possess of the habitibility of the moon is very scanty. Indeed, it does not even furnish a clue by which we might institute a series of observations likely to lead to a positive result.

It must, however, be remembered that the walled plain, Plato, to which the foregoing remarks refer, is but a very small part of the moon's surface, and it would be manifestly unsafe to draw any conclusions on the above question from the examination of so small a part, carefully as that part has been examined. While there may be great difficulty in detecting any evidence of artificial construction, it is beginning to be ascertained that there is not so much difficulty as formerly in detecting instances of physical change. The discovery in May, 1877, by Dr. Klein, of a dark spot northwest of Hyginus, where nothing of the kind had been seen before, combined with the celebrated case of Linné, will go far to show that changes of a physical character and of sufficient magnitude to be seen from the earth are now in operation, and will doubtless open up a line of research by which we may learn something of the nature of the forces at work within the moon, and form more accurate notions of our satellite than those to which we have been treated of late years, such as a "burnt-up cinder," "a dead world," or one reduced to its last stage of existence. So far as we are able to judge of the mundane processes going on around us, there is a perpetual cycle of recurring physical events by which decay is replaced by renovation. We have, on our own globe, instances of very ancient formations, and others of a most recent date: the same alternation of ancient and recent tracts are found on the moon, and it would not be difficult from careful observation to assign the epochs of some of the most striking series of changes. Indeed, a chronological arrangement of the large grey plains, of the craters in their neighbourhoods previously existing, and of those opened upon their surfaces, has been attempted upon a large scale, but it is evident that the study of the more minute objects is likely to be attended with results upon which a more correct system of lunar topography can be raised, which, in its turn, will conduct the student to a satisfactory system of selenology.

TRAMWAYS.*

TRAMWAYS are now a recognised mode of working urban and suburban traffic; they have made their way into public favour in the face of persistent opposition, and, instead of being removed, will probably ultimately become the only public means of conveyance on the main roads leading to and between our principal towns. Tramways are not railways, it is true, but Mr. Clark is justified in protesting against tramway-engineering being regarded as but a humble branch of the profession. On the contrary, tramways require the exercise of the highest skill that can be found, for just as railways in their infancy were often failures, so tramways have arrived at the present degree of efficiency after a series of blunders. They cost more for working expenses than railways, and they earn more per mile, but they are, of course, cheaper to construct. Such a work as Mr. Clark has placed before us was much wanted. Sooner or later steam or some other mechanical power will be employed to haul the "ponderous cars," for Mr. Clark is not alone in the opinion that the employment of horse-power in the work of starting and dragging, often on severe gradients, heavily-loaded tramcars is an element of barbarism much out of place in a civilised country. It may be true that steam-cars, or the locomotives at present devised for drawing the cars, are not all that could be desired; but it is, nevertheless, a fact that, where they have been tried under suitable conditions, they have answered the purpose very well, considering that, as yet, they stand very much in the same position that Stephenson's Rocket did to the magnificent machines that came after it. The withdrawal of the steam "dummies" (a dummy is a steam-car, the engine and boiler being carried on the same platform as the passengers), from the Market-street route in Philadelphia gave rise to the idea that steam was a failure: the fact being that the company had not enough dummies to work the traffic, and so, having to keep as many men to look after three as would suffice for twenty, and having, moreover, to run those three in conjunction with cars drawn by horses, the advantages of steam were discounted. The dummies are, however, objected to, because, in summer especially, they are hot and smell badly, and it is consequently seen that the direction in which to look for a more successful application of steam to street traffic is in the shape of a locomotive like that of Hughes or Merryweather. But in that direction we are met by two difficulties. To employ a separate motor is to lose the adhesion of the car itself, and if the engine is made heavy enough to provide sufficient adhesion to enable it to drag the car up any gradient on the road, it is probably too heavy for the permanent way, which will consequently require continual and costly repairs. The self-contained or steam-car has, therefore, one great advantage over that drawn by a locomotive—that it is best adapted for the tramways at present laid; but there is no doubt that when once Parliamentry sanction is obtained for the employment of steam or other mechanical power without unnecessary restrictions, the demand for motors will be met by the invention of the engine required. Mr. Clark divides his work into five parts, and presents us with an enormous collection of facts, carefully arranged for the guidance and instruction of the engineer and the capitalist. His first part is a history of the origin and progress of tramways, from the early timber rails employed 200 years ago, to the elaborate arrangements of rails, ties, and sleepers adopted in this country and abroad. The wooden tram-rails were occasionally plated with wrought iron, but in 1767 the Coalbrook Dale Company determined to protect their oak rails with cast-iron, because the price of iron being very low, and not wishing to blow out the furnaces, they were in a difficulty as to stocking. Accordingly, they cast the iron into pigs 5ft. long, 4in. wide, and 1¼in. thick, with three holes, through which they were fastened to the timber rails. By this means they made the iron help to pay the interest by reducing the cost of repairs, and the pigs were there at any time when wanted. The modern tramway was first employed in the United States, where, owing to the badness of the roads and the long distances to be traversed, a rapid means of transport was the first necessity to the pursuit of business. The New York and Haarlem line was opened in 1832, but did not meet with favour, and was for a time suppressed. In 1852, however, M. Loùbat, a French engineer, laid down a tramway in New York, consisting of rolled-iron rails placed upon wooden sleepers. The rails had a wide groove in the upper surface, and were similar to those afterwards laid down by the same engineer in Paris. Tramways had by this time become so essential to New York that the objections made to them by the proprietors of other vehicles were disregarded, and they multiplied rapidly, not only in the Empire city, which owes most of its amazingly rapid development to them, but in the principal towns of the States.

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* Tramways, their Construction and Working. By. D. K. Clark, C.E. London: Crosby Lockwood and Co.

Mr. Clark speaks of the "fearless manner" in which the rails were proportioned, but they were tolerated because the tramways were of more importance than the comparatively few vehicles which traversed the streets. In 1856 a Mr. C. L. Light, an English engineer, laid an improved tramway in Boston, in which the depth of the groove was only ¾in., while the inner side of the rail formed a flat slope. The Philadelphia step-rail was also an improvement, dispensing with a groove altogether, but having a ridge at one side against which the wheel-flanges ran; it answered its purpose well, and is still in use in that city, while a similar pattern has been adopted for New York. In fact, the step-rail may be said to be that most generally used in the United States. When introduced to England by Mr. Train it was speedily condemned, and the lines laid by him at Birkenhead and the Potteries were only saved from suppression by the substitution of flat-grooved rails of the kind with which we have since become familiar. The modern practices, for there are several methods still, as it were, under trial, are fully explained in Mr. Clark's book, and the numerous woodcuts and lithographic plates render his work of great value. The present practice of tramway construction forms the second part of the book, and the many tables of cost and working expenditure which he has inserted in part three will be studied with attention by the municipal authorities and capitalists. Part four introduces us to what may be termed the mechanical portion of the subject, although it is confined to a description of tramway cars. It is impossible, within the limits we can devote to a notice of this book to give even an outline of the many details of the numerous cars which Mr. Clark describes. It must suffice to say that examples of the best constructions are fully illustrated, and that the latest improvements are noticed, down even to Eade's reversible car, which was patented in 1877. This car is swivelled centrally on the underframe, so that after the locking apparatus is unfastened, the driver can turn the car round without leaving his seat. This arrangement avoids the necessity for shifting the horses and the pole, and the car is, of course, constructed with only one door and two staircases to the roof, one on each side of the platform. Mr. Clark says it is reported that the reversible car effects a saving of 30 per cent. in the horse-power required—a stud of eight horses working it as efficiently as twelve work the ordinary car. Eade's car is unusually light, weighing empty only 34cwt., while one wheel on each axle runs loose. The alleged saving in power is, of course, due to the lightness of the car, not to its reversibility. It is in use on the Salford tramways. The fifth part, Mechanical Power on Tramways, will be of most interest to the great majority of readers, for the further development of the tramways system depends almost entirely on the application of mechanical power for their working. The report of the Select Committee issued recently will probably give a stimulus to the introduction of steam and compressed air motors, though they will still be hampered by restrictions which seem, to those familiar with engines, to border on the absurd. Mr. Clark, in his historical sketch of the application of mechanical power to tramway cars, commences with Latta's "dummy," put on the Cincinnati Tramway in 1859. The earlier efforts of Trevithick and others are ignored as not, strictly speaking, belonging to the subject. Mr. L. J. Todd was, however, the first engineer to bring forward any practical designs for the employment on roads of steam-propelled tramcars; and, we believe, his engines were the earliest which met all the conditions imposed—viz., the absence of noise, smoke, and steam, with the possession of the power of stopping and starting quickly. About the same time Dr. Lamm experimented with an ammoniacal-gas car, and demonstrated the practicability of the invention; but the necessity for preventing all escape of the gas, together with its chemical action on iron, led Dr. Lamm to abandon for a time his ammonia engine in favour of the fireless locomotive, which consists of a strong well-clothed reservoir filled with water at a very high temperature. The fireless locomotive is running on the line, about six miles in length, between New Orleans and Carrolton, the stationary steam-generator being at the latter place. The reservoir of the locomotive is filled with cold or preferably warm water, and then is connected to the Carrolton boiler, and steam of 200lb. pressure forced in. The water is thus quickly heated and a pressure of about 180lb. per square inch obtained. The content of the reservoir is about 60 cubic feet, and in practice it is found to contain sufficient steam to run the car from Carrolton to New Orleans and back without reducing the pressure much below 50lb. The exhaust was discharged into the atmosphere making clouds of moist white vapour. Two other fireless locomotives were tried on the East New York and Canartio Tramway, but they were not so successful as Dr. Lamm's. About this time Mr. Baxter, in America, and Mr. John Grantham, in this country, brought out steam-cars. Baxter's had an engine with compound cylinders and carried 54 passengers; and Grantham's, which was the first steam-car actually built and tried in England, had a boiler on each side of the body, in the centre of the length, with the engine underneath. It carried 44 passengers and worked well enough on the trial line at Brompton, but failed when tested on the line between Vauxhall Bridge and Victoria Station. It was removed to Wantage, but was unfitted for the inclines and curves of that tramway. It was subsequently altered by the advice of Mr. E. Woods, who replaced the two separated boilers by one, which was completely boxed in, and served to divide the car into portions, leaving a passage at one side communicating between the first and second class divisions. One pair of the wheels was used for driving and one wheel of the other pair ran loose, for ease in passing curves. It accomodated 60 passengers, and its estimated cost, from experience of its work on the Wantage line, was less than 4d. a mile run. Mr. Woods recommended that the Grantham car, built for the Vienna tramways, should have the boiler and engine placed at one end, while instead of the loose wheel on the undriven axle, he proposed a four-wheel bogie. This car was fairly successful, but the boiler, though a rapid generator, was too limited in water room, and required very skilful management. On a good road the working speed is from 10 to 12 miles per hour. In 1874 Mr. Loftus Perkins designed a tramway locomotive for a Belgian company. It was worked at a pressure of 500lb. on the square inch, and had compound engines, the high-pressure cylinder being single-acting. The steam exhausted into an air-surface condenser, consisting of a number of copper tubes. The boiler was of bent-iron tubes, 2¼in. diameter (inside) and ⅜in. thick, tested to 2,500lb. on the square inch. Coke was the fuel, the draught being due to the height of chimney alone. The speed of the crank shaft was reduced by toothed gearing in the ratio of four to one, and the motion was taken off the second shaft to the wheels of coupling-rods. At the commencement of its working life this locomotive was reported to be perfect—"no smoke, no escape of steam into the atmosphere, no noise, no feeding of water during the trip, nor even, if needful, for several days." The high pressure, however, rendered it very difficult to maintain the joints, and, after altering the engine, the Belgian authorities concluded to take it to pieces and sell it as old metal. Mr. Perkins has, however, recently improved his design, and Mr. Clark says at the conclusion of an elaborate description, accompanied by an excellent lithograph, that "it is anticipated that very economical results of performance will be obtained by the use of this locomotive. The Société Métallurgique et Charbonnière of Belgium constructed a tramway locomotive in 1875, with a Brotherhood three-cylinder engine and a Bellville "inexplodable boiler," the speed being reduced by spur gear. It resembles an omnibus in appearance, and altogether is scarcely likely to become the motor of the future. Of the numerous devices that have been tried we can only allude to Francq's improved hot-water locomotive, in which the steam from the reservoir is admitted to an intermediate chamber, where it is maintained at a fixed pressure; to Todd's hot-water steam-car, in which the reservoir and machinery is carried beneath the floor; to MM. Bède and Co.'s hot-water steam-car, which has been running regularly and successfully in Belgium, and to the engines of Merryweather, Hughes, H. P. Holt, Ransom, and Baldwin, the two former of which are well known from descriptions already published. Most of the designs are illustrated by diagrams, and some have large lithographic plates devoted to them. It will be understood, from what we have said, that Mr. Clark's work is a perfect treasury of tramway facts, but it is even more than that, because some of his chapters are occupied with dissertations on the principles of tramway construction and working, in which points apt to be overlooked by inventors are carefully considered. Cars, he thinks, should be constructed on double bogies, or, still better, on radiating axles, and they should have a longer wheel base than is now usual. The results obtained with the Paris omnibus car, Mr. Eade's car, and Mr. Cleminson's flexible wheel-base car, point to the desirability of starting afresh with new ideas, and recasting the design of the tramcar. The production of a noiseless, vapourless, smokeless, and handy machine will not come from those who too slavishly follow the old lines; but of the present devices Mr. Clark awards the palm, as first in order, and foremost in practical performance, to the Merryweather, which in Paris and in other parts of the Continent has been doing effective service on the tramways, "causeless of annoyance or hindrance to the ordinary traffic of the streets." It is too much to hope that this work will lead to the prompt withdrawal of all vexatious restrictions on the use of mechanical power for propelling street cars; but, while it places a vast amount of practical information before the engineer, it serves to enlighten those who may ultimately have to decide whether a mechanical-power tramway shall or shall not be allowed in the districts over which they have control.

HE ORGAN: A COMPREHENSIVE TREATISE ON ITS MANUFACTURE, PROCURAL, AND LODGMENT.*

By John Watson Warman,

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ART I.—GENERAL TREATMENT IN MANUFACTURE.

[16, a.] *Octave Coupler.* When this is ap- lied to a Manual let two Stops reckon as ree; when applied to Pedale let one Stop ckon as two, as then the notes are all (or arly all) doubled. No distinction is made tween Super and Sub-octave, for in the Man. e latter will often only bring on notes that e liable to be down by Man. to Ped.; on the dale, if the Pipes run beyond the lowest note the Clavier they will be already provided r by the rule that gives more surface as soon the Pipe exceeds a certain length. With th Sup. and Sub-oct. present every two Stops that Clavier reckon as, say, five of Manual; Ped. in such case every Stop reckons as ee if the additional octave of Pipes be sup- ed. In Partial Couplers (*see* 10, l.) the calcu- ion must always be confined to the Stops ually affected.

b. *Pallets.* Where these are larger than ual, and Pipes voiced in accordance, a little tra should be allowed (*see Dep.* of PALLETS).

c. *Pressure.* Where the pressure is heavier an ordinary a little extra should be given.

d. *Feeders.* When these are *Whole-drop*— at is, with ribs of same breadth all round, d of course no hinge—rather less per Stop ay be allowed; but remember, if Receiver no rger than total area of Feeder surface, the pply will be unsteady: when Double or rench Feeders are used still less per Stop may e given, but bear in mind unsteadiness will ere be still greater. A Reservoir (*see* 15, j.) contemplated in latter case. Whole-drop Feeders that are not Double-action are never dvocated by the present writer, except in some ses with Machine-blowing (*see* 6, g.).

e. *Pneumatic Touch-action.* The allowance r this obviously varies with the Pressure, size f Motor Bellows, &c.; it may, I think, be con- dently laid down that an allowance of 6 square et is the least to be given—that is, if separate ellows for the Pneumatic Action they must t be smaller than this (say 3ft. by 2ft.), and supplied from another Bellows the size of tter must be increased that amount at least. ear in mind this is for *one* Pneumatic action; here more than one are present allow this inimum of square feet to *each.*

f. *Other Motors.* It is impossible to give act directions for Draw and Composition- tion Pneumatics; calculate the size of the ocks or Valves, and then consider how often n the average they will be in use; as always, ly at intervals even with the most *restless* layer.

g. ILLUSTRATION. In order to avoid chance f error I have given instances of calculation of ellows size, taking the Organ just instanced— s, 10 on Great, 8 on Swell, 1 (Open Diap.) on edale. The Sounding-size is, of course, the tal, 19; 19 times 2½ gives 47½ square feet, y 48; Bellows, 8ft. by 6ft. Three of the ops, however, will probably run only to Ten C; is reduces the Sounding-size to 18 Registers, sq. feet. Now, suppose we add one Stop— eferably a Bourdon—to the Pedale; this ings the size up to what it was before, 47½. w, imagine we add a Sub-octave to Ped. urdon, carrying the latter down to G, 10 prox. actual length; this will add another , making the total Bellows area 50 square t: but if we apply the Sub-oct. to Ped. Open p., instead of Bourdon, the allowance per p rises at once to 2¾ (*see* 15, w.); making the al Bellows-area 55ft. If now we add a Choir 6 Stops, and a Choir to Gt. (or to Swell) upler, this brings the Sounding-size up to Registers; which, at 2¾ per Register, gives ½ sq. feet—say 72. If now we add a Super- t. to Ped. Bourdon, we get another 2¾ft.; aking 74¼ total. If now we apply Sup.- t. to Swell, its 8 Stops become 12, the addi- onal Registers will demand 11 sq. feet; aking them 85¼ altogether: a Pneumatic-action will now be imperative, bringing the whole up to 91¼.

h. The foregoing does not touch upon the *shape* of Bellows, for which *see* own Head (5, m.).

i. This calculation has been given as that on the whole, in the author's estimation best; but it is right to observe that there are perfectly satisfactory Organs existing in which the allowance of wind per Stop is under the 2 sq. feet; the explanation being that, as the Organ increases in size, the tendency is to consume *less* wind per Stop than with smaller Instruments (this is, remember, speaking exclusive of Pneumatic-action or other Motors); or that only a *little* wind may be admitted to each Pipe.

j. A noteworthy instance of this is furnished by the Organ built for Mr. Thos. Spratt (*see* 14, h.), which has a Sounding-size equivalent to 63 Registers, possesses a Bellows-area of but 72 square feet; drop of Feeder, 10in.: and as there is the Pneumatic to reckon also (this being supplied from same Bellows), as well as the loss of space by *three* Feeders, and Trunks, Waste-pallet, &c., between them, the allowance in this case cannot certainly be set at more than about 1 square foot per Sounding Stop. There is not, so far as author is aware, any deficiency whatever in the wind supply of this Instrument; but it must be borne in mind that, large as it is, it is but a Chamber Organ, and voiced and winded accordingly.

k. *See* also a little more in accounts of Bellows of Large Instruments (9, e.).

l. It is necessary to observe that when Receiver itself is made to perform the throwing-off duty of the Engine care must be taken that the resistance be not too great in proportion to the size of Receiver; an ordinary throwing off and on with fast and loose pulley will require a force of not less than 7lb.; 7lb. additional pressure on a Bellows 1ft. 7in. × 3ft. 9in. (a trifle under 6 sq. feet) gives an increase of wind-pressure of ¼in. In the Organ just instanced one Receiver, 6ft. × 6ft., performs the whole of throwing off and on quite satisfactorily.

m. The governing valve of the Hydraulic Engine may, however, be much lighter than this.

m. m. It cannot be too strongly borne in mind that where space is too limited for a Bellows of proper size *and* a Reservoir, the latter *must* be sacrificed, for its function of steadiness can be partly—and in one respect better—fulfilled by Concussion-bellows, and different pressure, if indispensable, must be obtained by Combination Bellows (*see* 7, f., and 15 d. d.)

*** TELL-TALE.—*See own Department.*

*** WEIGHTS.

n. These may be either of Stone or Cast Iron; the former has been objected to on account of its absorbing moisture, and being therefore heavier during damp weather than dry. Seeing, however, that at former time the windways of all the Wood Pipes are inevitably slightly contracted, it is a question whether the rough compensation thus introduced be not an advantage rather than otherwise, as the Metal Pipes can easily be voiced to bear a *little* increase of pressure. At any rate a large number of fine Instruments are weighted with Stone, and no complaint of practical inconvenience from that cause has ever reached the present writer.

o. Iron must be used when space is very limited; and there ought by rights to be one pattern of bar thin and narrow enough to lie on the styles and rails of even the smallest Bellows-tops without rising above the screwed Panels.

o. o. With the view of rendering Concussion-Bellows unnecessary, Mr. Willis in 1868 devised the very ingenious method of suspending the weights from springs; the weight either overhanging or placed inside the Bellows. It may be considered that the additional cost and space required make quite as serious a matter as the Con.-Bellows; and in addition it will have been already seen (12, x.) that any disturbing—and consequently any *corrective*—influence at the other end of a Wind-trunk is modified or weakened by the friction offered by latter. I have not met with any instance of employment. The patent is No. 812.

**** BLOWING-ACTION—ALL KINDS, FORMS, AND MOTORS.

p. It will be evident that it is advisable, in the first laying out of the Organ, to know what method of actuating the Bellows is to be adopted; for, although in many cases the precise Motor need not be decided on, yet in many others the arrangement for a particular kind can be favoured in the first lay-out of the Instrument; and at no time can it be certain that want of first accommodation will not ultimately hamper or interfere with. Sufficiently full descriptions of all will be given in *Detailed* Treatment.

q. What will here be given are—1, a slight description of the various Motors; 2, a comparison of the various merits of each.

*** GENERAL STRUCTURE AND ARRANGEMENT.

r. The only kinds necessary to treat of here are the following: Finger (Clavier); Foot; Gas; Hand; Hydraulic; Steam; Weight; and Wind.

** FINGER BLOWER.

This is a method devised by Mr. W. Dawes (Patent, A.D. 1873, No. 3337), for obtaining wind by the mere action of playing upon the keys; each of the latter (man. or Ped.) is connected with a very small Feeder, the whole supplying into one Reservoir. It need hardly be remarked that the cost and elaboration, combined with the small amount of wind supplied, render this invention practically valueless.

** FOOT BLOWER.

s. This may be divided broadly into two kinds—viz., *Free* and *Power*. *Free* Foot Blowers are all those that are actuated by the Foot and Leg muscles solely; the *Power* kind includes those which require the whole weight of the blowist (obviously in this case always another than the player) to set in operation. The Free kind should always be so placed as to admit of being used by the Player; and where there is a Pedal-board must, if possible, be so fitted as to leave one (the left) foot free for latter.

t. *Free Foot Blowers* may be divided into three—*Crank* or *Elbowed*, *Straight*, and *Treadle*; the *Elbowed* is the most usual but the least convenient. It is a simple bar flattened at one end for the foot to rest on, the other being cranked so to fit and go on or into the end of the T-spindle that is actually beneath the Feeder; the Pedal itself of course stands, *on plan*, parallel with the Plinth. When this Blower is used, the following should be observed:—*a*, the Pedal should be sufficiently short and rigid, and set far enough from Plinth to avoid risk of the toe "grubbing" or catching latter; *b*, the whole action should be sufficiently far to the left to bring the part on which the foot presses sufficiently directly under the player; *c*, the part on which the foot rests should be so constructed as to retain the latter firmly, the best treatment is a small shallow segmental saucer or shoe exactly fitting the ball of the foot; *d*, the resistance should be moderate. Note.—When intended to allow of the left foot being left free for Pedaling, *b* may be relaxed to some extent, so as to keep right foot out of the way of left. The elbowed Pedal obviously demands, as a rule, that Bellows-Feeder be hinged at left end. It is sometimes made to admit of also inserting at the side or other part of Organ, so as to allow of blowing by a second person; but this is obviously less convenient than having a Handle for the purpose. The Pedal easily *unships* when not in use.

u. The *Straight* Pedal is less common but more convenient, as motion can be more made to correspond with forward thrust of player's foot. It is simply one, or, much better, two pedals standing straight out from the Plinth. The only form contemplated by author assumes the Bellows-feeders to be hinged at front—that is, nearest player, the Pedals being thus two simple iron bars sliding into sockets formed by pieces of hard wood suitably channelled, firmly screwed against under face of Feeder, the hinges of the latter always extra strong to bear the strain. When the Feeder is too large to be actuated thus a Lever is required, suitably centred, the Pedal entering a socket formed in the end of the Lever. This Pedal should not strike or slant upwards even when the Feeder is fully down; and if the Pedal slope downwards, or even be cranked downwards, so much the better for its action, only that in this case rather apt to strike Playing Pedals. A simple bar set at such an angle as to be horizontal when Feeder down, the toe or tip end being furnished with Foot-cap or Shoe as described with the previous variety, will be the best practical form whenever Playing pedals are present. Straight Pedals easily *unship* by merely drawing forward out of their sockets, but cannot in any case be shifted to any other point than the free or dropping side of feeder. No example of the exact treatment is at present known to writer.

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v. The *Treadle* is simply the Foot-boards as we see them in Harmoniums and American "Organs." The best material will probably be hard wood, with a facing of embossed metal, as in the said American instruments: a Lever, with wheel at each end, will be required for the Treadles to act on, one wheel being beneath the Treadle, the other under and acting directly on the Feeder, which here also should be hinged at front: this Blower does not obviously admit of removal at all. About 9in. will be good dimensions for width of Treadle, the depth being from 9in. to 1ft. Of course no Foot cap is necessary here; but the Lever may often require crooking on elevation to bring it in more direct action to its contacts. The action of Treadles is very pleasant indeed to the feet.

w. *The Power Foot-blower* is the most ancient of all; sometimes it is constructed of a Plank, centred at middle, a man walking to and fro being the means of operating (as at Seville Cathedral); at other times the Feeder Upper-board itself was furnished with a shoe, into which the Blowist's foot was inserted (see Rimbault, page 33). A third method is to have two projecting Treadles side by side, so that one Foot is conveniently on each, then by bearing the whole weight alternately on each the requisite descent is made, and the Feeders actuated. Some suitable affixture is provided for the Blowist to hold on by; either a horizontal rail or an upright rod fixed in the Treadle itself: the projecting portion forming the Treadle should, if practicable, be the end of actual Lever in immediate or direct contact with the Feeders.

(*To be continued.*)

AMBER VARNISH.

AN improved method of preparing amber varnish has yielded results so excellent that the discoverer has obtained letters patent for it. Mr. S. Meredith, of Edgbaston, says that the varnish he produces is capable of giving a very superior polish or surface, and is especially valuable for coach and other high-class work. In carrying out his process he first bleaches the amber by placing a quantity —about, say, 7lb.—of yellow amber in a suitable receptacle, such as an earthen crucible, of sufficient strength, adding 14lb. of sal gemmæ (rock or fossil salt), and then pouring in as much spring water as will dissolve the sal gemmæ. When the latter is dissolved more water is added, and the crucible is stood over a fire until the colour of the amber is changed to a perfect white. The bleached amber is then placed in an iron pot and heated over a common fire until it is completely dissolved, after which the melting-pot is removed from the fire, and when sufficiently cool the amber is removed from the pot and immersed in spring water to eliminate the sal gemmæ, after which the amber is put back into the pot, and is again heated over the fire until the amber is dissolved. When the operation is finished, the amber is removed from the pot and spread out upon a clean marble slab to dry, until all the water has evaporated, and is afterwards exposed to a gentle heat to entirely deprive it of humidity. To make a varnish, white amber prepared as above described is reduced to powder in a mortar, or otherwise, and is melted over a fire in a clean iron pot, and as much fine nut oil as will make it into a varnish is then added, after which the *whole is well* stirred until thoroughly mixed. The pot is then removed from the fire, and when the heat has sufficiently moderated, essence of turpentine is added to form a composition of the proper consistency for use. The following proportions answer well, but the patentee does not limit himself thereto:—

White amber	... ...	1lb.
Fine nut oil	... ...	1lb.
Essence of turpentine	...	2lb.

Such a varnish, if really superior to the present amber varnish, will be of great value for many purposes.

DYNAMO-ELECTRIC MACHINES.

THE report of the committee of the Franklin Institute on dynamo-electric machines has been specially reprinted from the *Journal* and has been widely circulated. It is an important paper so far as it goes, as the experiments described were carefully made, and the results may be relied upon. Neither the makers of the Gramme, the Siemens, or the Weston machine replied to the invitations of the committee, the only machines supplied direct from the makers being two each of the Brush type, made by the Telegraph Supply Company, of Cleveland, Ohio, and of the Wallace-Farmer type, made by Wallace and Sons, of Ansonia, Connecticut. A Gramme machine was lent by Prof. H. W. Wiley, of Purdue University, Lafayette, Indiana, and as it originally formed a part of the exhibit of M. Breguet, at the Centennial, it was assumed to be a good example of its class. A Brown dynamometer was used to measure the power required to drive the machines, which were worked by the engine belonging to the Institute, except in the case of the large Wallace machine, which required more power than could be obtained from the small engine. The Gramme machine is tolerably well known, and it is only necessary to say that the specimen tried ran smoothly and quietly with few (if any) sparks at the commutator, and little heating, the temperature of the armature being only 98° Fahr. after running nearly five hours. The Brush machine has, for its magnetic field, two horseshoe electro-magnets, with their like poles facing each other at a suitable distance apart, the circular armature rotating between them. In this machine the currents are generated in coils of copper wire, wound upon an iron ring, constituting the armature. This ring is not entirely covered by the coils, as in the Gramme armature, but the alternate uncovered spaces between the coils are almost completely filled by iron extensions from the ring, thus exposing large surfaces of the armature ring for the dissipation of heat, due to its constantly changing magnetism, as in the Pacinotti machine. The ring revolves between the poles of two large field magnets, the two positive poles of which are at the same extremity of the diameter of the armature, and the two negative poles at the opposite extremity, each pair constituting practically extended poles of opposite character. The coils on the armature ring are eight in number, opposite ones being connected end to end, and the terminals carried out to the commutator. In order to place the commutator in a convenient position, the terminal wires are carried through the centre of the shaft, to a point outside the bearings.

The commutators are so arranged, that, at any instant, three pairs of coils are interposed in the circuit of the machine, working, as it were, in multiple arc, the remaining pair being cut out at the neutral point; while in the Gramme machine the numerous armature coils being connected end to end throughout, and connections being made to the metal strips composing the commutator, two sets of coils in multiple arc are at one time interposed in the circuit, each set constituting one-half of the coils on the armature. The commutator consists of segments of brass, secured to a ring of non-conducting material, carried on the shaft. These segments are divided into two thicknesses, the inner being permanently secured to the non-conducting material, and the outer ones, which take all the wear, are fastened to the inner in such a manner that they can be easily removed when required.

The commutator brushes, which are composed of strips of hard brass, joined together at their outer ends, are inexpensive and easily renewed. The high speed at which these machines are run, together with the form of the armature, cause the rotation of the latter to be considerably resisted by the air, producing a humming sound, but otherwise they run smoothly, the heating of the armature being inconsiderable, not exceeding 120° Fahr. after four and three-quarter hours' run. They are simple in construction, all the working parts being easily accessible, and the cost of maintenance low.

The smaller Brush machine is identical in mechanical design with the larger, except that in the former there are two commutators, each of which is connected with alternate armature coils. By this arrangement connections can be so made as to produce electric currents of high or low electromotive force (55 to 120 volts), or the conductor can be divided into two circuits, each of which can be utilised for producing its own light, or for performing other work.

In the Wallace - Farmer machine the magnetic field is also produced by two horseshoe electro-magnets, but with poles of opposite character facing each other. Between the arms of the magnets, and passing through the uprights supporting them is the shaft, carrying at its centre the rotating armature. That consists of a disc of cast-iron, near the periphery of which, and at right angles to either face, are iron cores, bound with insulated wire, thus constituting a double series of coils. These armature coils being connected end to end, the loops so formed are connected in the same manner, and to a commutator of the same construction, as that of the Gramme. As the armature rotates, the cores pass between the opposed north and south poles of the field magnets, and the current generated depends on the change of polarity of the cores. It will be seen that this constitutes a double machine, each series of coils, with its commutator, being capable of use quite independently of the other; but in practice the electrical connections are so made that the currents generated in the two series of armature coils pass through the field-magnet coils, and are joined in one external circuit. This form of armature also presents considerable uncovered surface of iron to the cooling effect of the air, but its external form, in its fan-like action on the air, like that of the Brush, presents considerable resistance to rotation. In the Wallace-Farmer machine there was considerable heating of the armature, the temperature being sufficiently high to melt sealing-wax.

The Brush and Wallace-Farmer machines were accompanied by lamps, or carbon holders, which were thought by their makers to present advantages, if not for all machines, at least to be especially adapted to the requirements of their own; the usual "Serrin" lamp, which is made by M. Breguet for the Gramme machine did not accompany the latter. The result of experiment, however, quickly established the suitability of the Brush lamp as the source of light from all the machines, and the same lamp, with carbons properly adjusted as to size, was used for the several trials.

The lamp is shown in Figs. 1 and 2, in which *a* is a helix of insulated copper wire, resting upon an insulated plate, *b*, upheld by the matallic post, *c*. Loosely fitted within the helix is the core, *d*, partially supported by the adjustable springs, *e*. The rod, *f*, passes freely through the centre of the core, *d*, and has at its lower end a clamp for holding the carbon pencil. A washer, *h*, of brass, surrounds the rod, *f*, just below the core, *d*, and has one edge resting on the lifting finger attached to the latter, while the other edge is overhung by the head of an adjustable screw stop, *s*. The metal post, *c*, is supported and guided by a tubular post, *i*, secured to a suitable base plate. Attached to the lower end of the post, *c*, and passing out through a slot in *i*, is the arm, *g*, supporting an insulated holder for the lower carbon.

If now one conducting wire, from the machine, be connected to the base plate, and the other to the lower carbon holder, the current of electricity will pass up through the posts, *i* and *c*, through the helix, *a*, rod, *f*, and the carbons, *k k*, thus completing the circuit

l magnetism produced in the helix will
the core, *d*, and it, by means of the
nger, will raise one edge of the washer,
, by its angular impingement against
f, clamps and lifts it to a distance con-
y the adjustable stop, *x*, but separating
on points far enough to produce the

e carbons burn away the increased
f the electric arc increases its resistance
kens the magnetism of the helix, and,
ə, the coil, rod, and carbon move down-
' the force of gravity, until, by the
ng of the arc, the magnetism of the
strengthened and the downward move-
ested. When, however, the downward
nt is sufficient to bring the clutch-
h, to the support, *l*, it will be released
ə clamping effect of the lifting finger,
rod, *f*, will slip through until arrested
pward movement of the core, due to
ased magnetism of the helix.

FIG. 1

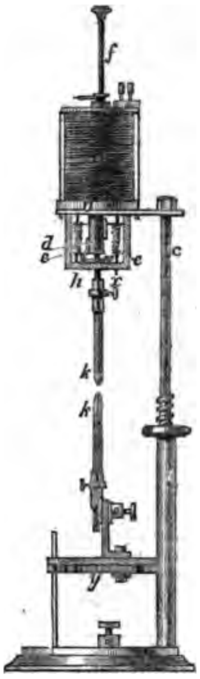
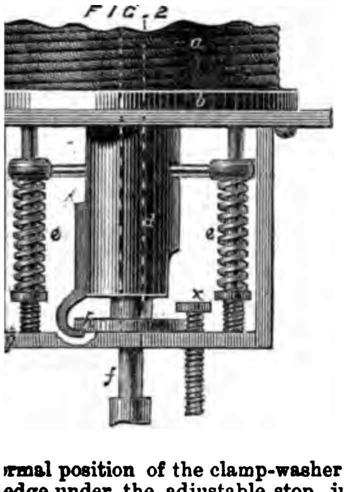


FIG. 2



rmal position of the clamp-washer is
edge under the adjustable stop, just
the support, *l*, the office of the core
› regulate the slipping of the rod
it. If, however, the rod, from any
lls too far, it will instantly and auto-
' be raised again, as at first, and the
oints thus continued at the proper dis-
m each other.
lamp used in these experiments, the
ı composed of two separate insulated
und together, so that, by means of
pin contacts, shown at the top of Fig.
ould be connected either in couples or
nd, thus varying the intensity of the
m of the helix.
er to make the measurements as
as possible,•it was found necessary so

to arrange the apparatus that no reflected or diffused light should fall on the photometer, and thus introduce an element of error. The arrangement of the apparatus to accomplish this is shown in Fig. 3. The electric lamp was enclosed in a box, open at the back for convenience of access, but closed with a non-reflecting and opaque screen during the experiments. Projecting from a hole in the front of the box was a wooden tube, *b*, 6in. square inside and 8ft. long, with its inner surface blackened to prevent reflection, thus allowing only a small beam of direct light to leave the box. This beam of light passed into a similar wooden tube, *c*, placed at a proper distance from the first, and holding in its farther end the standard candle, *d*. This tube also held the dark box of a Bunsen photometer, mounted on a slide, so as to be easily adjusted at the proper distance between the two sources of light. A slit in the side of the tube enabled the observer to see the diaphragm. The outer end of the second tube was also covered with a non-reflecting hood, and the room was, of course, darkened when photometric measurements were taken. The rigid exclusion of all reflected or diffused light is believed to be the only trustworthy method of obtaining true results, and will, no doubt, account in a large measure for the lower candle-power obtained in these experiments than that obtained by many previous experimenters.

FIG. 4.

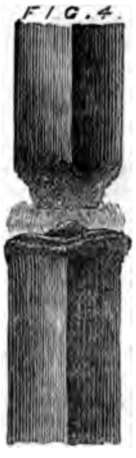


FIG. 5.

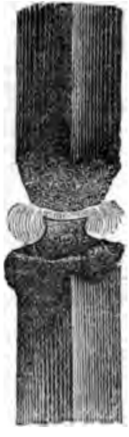


FIG. 3

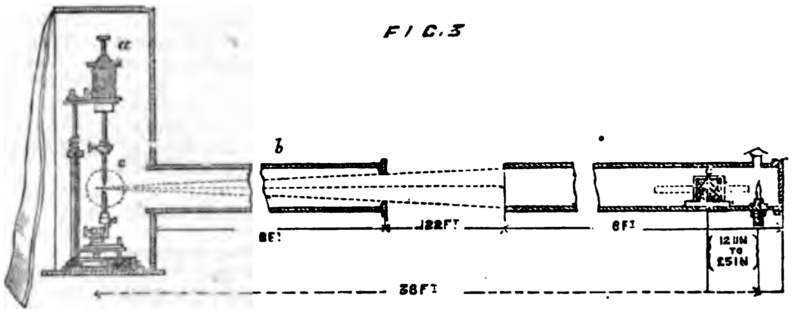


FIG. 6

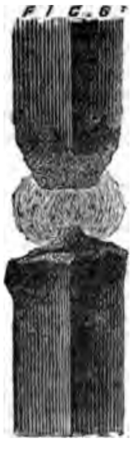
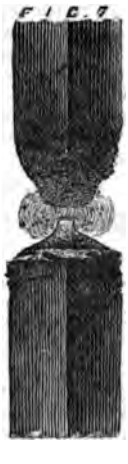


FIG. 7



The difficulties encountered in the measurement of the light arising from the difference in colour, were at first thought to be considerable, but further practice and experience enabled the observer to overcome them to such an extent that the error arising from this cause is inconsiderable, being greatly less than that due to the fluctuations of the electric arc.

FIG. 8.

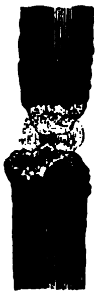
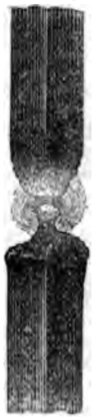


FIG. 9



The committee considered what advantage would be gained by using a larger source of light than the standard candle, but after making several experiments with gas flames and the oxyhydrogen light they determined to use a standard candle, making corrections for any variation in the rate of consumption of 120 grains per hour. In determining the light-giving power of the current produced by the different machines, a continuous run of from four to five hours was made, and great care was taken to keep the axes of the two carbons of the lamp in the same line. To facilitate observations, a focussing lens, *e*, was attached to the side of the box, *a* (Fig. 3), the axis of which lens was at right angles to the beam of light, to the photometer, and an image projected upon a screen, enabling the observer to note the condition of the carbon points without distressing the eye. Photographs of the points were also taken at the moment of making the photometric observations, and care was taken that, at the moment of making the measurement, there was no fluctuation or

FIG. 10

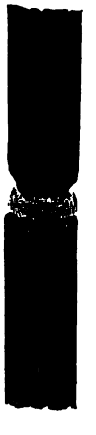
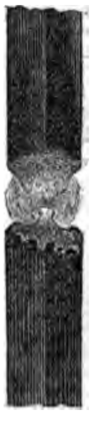


FIG. 11.



moving from side to side of the electric arc. Figs. 4 to 11 are full size, exact reproductions of the photographs; Figs. 4 and 5 being taken when the large Brush, Figs. 6 and 7 when the small Brush machine was at work. Figs. 8 and 9 were obtained when the Gramme was supplying the current, and Figs. 10 and 11 represent the average appearance of the carbons when the small Wallace was at work. All the carbons were coated with copper. It was found that, although there was a slow consumption of the negative carbon, there was, at the same time, a constant "stalagmitic" growth produced by particles carried from the positive carbon by the action of the electric current. The "stalagmites" assumed different forms, and increased with increase of current. They were built up gradually until they assumed such a shape as is seen in Figs. 9 and 11, and then growing narrower at the base, the current would be momentarily weakened, the lamp would readjust itself, and the stalagmite would drop off. Experiments were also made to determine what effect upon the amount of light was produced by adjusting the carbons so that the front edge of the upper was in line with the centre of the lower. The result gave with the small Brush 2,218 candles for the front, 578 for either side, and 111 for the back, or a mean of 871.

The annexed table will give the results obtained and other particulars of the machines, but the committee considered that reducing the figures given by Mr. Douglas to the mean or all round light they are still too high. They obtained, it will be seen, only 383 candles per h.-p. against 438 by Mr. Douglas with the Gramme, which, save the consumption of carbons, seems to be the best machine taken altogether. The electrical measurements were made by Professors E. J. Houston and Elihu Thomson, but we have no space to reproduce them on this occasion.

TABLE SHOWING WEIGHT, POWER ABSORBED, LIGHT PRODUCED, &c., BY DYNAMO-ELECTRIC MACHINES TESTED BY A COMMITTEE OF THE FRANKLIN INSTITUTE, 1877-8.

Name of Machine.	Weight.	Copper Wire in				Rev. of Armature per min.	Horse-power.	Light in Standard Candles		Ft. lb. power consumed per candle.	Size of carbons.	Length of carbon consumed per hour.	
		Armature.		Field Magnets.				Total.	Per h.-p.			+	−
Large Brush ...	475lb.	·081in.	32lb.	·134in.	100lb.	1,310	3·26	1,230	377	87·4	⅜ × ⅜	1·78	·34
Small Brush ...	390	·063	24	·196	80	1,400	3·76	900	239	137·	⅜ × ⅜	1·91	·58
Large Wallace ...	600	·042	50	·114	125	800		823					
Small Wallace ...	350	043	18¾	098	41	1,000	3·89	440	113	292·	¼ × ¼	2·45	·073
Gramme... ...	366	·059	104	·108	104	800	1·84	705	383	85·	¼ × ¼	3·15	·55

HEAT CONDUCTIVITY OF BADLY-CONDUCTING SUBSTANCES.

THE conduction of heat by substances that are poor conductors has recently been investigated by M. Less, in the laboratory of M. Wiedemann, for the same purpose as Hopkins had in view, and by a similar method to the one adopted by that experimenter. The substances examined were varieties of stone and wood. Plates were cut off them and placed on the bottom of a vessel equally heated with steam. On the other free surface was placed a soot-covered copper plate. In a dry inclosed space, protected from all external radiation, a thermopile was exposed at different distances to the radiating copper plate, and from the deflections of the galvanometer inserted in the circuit, after a short exposure (always the same) the heat conductivity of the plate under examination was determined. The experiments were performed with great care, and are detailed in a recent number of the *Annalen der Physik*. We give the following table of results (in it the conductivity of the best conductor is put = 1000):—

Substance.	Sp. Gr.	Conductivity.
Marble from the Pyrenees ...	2·616 ...	1000
Saxon granite (containing albite)	2·629 ...	804
Carrara marble	2·668 ...	769
Marble from Italy	2·682 ...	763
Basalt of Idar, near Oberstein...	2·712 ...	726
Seeberg fine-grained sandstone	2·130 ...	721
Granite from the Thuringian forest	2·545 ...	713
Strehlen sandstone	2 324 ...	701
Red gneiss of Tharandt ...	2·540 ...	696
Nephalin—Basalt of Mitterteich	2 853 ...	690
Serpentine of the Saxon Erzgebrige...	2·418 ...	678
Gneiss of Tharandt	2·654 ...	673
Carlsbaden Shiver	2·731 ...	537
Sandstone of Postelwitz ...	1·997 ...	487
Clay slate from the Schwartal...	2·685 ...	469
Sandstone with kaolin cement ...	1·951 ...	420
Common clay	2·003 ...	275
Maple wood (with the fibres) ...	0·634 ...	192
Oak wood (with the fibres) ...	0·621 ...	161
Box wood (with the fibres) ...	0·790 ...	135
Box wood across the fibres = the rings	0 754 ...	96
Oak wood across the fibres = the rings	0·508 ...	86
Maple wood across the fibres and rings...	0·571 ...	86
Maple wood across the fibres = the rings	0·607 ...	85
Oak wood across the fibres and the rings	0·571 ...	75

The numbers obtained for the stones show that, in general, density and compactness greatly favour the passage of heat: still, the values of the conductivity by no means depend on the specific gravity alone. The stones of crystalline texture conduct better than those mechanically mixed, and the stones with fine grains better than those with coarse. The few observations made on woods show that in them, as was long since demonstrated by Tyndall and others, there is a much more rapid passage of heat in the direction of the fibres than in that at right angles to them. The ratio numbers, however, are somewhat different from those formerly obtained.

EXPLOSIONS IN COAL-MINES.—IV.

By T. Wills, F.C.S.

THE four forms of safety lamps described in the last lecture are types of a very large number of lamps which have, from time to time, been introduced; each form of lamp has its own advantages, but no lamp is to be found the use of which, under all circumstances, is quite free from danger. Lamps of the original "Davy" form are the most liable to permit the passage of the flame through the wire gauze. In the "Stephenson" lamp a danger is apt to arise from the irregularity of the holes in the plate or plates, through which the air enters; those holes are drilled by hand, and under these circumstances their accuracy cannot be ensured to the same extent as in the machine-made wire gauze. A "Stephenson" lamp requires to be held in a nearly vertical position. In the "Clanny" form of lamp the imperfect supply of air is a difficulty, as it is attended with a loss of light. That this is the case is well illustrated by comparing a "Clanny" with a "Mueseler," in which it is found that, the two lamps being almost of the same character, the better air supply in the "Mueseler" is coupled with an increased amount of light.

The following comparative experiments, which were made with a view to these lectures, exhibit the relative photometric value of these four lamps; the loss of light is also shown when the flame is surrounded by the gauze, or gauze and glass:—

A Sperm Candle burning 120 grains per hour = 1 Oil Lamp.

			Loss or gain in light on surrounding the flame with the upper part of the lamp. Per cent.
"Davy"	Naked	= ·398	
	Complete	= ·146	= 63 loss.
"Stephenson"	Naked	= ·366	
	Complete	= ·131	= 64 loss.
"Clanny"	Naked	= ·378	
	Complete	= ·296	= 21 loss.
"Mueseler"	Naked	= ·368	
	Complete	= ·385	= 4 gain.

The observations were made by means of a Bunsen's photometer, and the lamps used were ordinary working lamps, but new. In this table it is seen that, when the naked light is inclosed within the lamp, there is a considerable loss of light in each case, except that of the Mueseler, and the remarkable difference in this instance must be attributed to the more perfect supply of air in this lamp. Practically, the placing of the glass and gauze round a Mueseler lamp makes no difference in the amount of light obtained.

Occasionally, for special purposes, shields or reflectors are placed entirely or partially round the lamps on a level with the flame, but their advantage is very doubtful. Before quitting this subject, a form of lamp, which is in extensive use in Scotland, must be mentioned. This lamp is called a gauze lamp, and is of a somewhat primitive construction; it is much larger than the other forms of lamps, the outer case consisting entirely of unprotected gauze. This gauze cylinder is about 8in. high by 3½in. diameter; a lamp with a flat wick is used, and more light is obtained from it than from the ordinary Davy, but its safety is not so great; the considerable space within the lamp forms an element of danger in the event of its being exposed to an explosive atmosphere. This description of lamp was in use at the Blantyre Colliery when the terrible explosion took place last October.

Vegetable oils are mostly used in lamps, but in some cases the rock or mineral oils have been substituted; there is a prejudice against these latter which has prevented their common adoption, although the saving in cost, the cleanliness in use, and the much greater amount of light obtained, are decided advantages; it is probable that these important considerations will eventually lead to their more general use. A lamp burning a mineral oil gives more than twice as much light, under the same circumstances, as one of the ordinary character. Some lamps burning the lighter mineral oils are constructed without wicks, a small piece of cotton-wool or sponge serving the purpose of a wick for an indefinite length of time. When lamps are used with these oils, care and caution must be exercised in the storage of the material, and in the filling of the lamp.

Although the introduction of the Davy lamp marks a very important era in the working of coal-mines, it singularly happened that instead of at once largely decreasing the accidents from explosion, these in the immediately succeeding years became greater. The Davy lamp was introduced and adopted in 1815, in the 21 years previous to which the average annual loss of life by explosion was 23, but in the 15 years subsequent to its invention there was an increase, the yearly destruction being 28; this fact, although remarkable, is accounted for by the false notion of absolute security in the use of a Davy lamp which was held at the time, and which led to the immediate opening up and working of dangerous places which had previously been abandoned.

Dangers connected with the Use of Safety Lamps.

From what has been already said it will be gathered that safety lamps can be by no means implicitly trusted to prevent an explosion; much care is required in their construction and use, as any defect or failure in the lamps may be, and frequently has been, the source of much danger. Every lamp supplied to a mine should, in its vital part, be of the best manufacture, and much care should be taken in putting the various parts of the lamp together. Lamps, as a rule, do undoubtedly leave the workshop in an excellent condition, but occasionally, from some perhaps exceptional cause, a defect occurs, which, if not afterwards detected, may be the source of accident. A short time ago some Stephenson lamps were tested in the North of England, and in one batch the several lamps were found which would kindle an inflammable mixture on the utside with the greatest ease; the Stephenson is iable to this defect owing to the difficulty (already nentioned) of making the small holes uniform. It nay be suggested whether it would not be possible o practically test every lamp in an explosive atmosphere before it is sent away from the manufacturer's premises. The defects in the lamps which occasionally occur during the manufacture, are, however, of small moment when compared with those that arise afterwards through the wear and tear of use. After every time of using a lamp should be thoroughly inspected; this is, at the present time, supposed to be carried out. The Coal Mines Regulation Act requires the lamp to be inspected by a competent person before such lamps are carried into the workings, but in too many instances this inspection is the barest matter of form; perhaps hundreds of lamps have to be examined within a very short time, and the most casual observation has to suffice; it is by no means sufficient to observe whether the lamp is locked or not; the state of the gauze, and of the lamps generally, requires more than a superficial examination. Want of cleanliness is in itself a source of evil. If il and dirt be allowed to remain on the gauzes, part from its rapidly causing deterioration, it is ound that a flame will more readily pass through ach a gauze; a lamp should also be properly rimmed before entering the mine, as in this way the emptation which a miner has to open his lamp to nprove the light is lessened. It is the custom in ome districts for the miners to provide their own amps, and to retain them in their possession when t in the pit; this, without doubt, is a bad practice; it cannot be expected that a miner will go to ore expense than he can help, and as to him probably all lamps are much alike, he is sure to get one om a fellow-miner, or from some second-hand store. he care and cleaning of the lamps also is not well ft to the miners themselves; a properly authorised d competent person or persons should have the entire control of the lamps when not in use. A miner's tion of cleanliness is not always satisfactory. n instance occurred in the North in which a miner, order to cleanse the gauze of a lamp from oil d dirt, removed it and thrust it into the midst of fire, replacing it after the combustible matter d been burnt away; it need hardly be stated at such a gauze would afterwards be most ngerous, both from the enlarging of the holes, d from the extreme brittleness of the wires. nother and much to be regretted cause of danger the use of safety lamps arises from unauthorised mpering with the lamps; opening a lamp in an safe pit is a most serious evil, and when the vial causes are considered for which this is ne, the subject is rather disheartening. Smoking one of the most general causes of opening the ups, and although in most cases strictly and wisely hibited, is a source of constant trouble, and it is be feared will continue so until the miners can be de to feel their responsibility. Rules and regulations on the subject are evaded in the most terribly kless manner, even in circumstances where it ght be supposed the miner's own knowledge would icken his sense of danger. Where the wilfulness negligence of one man may bring disaster and sibly destruction to large numbers, it is surely no ustice or hardship to ask that when such a case is covered, and the offender is called to account, a ere punishment should be inflicted; too often, wever, such culprits escape with the payment of a ght fine. Within the last fortnight (January 23) o miners have been fined at the Burslem Police-court for actually smoking in a place in a mine in ich at the time there existed explosive gas. A pipe y be lighted from an ordinary Davy lamp without ning it, if the lamp be tilted on one side and the e is placed close against the gauze; the operation however, by no means free from danger if gas ts in the neighbourhood; to obtain a light from other descriptions of lamps, the lamp must be en apart. The lighting of pipes, although the st general, is not the only cause of tampering with lamp; the small amount of light which even the t of them give offers an inducement for the noval of the gauze in order to obtain the l benefit of the naked light, also when fuse of a blasting shot has to be fired quently the lamp top is removed; this is not lly necessary, as a hot wire, which may be sted through one of the meshes of the wire uze, would be quite sufficient. Special care is essary with the lamps on the occasion of shot ng, as it may be the case that while there is no reciable amount of gas near the spot before the losion, this state of things may not exist afterwards, and supposing a lamp to have been taken rt and not put together again, a serious result y follow. It is certain that this tampering with safety lamps by those who should exhibit the st care forms one of the most serious evils against ich colliery proprietors have to contend; experience, which is generally the most successful teacher, ems here to fail, and the plea of ignorance in very ny cases cannot certainly be justified. An incredible number of cases of the most reckless carelessness, resulting sometimes in a catastrophe sometimes not owing to circumstances out of the miner's knowledge or control, might be placed on record, if any good might be hoped from so doing. This state of things has rendered it necessary that any precautionary measures which can be applied to the lamp itself shall be adopted, and hence in all lamps ordinarily in use in any fiery mine a locking arrangement is attached, which is intended to prevent the lamp from being taken apart with impunity, so as to expose the light, or, if so taken apart, to insure that the fact shall afterwards be revealed. This affords a certain measure of safety, but entire reliance upon it has, in most cases, become a trust in a very broken reed. Various locks have been introduced, each claiming special advantages, and many forms are in constant use; they are intended either to prevent the lamp from being opened at all, except by authorised persons, or, if taken apart, to cause the fact to be afterwards readily detected; or, lastly, if an attempt is made to expose the light, to cause it to be extinguished in the operation.

The Coal Mines Regulation Act requires that "In every working approaching any place where there is likely to be an accumulation of explosive gas, no lamp or light, other than a locked safety lamp, shall be allowed or used; and whenever safety lamps are required by this Act to be used, a competent person, who shall be appointed for the purpose, shall examine every safety lamp immediately before it is taken into the workings for use, and ascertain it to be secure and securely locked, and in any part of a mine in which safety lamps are so required to be used they shall not be used until they have been so examined and found secure and securely locked, and shall not without due authority be unlocked." The locking arrangement here contemplated is undoubtedly some apparatus which shall prevent the exposure of the flame by an ordinary miner. The readiest method, and the one largely adopted for this purpose, is so to fasten the upper part of the lamp or gauze cylinder to the lower part or lamp vessel, that the two cannot be separated without a key or special instrument, to be retained by those with whom the authority rests. The ordinary "screw" lock is an illustration of the way in which this is practically done. The two parts of the lamp are joined by a screw thread; above or below this thread is a groove cut round the circumference; the upper part of the lamp carries a counter sunk screw plug, which, when the lamp is fitted together, can be screwed into the groove, and afterwards the lamp cannot be separated or opened without the first removal of this plug. The success of this arrangement, as far as the tampering with the lamp is concerned, depends almost entirely upon the kind of key required to loosen this screw plug; usually this key is simply a piece of round iron or steel with a slit in it, fitting to the head of the screw, the imitation of which is most easy, and a variety of impromptu instruments may be substituted for it—such as an iron nail or a penknife with a slit cut in it, or two nails fastened together, &c.; also after a time the screw is apt to become loose, when not even these means need to be resorted to to open the lamp, as the point of almost any solid body can be made to turn the screw sufficiently to allow the lamp to be taken apart. The largest number of locks adapted to ordinary safety lamps are of this pattern, which it must be acknowledged is not by any means satisfactory. It is rather sad to have to admit that so little faith can be placed in miners with respect to this matter of locked lamps, for it appears that, however carefully a lamp may be so guarded, the ingenuity of the workmen will compass the matter, and find a means of breaking the rules. At an explosion which took place at Talk'e-o'-the-Hill, in 1867, in which 80 persons were killed, 27 false lamp keys were found on the bodies.

In some forms of lamp a powerful spring replaces the screw plug ordinarily used.

Magnetic locks have also been proposed, and occasionally used, an iron bolt fastening the lamps together, which can only be withdrawn by the action of a powerful magnet; practical difficulties, however, occur in this arrangement.

In the Scotch gauze lamps a simple padlock, passing through two eyes, one in the upper and the other in the lower part of the lamp, is used.

Other forms of lock seek to prevent the tampering with the lamps by rendering detection certain, on which, of course, a severe punishment should follow. One form of these "detector" locks consists in joining the two parts of the lamp together with a bayonet joint; when this is done a lead plug is passed through an eye in each part, and, by a pair of nippers, is squeezed together, and impressed with some form of seal. Before such a lamp can be opened this lead plug must be cut, and its replacement, if it carries a stamp, is difficult.

As the aim of all forms of locking apparatus is to prevent the exposure of the light, attention has been given in many cases to some arrangements whereby the light shall be extinguished whenever the lamp is opened. In some, by means of a lever an extinguisher is brought down upon the wick when the oil vessel is unscrewed; in oil lamps, however, apart from the difficulty of maintaining the apparatus in working order, the flame is apt to be persistent, and if the operation of opening is done quickly it may still be alight when the lamp is taken apart. In lamps burning mineral oil the effect can be more easily accomplished, and a lamp, the flame of which is always extinguished before it can be exposed, has lately been introduced, called the "Protector" lamp; this lamp is the invention of Mr. W. E. Teale, to whose kindness I am indebted for several of the specimens exhibited. Surrounding the tube of the lamp carrying the wick is a second brass tube; before the lamp can be opened the oil vessel has to be unscrewed from the body of the lamp; this operation draws the wick and the flame down through the outer tube, the proximity and cooling effect of which invariably extinguishes the flame before it can be withdrawn; a spring bolt retains the outer tube in its place, and the bolt can only be released after the lamp vessel has been taken apart, and, consequently, when the flame is out; in practice the lamp works quite successfully, and I believe its adoption is increasing. Any of the ordinary forms of locking apparatus may be attached to it, but without these means it would appear to fulfil the spirit of the Mines Regulation Act, if not the letter.

THE MICROPHONE.*

THERE is nothing new in the fact that, if a telephone be placed in circuit with a battery or other generator of electricity, sound will be heard on the telephone each time the circuit is completed or broken, which can be easily done by separating the wire forming part of the circuit and holding one end in each hand, and making or breaking by touching or separating the two ends. The magnitude of the sound on the telephone will of course be in proportion to the magnitude of the power employed, and may be like the fall of a pin or the report of a cannon. Instead of making or breaking the circuit as I have described, what is technically known as a commutator or key may be employed. The beam of a balance which the hundredth part of a grain would turn makes a very sensitive commutator.

It follows as a matter of course that, if any sensitive commutator be placed on a vibrating-board or any convenient substitute for the same, the slightest vibration will cause the commutator to oscillate, and thus make or break the circuit, and the intensity of the sound produced depends, as before, upon the amount of battery power employed.

M. Fromont was kind enough to show me, some eighteen years ago, over his workshops in Paris; and in one room, amongst many of the instruments, there was a very sensitive commutator, which in some way was concealed in the wall of the room. He requested me to stand, as well as I remember, about six feet from the wall facing me, and to agitate the atmosphere by ejecting a breath as though in the act of giving a low whistle. Each time I did so there came from some other part of the building a sound similar to that produced by striking a large gong.

I had repeated successfully with a simple commutator most of the experiments reported to have been made by Professor Hughes, but I was still in doubt whether I fully understood the subject or not, as I had read of "two wave-currents running through the circuit—one of electricity, the other of sound vibrations," &c. I was, therefore, pleased to have the opportunity of witnessing the experiments, and hearing the lecture on the microphone, given by Mr. W. H. Preece, assisted by Professor Hughes, at the Society of Telegraph Engineers, on the evening of the 23rd ult. In the discussion which followed there appeared to be a difference of opinion as to the law on which the microphone acted, but if I had required further evidence to strengthen my assertion that the microphone was simply a sensitive commutator, I should have found it in the experiments which were exhibited. Mr. Preece told us that Professor Hughes's first experiment was to include a length of copper wire in circuit with a battery and telephone. While so placed he plucked at it, talked to it, and stretched it without effect, until the wire broke, and then he heard a slight sound at the telephone, and he reproduced the sound whenever he rubbed the ends of the wires together. That being so, what can molecular changes in the material, and two wave-currents running through the circuit—one of electricity and the other of sound vibration—have to do with it? Mr Preece then exhibited the experiment of placing a timepiece on a vibrating board, when the beat of the pendulum could be distinctly heard on the telephone at the most distant part of the room; but when the clock was removed from the board no such sound was audible, and why? Because on the board was fixed a sensitive commutator which was affected by the vibrations of the pendulum, and this kept up a continuous make and break of a circuit in which were placed the battery and telephone. Again, when Professor Hughes wrote an imaginary letter on the vibrating-board, of course the pressure of the pen affected the commutator, and a sound was produced on the telephone. When he disconnected the commutator nothing was heard but the scratching of the pen upon the paper.

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* Extracted from a paper by Mr. Willoughby Smith in the *Electrician*

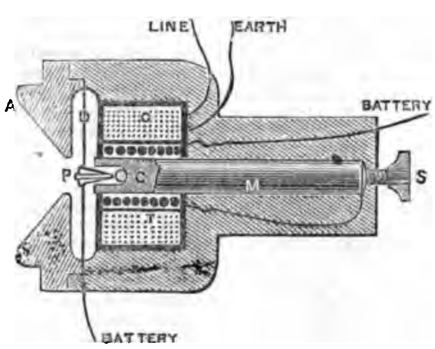
Mr. Preece stated that Professor Hughes had obtained wonderful results from placing his gold watch-guard in the circuit and shaking it. Of course it would be so. The chain so placed would be analogous to an intermittent contact. I would illustrate what I mean by intermittent contact by what occurred some years ago in an underground wire which was laid in a trench two feet deep by the side of a railway. It was a copper wire covered with gutta-percha; the wire was broken, but the two ends pressed close together, and did not show any signs of being broken until a train passed close by the spot where it was laid, and then the vibrations caused by the motion of the train produced the intermittent contact. The same remarks will apply to the five pieces of mercurially-prepared carbon which were enclosed in the glass tube, and used by Professor Hughes as a microphone.

When a telegraph operator is sending a message to be received on the Morse instruments he works the commutator, or key as it is more frequently called, with his hand, and gives time-contacts—that s to say, to form a *dash* the contact remains double the time necessary to form a *dot*. Professor Hughes, if I understand it rightly, has discovered that, by allowing the breath to impinge upon a sensitive commutator, contacts of varying duration are made which are faithfully reproduced in corresponding sounds upon that marvellous instrument, the telephone. This is an important discovery, and must henceforth identify Professor Hughes with the telephone. By this discovery the telephone at once becomes a thoroughly practical and useful instrument, not only for telegraphic purposes, in the ordinary acceptation of the term, but it can be utilised in endless ways. By the magnitude and number of beats on the telephone the engineer can learn the amount of vibrations caused by heavy weights passing over new or old structures; a soldier can discern the approach of a enemy miles distant, and, whether it be the tread of cavalry or the rattle of artillery, it can be distinctly distinguished. By these commutators, or microphones, being conveniently placed in the room where an eminent man, say in London, is speaking, to an audience on scientific or other subjects, he can be as distinctly heard by an audience assembled in any room where a telephone is placed in the same circuit. If the microphone will do all that its discoverer claims for it there is no reason why friends or foes should not be able to converse with each other, although thousands of miles of land or *sea* may divide them. The low current generated by the telephone is not sufficient to overcome the electro-static induction of submarine cables or underground wires, but, with the microphone as a sender, the electro-motive force can be whatever is required. Professor Hughes by this discovery has added an important leaf to the branch of our electrical knowledge, and I most heartily congratulate him.

THE REACTION TELEPHONE.*

By Profs. Elihu Thomson and Edwin J. Houston.

In the course of experiments on various forms of telephones we have developed an apparatus which combines in its action certain principles not heretofore used in the construction of these instruments. By the employment of our form of telephone we have obtained a marked increase in the volume of the sound, together with an improvement in its quality. The instrument used by us was constructed as follows:—In the figure, the sheet-iron diaphragm, D, supports at its centre a small point of some resisting material, P, such as plumbago. The point, P, dips into a mercury globule, G, placed in a suitable cavity in the end of the iron core, M, nearest the diaphragm. The iron core has on it a primary coil, T, which forms part of a battery circuit, in which are included the variable resistance, P G. Suitable screws at S and P allow proper adjustments to be made. Surrounding the primary coil, T, is a secondary coil, C, which is included in the line circuit. This instrument can be used both as a transmitter and as a receiver. Its operation as a transmitter is as follows:—By speaking into the mouth-piece, A, the diaphragm, D, is set into vibration, thus causing the point, P, to dip to a greater or less extent into the mercury globule, G. The latter being in the circuit of the primary wire, T, the currents therein are varied in accordance with the movements of the point, P. If, for example, the point, P, is so moved as to dip more deeply into the mercury, an increase in the primary current follows, thus producing an increase in the magnetism of the iron core, causing a still further approach of the diaphragm and further increase of current—this action continuing until a position of equilibrium is reached between the attraction of the core and the elasticity of the diaphragm. On the recession of the diaphragm, opposite effects follow—namely, weakening of the primary current, of the magnetism of the core, and further recession of the diaphragm consequent thereon, with a further decrease of current. The changes thus produced in the primary current and in the magnetism of the core give rise to inductive currents in the secondary coil which pass into the line and the receiving instruments. The induction currents so produced are still further intensified by the movements of the diaphragm to and from the core as in the ordinary magneto telephone. Since the inductive effect of the diaphragm produces a current in the secondary wire in the same direction as that producod by an increase in the primary current, these two are combined in a single intensified current.



From the foregoing description it is evident that any variation in the primary current consequent on the motion of the diaphragm reacts to increase such variations; while the induced current in the secondary still further reacts to increase that produced by the inductive action of the diaphragm. In view of these facts, we call our instrument the reaction telephone. We have found by actual trial that an instrument constructed identically the same as that just described acts admirably as a receiver. Instead of the mercury globule and plumbago point as described, it is evident that any method of varying the primary current by the movements of the diaphragm may serve the same end. Used as a transmitter, the instrument described gave remarkably good results, even though the speaker was situated at some distance from the instrument. In this form of telephone it is evident that the best results can only be obtained by properly proportioning the resistances of the various parts of the primary and secondary circuits. The improvement in the quality of the voice, as given by this instrument when used as a receiver, is probably due, among other causes, to the slight damping of the middle of the diaphragm, which thus partially prevents the strengthening of the metallic notes of the diaphragm.

THE INJECTOR.*

Taking steam from a boiler at a given pressure and causing it to drive water into that boiler at the same or a higher pressure would seem at first sight paradoxical. But we must remember that we do this very same thing with the ordinary steam "donkey" pump, and the mystery lessens, the wonder becoming that it can be effected without any differential areas of pistons, &c., and by a simple arrangement of tapered tubes. We propose to show that it is not at all like "lifting one's self up by the bootstraps," but is just as philosophical and unmysterious as any other operation and result in steam engineering. There is no "perpetual motion" about it.

FIG. 1

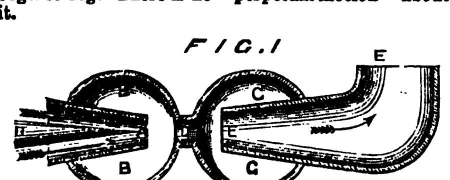
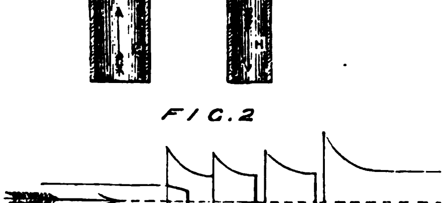


FIG. 2



Suppose we have a conical tube, A (Fig. 1), discharging steam through a chamber, B, with contracted orifice, D, and a diverging tube, E, all three placed exactly in line. If the chamber, B, is closed the air in it is rarefied, and causes water through the tube, C, if proper connection This water condenses the steam, and the pass out through the diverging "Venturi" If this last be sufficiently "flaring" and of the jet unbroken, the water will be abl the tube, E E, to a height (or against a proportionate to the amount of taper of ging cone. If the tube widens, say, f section to *b*, this pressure of the water cc be equal to $\frac{V^2}{2g}$ times the difference be atmospheric pressure and the square of t section divided by the square of the grea common to make this ratio of diameter $\frac{a}{b}$ then $\frac{a^2}{b^2} = 0·0256$, and as $1 - 0·0256$ we have the height in feet correspondi water pressure, $H = \frac{V^2}{2g} \times 0·9744$.

But we may wish to make the tap greater, so as to make H greater; an assume $\frac{V^2}{2g}$ = this height.

The mixed jet must be kept at such a rature as not to be vapourised in the secon G—that is, less than 212° Fah. (= 100° wise steam will escape from the pipe, H, such a discharge.

To improve the machine we can eithe the useful section of the orifice, D, by n pipe, A, further back, or keep this no and lessen its steam discharge by insertin rod, R. What we want is to get all condensed by water in the first chamber keep the temperature of the mixture lowe of corresponding saturation at the mea that there is in the second chamber ((communicate with the air this temperatu ration is 212° Fah.) If the feed supply than the steam jet (as in the diagram), th in B a mean pressure correspondingly l that of the atmosphere. If the feed suppl there will be a corresponding increased pr the chamber, G, communicates with th temperature of the liquid jet entering it w than 212° Fah. We can obtain at will eith or velocity (that is, pressure) of conve Raising the temperature of the supply creases the quantity of conveyed water, the velocity of the mixed streams. Lo temperature of the mixture rapidly in proportion of conveyed water. At 212 water has maximum velocity and is in quantity. With dry steam the proporti veyed water increases over that obtained w steam. The injector is a much more boiler feeder than pumps are; but, conside as a water-raiser, its duty is compara (about ⅓ that of the pump), most of the steam being employed in raising the tem the feed. To get the best mechanical pe out of an injector we wish to place it as possible. This diminishes the pressu chamber, G (if closed), and lowers the te of the steam jet—that is, the temperature tion due to the reservoir pressure in G. of getting the water into G will then be suction pump, and practicable up to abo feet lift. This will give the greatest pos steam temperature between the boiler and t orifice, and thus secure the highest effect attainable here; and an injector wo will differ from one doing ordinary fee steam about 212°, just as a condensing en from a non-condensing.

The water-raising performance of th increases rapidly with great heights, and of its great convenience the machine is l for draining mines, &c. It should be r that it is best for this purpose to give height of draught it will stand. A water substituted for a steam jet, and we ma water jet injectors at some other time.

Using several successive funnels, Fig. useful effect of permitting the water raise at the injector with considerable velocity may be used as a condenser, and then ejector. An injector may be used to ad working a hydraulic press, where a pump power is lacking. The very causes of w the steam injector as a draining pump (portion existing between the possible and lifting height of a liquid, and also the di between the specific gravities of the ste liquid raised by it) make it a more device for a gas pump. The exhaust locomotive is an instance of an injector u pump; the employment of an intermitte found an advantage for the purpose na injector is also used as a blower and ve which case it is really a gas pump. One important steps in the progress of the in special adaptation to locomotive feeding employing two devices—one a lifter, cal the difficult suction and the varying steam pressures, the other a forcer, taking the water from the lifter and putting it at any desired temperature or pressure into the boiler. The beauty of this combination is that by using only part of the steam in the lifter the increase of temperature of the water is very slight; the supply may, therefore, be quite hot without bringing the temperature in the condensing space up to 194° Fah. (about the maximum). Also the forcer is fed under invariable pressure by the lifter, and is not dependent upon variable degrees of vacuum. No Watt's regulation is thus necessary.

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* From the *Polytechnic Review.*

* From the *Scientific American.*

PLIOCENE MAN.

FROM the report of a lecture delivered at Cambridge, Mass., by Prof. J. D. Whitney, we learn that his subject was the "Californian Pliocene Man," become famous through Bret Harte's verses, as well as by more elaborate discussion. The lecturer began by giving some account of the general geology of the Sierra Nevade. Granite is found in the foot-hills of the western slope, while much of this slope is made up of auriferous slates, succeeded on the crests by granite. Such were the principal surface rocks until the Pliocene epoch, and this surface had been deeply eroded by the rivers of that and previous epochs. During the Pliocene age California and Oregon became the theatre of the most tremendous volcanic activity that has devastated the face of the globe. The valleys of the rivers on the Sierra were filled, and much of the country, particularly towards the north of California, was entirely buried in lava and ashes. Since then, the rivers seeking new channels, have made for themselves deep canons, leaving their old beds deeply buried under the lava. These old buried river gravels are very rich in gold, and extensive tunneling into the sides of the mountains and under the old lavas has been done. In one of these old river bottoms, under the solid basalt of Table Mountain, many works of human hands have been obtained, as well as the celebrated human skull of the Pliocene, now so well known in connection with "Brown of Calaveras." The age of these deposits under the lavas is known to be Pliocene on account of the remains of the contemporaneously buried flora and fauna, which were almost totally unlike the flora and fauna of California at the present time. That the skull was found in these old, intact, cemented gravels, has been abundantly proved by evidence that cannot be gainsaid. At the time it came into the speaker's hands, the skull was still imbedded in a great measure in its original gravelly matrix; in this condition it was taken by him to Cambridge, where, under his charge, and in the presence of Professor Jeffries Wyman, of Harvard University, and Professor W. H. Brewer, of Yale College, the imbedding matrix was chiselled away. In and about the skull were found other human bones, including some that must have belonged to an infant. Chemical analysis shows that it is a true fossil, its organic matter being almost entirely lost, and the phosphate of lime replaced by carbonate of lime.

So far as human and geological testimony can at present go, there is no question but that the skull was found under Table Mountain, and is of Pliocene age. However thoroughly the vast antiquity of man upon the globe is proved, the acceptance of this particular discovery as a fixed fact is retarded by the Theologians and Darwinians. The reason of the opposition of the latter is because the skull might belong to an Indian of the present day, so far as its form is concerned. Therefore it lends no support at present to the Evolution theory. The vast antiquity of man does not rest on this alone, but on many similar discoveries, both in America and Europe. The lecture says, the *New York Tribune* was well illustrated by maps and sections, and was also enlivened by the presence of "Brown" himself.

The Microphone in the Pulpit.—A young gentleman, well known in connection with a firm of telegraph engineers in Halifax, furnishes the following interesting account regarding the microphone:—"Last Sunday, a microphone was placed in the pulpit of a chapel in this town, and connected by a private telegraph line running by with the residence of a gentleman over a mile distant. Every part of the service was distinctly heard at the gentleman's house, with the exception of a few words rendered indistinct by the preacher becoming a little excited, and shaking the microphone, the presence of which he never dreamt of, or he might have been somewhat nervous at the idea that his sermon was being conveyed away, he knew not whither. So faithfully did the microphone do its work that the chapel-keeper was heard to close the doors after service, walk up the aisle, and up the pulpit steps, in conversation with some one else. During the week experiments have been made in the schoolroom of another chapel, and the singing of the scholars was transmitted and retransmitted over a number of telegraph lines with remarkable clearness. The idea is about to be put to practical use, the gentleman already referred to having given instructions that his house should be connected with that of a gentleman near, in order that an invalid may hear the service from one of the churches in the town."—*Halifax Guardian.*

SCIENTIFIC SOCIETIES.

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ROYAL ASTRONOMICAL SOCIETY.

THE last meeting before the long vacation was held at the Society's rooms, Burlington House, on Friday, the 14th inst., Prof. Cayley, vice-president, in the chair. The following gentlemen were elected fellows of the society:—M. Edouard G. Deville, Quebec. Mr. John Frederick Main, B.A., D.Sc. University College, Bristol.

Prof. Adams explained on the black-board, a remarkable property which he had discovered, of the analytical expression for the constant term in the reciprocal of the moon's radius vector, or what is commonly called the constant term of the moon's horizontal parallax.

Captain Tupman read a paper upon the measurement of the photographs of the transit of Venus. The photographs of the English Government expeditions have all been taken with similar photo-heliographs, made by Dallmeyer. The image of the sun has been enlarged by secondary magnifiers to 3·9in. in diameter, and a series of measurements have been made to determine the distortion of the photographs at the parts of the plates where the limb of the sun and the limb of Venus fall. The results of these measurements show that there is very little difference in the distortion of the different instruments. The photographs of the transit were then taken and marked by Mr. Burton and Captain Tupman independently, with lines indicating the direction of the diameter joining the centre of Venus and the centre of the sun, and in this they found that there was hardly any perceptible difference between their two estimates; but when they came to measure the distances between the centres the discordances between Mr. Burton and Captain Tupman were so great that it was evident that their measures would be quite useless for the purpose of determining the sun's distance.

The Astronomer Royal said: all the preliminary investigations for determining any constant source of error in measuring the photographs were very carefully carried out. The errors of a scale of millimetres, which was made for us by Mr. Simms for measuring the photographs, were very carefully determined, and the distortion of the photo-heliographs was also determined by means of a scale of equal parts 16ft. long, which was lent to the Observatory by Mr. De La Rue; this was photographed in various positions, and the photographs were then measured with the millimetre scale. So far everything went well, but when we came to measure the photographs of the transit I must say I was grievously disappointed. When I was officially called upon to express my opinion on the propriety of incurring the expense of the photographic work, although, as I then stated, I had some doubts about it, yet I expressed myself favourably to it, and I hold myself responsible in some degree for having incurred so much expense and labour. But I can only say that the results have been most disappointing. The images are very troublesome, partly owing to difficulties arising from irradiation, and partly to other causes, one of which is the very excessive brightness about Venus, which makes it look somewhat like a hat with a brim round it, and another is the excessively gradual degradation of light at the limb of the sun. When the measures were made there was some doubt as to the scale to which they ought to be referred; the scale I adopted as the best I could get was to take the sum of the measures of the diameter of the sun and the diameter of Venus, thus getting a quantity affected by two opposite kinds of irradiation, for the diameter of the sun is increased by the irradiation action, while the diameter of Venus is diminished by it, and we might suppose that the two opposite effects would annihilate each other, but it appears that they do not, and no doubt this is one of the sources of uncertainty. By means of the eye-observations Captain Tupman, after a most careful discussion, fixes upon something like 8″·83 (I will not answer for the one-hundredth part of a second), but from the reduction of the photographic measures, treated as well as we can, we get a parallax of 8″·2, a parallax which would be utterly irreconcilable with the eye-observations, and I do not see at the present time any sufficient explanation of the great difference.

Mr. Common asked whether the distortion determined from photographs of a scale at a few hundred feet distance would not differ from the distortion when the instrument was focused upon celestial objects?

Captain Tupman said that the focusing was done by moving the object-glass; the lenses of the eye-piece or magnifying apparatus had not been disturbed since the photographs were taken, and consequently he thought the distortion determined from photographing the scale might be relied upon.

Mr. Ranyard read a paper by Prof. C. A. Young, on his observations of the transit of Mercury, made at Princetown, America. Prof. Young had not been able to see any trace of a ring round the planet, or spot upon the disc. The structure of the photosphere in the neighbourhood of the planet was very carefully observed, and Prof. Young fancied that the rice grains in the neighbourhood of the limb appeared to be lengthened out radially, which was just the contrary effect from that which might be expected if the planet were surrounded by a refracting atmosphere, and he was inclined to think that the phenomenon was wholly subjective. The colour of the disc, when viewed with a Merz polarising eyepiece, appeared violet, exactly similar to the colour of the nuclei of sunspots.

Mr. Ranyard read a letter from Mr. Prince, of Tunbridge Wells, calling attention to an observation which he had made in the year 1867, and which he had described in a letter to the *Astronomical Register* of that year. The planet Mercury was at the time near to its greatest elongation, and on examining it in the daytime with a 5in. refractor he had seen a bright spot a little to the south of the centre of the planet. A friend in the neighbourhood, whose attention he had called to the phenomena, had also seen the bright spot with another instrument.

Mr. Christie read a paper on the bright lines or interspaces between dark lines in the solar spectrum in the neighbourhood of the G line, which have been attributed by Prof. Henry Draper to the presence of oxygen in the sun. Mr. Christie showed a drawing of that part of the spectrum which he made with the Greenwich half-prism spectroscope. He found that, when this region of the spectrum was examined with high dispersion, the bright lines appeared very broad, compared with the dark lines, and that they did not appear to degrade at the edges, as might be expected if they were really bright lines, and not parts of the continuous spectrum cut out or left by dark lines. Besides this, he found that there were certain fine dark lines towards the middle of each of the bright lines or spaces. This, he thought, rendered the hypothesis that they were bright lines, still more difficult, as one would have to assume that the oxygen lines were each double, and were only separated by a very fine sharply-defined interspace. Another point to which he wished to draw attention was, that since there were no dark lines in the solar spectrum which corresponded with lines in the spectrum of oxygen, it was evident that the lines of the oxygen spectrum must all fall upon interspaces between dark lines, and, therefore, no weight ought to be placed upon the mere fact of their coincidence with interspaces between dark lines.

Mr. Ranyard said that the identity of any series of lines in the solar spectrum with lines in the spectrum of a gas could never be absolutely determined. We should be nearer the truth if we spoke with greater accuracy, and said, with such and such a dispersion the lines of such and such an element appear to be coincident with such and such of the solar lines. We might find, on making use of a larger dispersion (as had actually been found in the case of the 1474 line, which was at first supposed to coincide with one of the iron lines, but was now found to be distinct from it) that there was a slight difference in the place of the lines, and that their centres did not accurately correspond, but this is not what Mr. Christie had shown; he had not examined the spectrum of oxygen with a high dispersion and shown that the centres of the oxygen lines did not correspond with the positions of the centres of the bright bands. It was not necessary that lines which did not correspond with the dark lines should all fall upon and exactly coincide with the interspaces, they might, and if taken at random, the probability was that they would, partly overlap such interspaces and partly overlap the dark lines. But, according to Dr. Draper's photograph, which, unfortunately, was not on a very large scale, the ten or eleven bright lines of oxygen there shown appeared to coincide centrally with the interspaces, and, more than that, they appeared to agree in relative brightness. He thought, therefore, that in speaking of the agreement of these lines in the solar spectrum with the lines of oxygen we ought to treat it as a matter of probability, and if, with any particular dispersion, the chances of a central or apparently central coincidence of any line with a line of the solar spectrum were x, then the probability of the coincidence of the ten lines of oxygen with the ten solar lines or interspaces would be measured by x^{10}, multiplied by something else, which would measure the probability of the observed similarity in the relative brightness. This was all that had been made out with regard to oxygen, and Mr. Christie had not shown that there was not this coincidence. With regard to the theoretical objection, that a gaseous atmosphere overlying a continuous spectrum must absorb its own wave length, and give rise to a dark line, there was the remarkable case of the D_3 line, which was seen bright in the chromosphere, but yet there was no equivalent dark line in the solar spectrum. There was also the 1474 line, which, though the brightest of the corona lines, had only a faint Fraunhofer line corresponding to it, showing that the law of exchanges did not universally hold. This was also proved by the bright lines of gaseous nebulæ, for, if the law of exchanges held absolutely true, the outer and cooler layers of a nebulous mass would absorb all the wave lengths emitted by the gas in the interior of the nebulæ.

Dr. Schuster said that none of the bright lines of oxygen were sharp lines, but the fact which had been pointed out by Mr. Christie, that the bright bands near G did not fade off at the edges, looked very much against their corresponding with the lines of oxygen. He had himself shown, in a communication to *Nature*, that there was another spectrum of oxygen, and that there were dark lines in the solar spectrum which corresponded to it; he did not think it was probable that oxygen would be present in the sun in its two forms. With regard to the theoretical difficulty, he did not think that the question was so simple as Mr. Ranyard had put it. In the nebulæ there was no background of continuous spectrum to be absorbed, the only way in which you could get bright lines in the sun without corresponding dark ones, was by assuming that hot matter was thrown up from the interior. If you considered the sun as a body at rest, no thickness of layer of any gas or metal would produce a bright line.

Mr. Knobel exhibited a chronograph tracing, made by the chronograph at the Naval Observatory at Washington. The remarkably accurate going of the clock, and the equable rate of the instrument, was shown by the absolute straightness of the line of seconds' marks on a sheet corresponding to a period of two hours.

The meeting adjourned at ten o'clock.

PHYSICAL SOCIETY.

The Physical Action of the Microphone.

AT the meeting of this society held on the 8th inst, a paper with the above title by Prof. Hughes was read by the Secretary. The author said:—In the paper read before the Royal Society on the 9th of May, I gave a general outline of the discoveries I had made, materials used, and form of microphones demonstrating important points. I have made such an innumerable quantity of microphones, each for some special purpose, varying in form, mechanical arrangement, and materials used, that it would require too much time to describe even a few of them, and as I am anxious in this paper to confine myself to general considerations, I will take it for granted that some of the forms and the results produced are already known.

The problem which the microphone resolves is this, to introduce into an electrical circuit an electrical resistance, which resistance shall vary in exact accord with sonorous vibrations, thus producing an undulatory current of electricity from a constant source, of whose waves the length and form shall be an exact amplitude of the sonorous waves.

In the microphone we have an electric conducting material susceptible of being influenced by sonorous vibrations, and here we have the first step of the problem. The second step is one of the highest importance, for it is necessary for the electrical current flowing at this point to be thrown into waves of determinate form by the sole action of the sonorous vibrations. I solved this by the discovery that when an electric conducting substance is in a divided state either in form of powder, filings, or surfaces, and put under a certain slight pressure, far less than that which would produce cohesion, and more than would allow it to be separated by sonorous vibrations, the molecules in presence at these surfaces being in a comparatively free state, although electrically joined, would of themselves so arrange their form, their number in contact, or their pressure by increased size or orbit of revolution, as to increase and diminish the electrical resistance of the circuit to so remarkable a degree as to be almost fabulous if we had not witnessed the fact.

The problem being solved, it requires only to observe the general considerations to produce an endless variety of microphones, each having a special range of variation of resistance. The tramp of a fly or the cry of an insect requires little range but great sensitiveness. Here two surfaces of chosen materials, under a very slight pressure, such as the weight itself of a small superposed conductor, suffices, but it would be unsuitable for the human voice; the vibrations would be too powerful, and would go far beyond the range allowed, producing interruptions of contact known as make and break.

The transmission of the human voice requires either four surfaces of pine charcoal as described in my paper read before the Royal Society, six of willow charcoal, eight of box wood, or ten of gas carbon; the effects are far superior, however, with the four of pine than the ten of gas carbon or any other material as yet used, being in its state of pine wood the best resonant material we possess, and it preserves this structure and quality when converted into the peculiar charcoal I have discovered and described.

We not only need a certain number of surfaces and materials in accordance with range and power of vibrations, but they must be put under more or less pressure in accordance with the force of the sonorous vibrations. Thus for the human voice, while the surfaces are under a far greater pressure than for the movements of insects, still the range of *useful effect is very great*, as in the boxes which I have specially arranged for articulation the apparatus is still sensitive to the tick or escapement of a watch.

In all cases we should so arrange it that a perfect undulatory current is obtained from the sonorous vibrations of a certain range. Thus when speaking to a microphone transmitter of human speech we should observe a galvanometer placed in circuit, and there should be observed no deflection whilst speaking, as the waves of electricity of plus and minus are equal and are too rapid to cause the needle to move, it can only record a general weakening or strengthening. If the pressure on materials be not sufficient we shall have a constant succession of interruptions of contact, and the needle of the galvonometer will at once record the fact. If the pressure on materials be gradually increased from a weak pressure to a great we shall have first loud tones, but wanting in perfection, the galvanometer indicating interruptions; as we increase the pressure the tone becomes more clear, the needle remaining stationary, we shall then arrive at a maximum of loudness and clearness; if we still increase the pressure, the sounds become weaker, though very clear, and as the pressure is increased the sounds die out as if a person was talking and walking away from us at the same time, and soon we arrive at a point when there is complete silence.

When attached to a resonant board, so that the sonorous vibrations act directly on it, the upper contact, where the required pressure is applied, should be as free as possible from the influence of the vibrations, except those directly transmitted to it by the surfaces underneath, and it should possess inertia in the form of a balance weight. This inertia I find necessary to keep the contact unbroken with powerful vibrations. No spring can supply the required inertia; but an adjustable spring may be used to give the requisite pressure to the contacts. The whole of the contacts when superposed may be screwed down by an insulated screw passing through them all, thus doing away with the lever and spring; but it is far more difficult to adjust, and the expansion by heat of the screw causes a different pressure; it is exceedingly simple, however, easily made, and illustrates the theoretical conditions better than the balanced lever I have adopted for practical use.

In order to study the theoretical considerations, and that with the most simple form freed from all surrounding mechanism, let us take a flat piece of charcoal two millimetres thick, and one centimetre square, and after making electrical connection by means of a copper wire to the lower surface, glue the latter to a small resonant board, or, better for our purpose, to a block or cube of wood ten centimetres square; upon this superpose one or more similar blocks, the upper surface in communication with a wire, the lower resting flat, or as near so as possible on the lower block.

The required pressure is put on the upper block, by means of an insulated screw. Let us call the lower piece A, and the upper B. When we put this block under the influence of sonorous vibrations, it is impossible to imagine that it can, within its small area, contain every dimension of wave length, some of which may be as much as several feet. Now we cannot suppose a wave of any length without admitting that the force must be transmitted from molecule to molecule throughout the entire length; thus any wave, of which this block represents a portion, must be in full molecular action; the lower portion of the charcoal A being part of the block itself, has this molecular action throughout, transmitting it also to the upper block. Now, how is it that this molecular action at these two surfaces, A and B, should so vary the conductibility or electrical resistance as to throw it into waves in the exact form of the sonorous vibrations? It cannot be because it throws up the upper portion making an intermittent current, because it is fastened to the lower, and the galvanometer indicates no interruption of current whatever. It cannot be because the molecules arrange themselves in stratified lines of greater or less resistance, for then we should not require surfaces, nor would the upper surface be thrown up if the pressure were removed, as sand would be on a vibrating glass. The throwing up of this upper piece, B, when pressure is removed proves that a blow, pressure, or upheaval of the lower portion takes place, and if this occur, of which there cannot be any doubt, the surface considered alone having no depth, could not bodily quit its mass—in fact there must have been a movement to a certain depth, and I am inclined from numerous experiments to believe that the whole block increases and diminishes in size at all points in the centre as well as the surface, exactly in accordance with the form of the sonorous wave. Confining our attention, however, to the points A and B, how can this increased molecular size or form produce a change in the electrical waves? First by increased pressure on the upper surface from its enlargement; or secondly by the molecules themselves, finding a certain resistance opposed to their upward movement, spreading themselves, and making an innumerable number of fresh contact points; thus an infinity of fresh contacts or decrease in the number produces practically an undulatory current. I am inclined to believe that the latter is the true explanation, as the first were alone true, we should have a greater effect from metal powder, carbon, or so elastic conductor, as metallised silk, than from go or other hard inoxidable matter; but as some of t best results as regards the human voice we obtained from two surfaces of solid gold, I a inclined to view with more favour the idea that infinite variation of conducting surface brought in play by the molecular pressure is the true explan tion, and it has the advantage of being demonstrat by the numerous forms of microphones I have co structed, in all of which I can fully trace this effec

I have been very much struck with the gre mechanical force exerted by this uprising of th molecules under sonorous vibrations. With th musical vibrations from a large musical box 2ft. i length, I found that one ounce of solid lead was n sufficient on a surface of contact of one centimet to keep it in constant contact, and it was only b removing it several feet distant that I was enabl to preserve continuity of current with a modera pressure. I have spoken to forty microphones once, and they all seemed to respond with equ force; of course there must be a loss of power in t conversion of molecular vibrations into electric waves, but it is so small that I have never been al to measure it with the simple appliances at my d posal. I have examined every portion of my roo wood, stone, metal, in fact all parts, even to a pie of indiarubber, all were in molecular moveme whenever I spoke. As yet I have found no insulat of sound, that is to say, no substance which is sound what guttapercha is to electricity. Caoutcho seems the best, but I have never been able by its to prevent the microphone reporting all it has be through any amount of caoutchouc at my disposal

The question of insulation has now become one necessity, as the microphone has opened to u world of sounds of which we were unaware. If can insulate it so as to direct its powers on a sin object, as at present I am enabled to do on movement of a fly, we shall be enabled to investig the object desired undisturbed by the pandemon of sounds which at present the microphone reve where we thought was complete silence.

However simple the microphone may appear first glance, it has taken me many months of un mitting labour and study to bring it to its pres state. The field of usefulness for it widens each d Sir Henry Thompson has succeeded in applying to surgical operations of great delicacy; and by means splinters, bullets—in fact, all foreign matte can at once be detected. Dr. Richardson a myself have been experimenting on lung and he diseases; and although the application by Sir He Thompson is more successful, I do not doubt that we shall ultimately succeed. There is ho also, that deafness may be relieved. For telepho articulation has become perfect with increased lo ness. Duplex and multiplex telegraphy will pro by its use; and there is hardly a science which w not be benefited where vibration has some direct indirect relation; and I feel happy in being able present this paper on the results obtained by purely physical action to such an appropriate a appreciative body as the Physical Society. In co clusion, allow me to state that throughout the wh of my investigations I have used Professor Bel wonderfully sensitive telephone as a receiver, a that it is, thanks to the discovery of such an adm able instrument, that I have been enabled to co mence and follow my researches in microphony.

Professor Hughes subsequently exhibited vario forms of his wonderful, but extremely simple-looki instrument, pointing out the peculiarities of ea He observed that new and important experime were made every day. He referred to Sir Thompson's recent delicate surgical operations, a exhibited a model of the instrument used by Henry—a probe for detecting bullets or sto Taking a piece of gloveskin, "to represent flesh," he put a bead in it, inserting the probe, a moving it around, taps were distinctly heard ea time the bead was struck. He then placed in hand a shot of the smallest number made, and a t was also heard in this case each time the shot w touched. Professor Hughes also indicated arrangement for relaying the human voice wh transmitted through the telephone.

ROYAL INSTITUTION.

Minute and Low Forms of Life.

THE Rev. W. H. Dallinger delivered his seco lecture on Tuesday last week, and ma some interesting remarks on the highest pow of our best lenses applied to continuous resear Most of the lenses employed by him were quite ne one of them, a 1-35 inch glass, was made Powell and Lealand specially for the lecturer, wi a view to these particular researches. The organi whose life-history was studied was one of the sep or putrefactive series, but one quite new to scien The lecturer found it some years since, but ne was able to get it in a condition fit for study u 1876. It was then found in a maceration, in whi the body of a water-rat was decomposing. It sen repeatedly found as small as the 1-5000th of an ich. It never exceeded the 1-4000th of an inch. a form was a long oval, constricted just above the iddle of its long diameter. It had three motile bres, known as *flagella*, two at the sides and one front, and by the aid of these its marvellous gility and grace of motion were effected. It was an pparently structureless speck, but its seeming exerion of volition, in all its diversities of movement, ould not be seen without wonder. Besides its iovements of translation, however, it had another, which its lateral flagella were fixed to some object, nd by means of a rapid coiling and darting motion —by its enormous numbers—powerfully assisted in reaking up the tissues of the decomposing mass. lo change ensues in this state; but they do not emain long in it, a constant flow of organisms to nd from any given piece of decaying tissue conantly going on. But if one were steadily followed the free-swimming state, it was soon seen, by a ost delicate and complex process, to *divide itself to two* through its long diameter. But in doing is a new lateral flagellum was provided for each by e pulling out of a neck of sarcode uniting them to a delicate thread, which snapped in the middle d set them both free as perfect forms. This goes with great rapidity for from four to seven hours; en the process stops, ending in the death of a proortion of the forms followed, but resulting in a riking metamorphosis in others, by means of which e lateral flagella are lost, and the organism becomes mooth oval with one flagellum. This unites with ordinary form; they fuse together, assume a indle shape which is quite still, and ultimately this rsts, pouring out a host of nearly opaque spore, eggs, so minute that the lecturer stated it as his nviction that lesser objects than these would not come definitely visible to our highest lenses. These ores were steadily watched, and were seen to velope into the full size and form of the adult. nother form from the same series of organisms was n described—one that had been worked out intly by the lecturer and Dr. Drysdale—and the ntrast and diversity taken in connection with the ity of vital method aided in generalisation. These rms, low and little as they were, were palpably as gid in their metamorphoses as a butterfly or a nap. If "heterogeneeis"—the transmutation of e organic form into another—were found anywhere ought to be here; but no trace of it was ever sible if the search and study were sufficiently proonged and careful. The sequential study of the west organism showed that the only changes to hich it was subject were those contained in the eat Darwinian doctrine of the origin of species. e question of the relative capacity for resisting at in the spore and the adult was next considered. wo methods were adopted—*dry* heat, and heat dured in a fluid.

MICROSCOPICAL SOCIETY OF LIVERPOOL.

THE sixth ordinary meeting of the tenth session was held on Friday evening, the 7th instant, t the Royal Institution; the President (Mr. George F. Chantrell) in the chair. Donations to the ciety's cabinet were received from Mr. H. F. twood, of Chicago, U.S.A., of six slides of marine es, &c., and from Mr. H. Walmsley, of Philaphia, U.S.A., of twelve slides of double-stained getable tissues, &c.

r. H. C. Beasley described and exhibited the ines and hairs of a poisonous caterpillar from San ulo, Brazil, which was referred to in a communiion from Mr. E. D. Jones, read at the last eting of the Literary and Philosophical Society. e caterpillar was covered with reddish-brown irs, growing in tufts, and at the base of each tuft s a cluster of 20 or 30 minute hollow spines, the gest about the 200th part of an inch long. At the e of each spine was a bulbous expansion, which was supposed served as a reservoir for the poison ected through the spine into the wound.

he President (Mr. Chantrell) made a short comication on the "Sphærosira Volvox" (Ehrenberg), phase in the life history of the "Volvox globator." stated that Ehrenberg, the great German icroscopist and early writer on this subject, conidered the volvox to be an animal, and that the hærosira was a distinct species. Subsequent vestigators, amongst whom were Professors iebold and Cohn, W. C. Williamson, George Busk, r. J. Braxton Hicks, H. J. Carter, and others, ve come to the conclusion that the volvox is getable. Mr. Carter was of opinion that the ærosira is a spermatic form of volvox. Mr. ntrell said that in his own investigations he had nd that not only were the discoidal forms (with ir antherozoids) and oospores to be found in the ire volvox, but that in some cases the volvox uld contain eight or nine daughter cells, six or n of which would have the usual grandghter cells, but the remaining two cells would nsist entirely of sphærosira forms and oospores. e he had seen twisting about alive in the cell, l in process of time would come away, moving at t slowly and gradually quicker, until at last he had seen them chasing, as it were, the oospores, the antherozoids of which intercepted the oospores and fertilised them. Drawings from life were exhibited showing this, and also the mounted slides of the objects themselves by himself, and also stained specimens by Mr. James Abbott, of Leeds. Mr. Chantrell hoped that during the coming months of the recess members would take the opportunity of investigating this little-known subject and confirm his observations. His specimens were gathered in the month of August last, and again this May.

Mr. W. H. Weightman then read a short paper on the "Polyzoarium of Onchospora hirsuta," an Australian polyzoon, prefaced by some remarks on the polyzoa generally. He mentioned the existence of a considerable number of radical tubes of a crozier-like form arising from the base of the lowest internode in this species, which had apparently escaped the notice of Mr. Busk, when describing it in the "Microscopical Transactions," and he exhibited some mounted slides of these radical hairs, as also an enlarged drawing of one of them. He then gave some hints as to collecting, drawing, and mounting various spines of this class, and illustrated the paper by several preparations of onchospora and other genera, and with living examples of the genera of Alcyonella, Fredericella, and Lophopus, living specimens of which had been forwarded to him that day by Mr. Thomas Bolton, of Birmingham. The meeting concluded with the usual conversazione.

The Microphone.—We have received from Mr. Th. Wiesendanger a well-made microphone on the principle described by Prof. Hughes, and illustrated in Fig. 4, p. 256. The rod and block of carbon are connected to binding screws, and secured on a piece of wood which is held by a screw on the bottom of the interior of a sounding chamber. The microphone is accompanied by an ingenious portable constant battery, which requires only a few drops of water occasionally, and which may be placed in any position without injury to itself or anything else. In a letter Mr. Wiesendanger informs us that, after trying many substances, he finds it best to use, instead of the carbon rod, a piece of copper wire, pivoted in the same manner, but resting with one end on a small piece of carbon laid loosely on the fixed carbon block. As, however, our telephones are out of town we have not had an opportunity of putting this microphone to the actual test; but there can be no doubt that it is what it is represented.

Hydrophobia.—A Parliamentary return relating to dog licences includes an account, supplied by the Registrar-General, of the number of deaths from hydrophobia in England and Wales down to the year 1876. They were 47 in 1875, and we find that they increased to 53 in 1876. Of this last number 10 occurred in the West Riding of Yorkshire, 8 in Lancashire, 6 in the county of Durham, and 6 in the metropolis. The total in the 11 years 1866-76 was 387, averaging 35 a year, but there were only 159 in the first 6 years, and there were 228 in the following five years. Of the whole 387 deaths no less than 118 occurred in Lancashire, 72 in the West Riding, 41 in the metropolis, and 26 in Durham. Hydrophobia appears to be almost unknown in the south-western counties, in the eastern counties, the south midland, and Wales.

A New Safety Lamp.—Mr. John Williamson, Hednesford, manager of the Cannock and Rugeley Colliery Company's works, has, after a long series of experiments, introduced a new safety lamp, as safe as the Stephenson—the safest lamp hitherto introduced, but objected to on account of its dim light—while it gives a better light than even the Clanny, and is not easily extinguished when exposed to air travelling at a high velocity. The inventor believes that the firing of a shot, the closing of doors, or the fall of a roof is sufficient to cause the Davy, the Clanny, or the Mueseler lamp to explode when in use in an explosive mixture, but his own lamp has been subjected to severe tests, both by himself and by engineers in the North of England, and in no case can it be made to explode. As a fireman's lamp it is stated to be invaluable, inasmuch as, when approaching a body of gas, the top or hole can be seen clearly, but if the lamp be plunged into a body of gas the light is extinguished before sufficient heat can be generated to do harm. In appearance the lamp is like the Clanny, the bottom or oil vessel and wick arrangement being the same. It contains two glass cylinders—an external one similar to the Clanny, and an internal one similar to the Stephenson—the latter being also capped with a copper or gauze cap, as in the Stephenson. The gauze in the lamp is similar to the Clanny, but without a cap. The improvement, as compared with the Clanny, consists in the arrangement of the inner ring, which in this lamp carries both glasses, and when screwed up presses the cap of the inner glass gently against the top of the gauze. The air passes through a perforated portion of the bottom part of the lamp, and through the gauze fixed on the periphery of the inner ring, and on to the flame; and the lamp is described as really a double lamp, there being no danger, even if the outer glass and gauze be stripped away, so long as the inner glass remains intact.

SCIENTIFIC NEWS.

A JOINT committee of the Royal Commissioners and members of the Society of Arts have held several meetings with the view of sending artisan reporters to the Paris Exhibition, and have already opened a correspondence with the Chambers of Commerce, the mayors of the principal manufacturing towns, and with representative artisans, in order to obtain information which will enable them to decide upon the method of selection. The Royal Commissioners and the Society of Arts each give 100 guineas to the fund, and the City Companies will, no doubt, subscribe liberally, some of those which have already sent in their contributions having sent trifling amounts in order to supplement them when they find that the movement is taken up in earnest. It is to be hoped that the men selected to act as reporters will be those who have the confidence of their fellows.

The Clothworkers' Company have voted a sum of 20 guineas towards the sustentation fund of the Parkes Museum of Hygiene, University College. The Lords of the Admiralty have forwarded a series of plans and drawings of hospital ships.

The report of the Miners' Association of Cornwall and Devon has reached us, and we learn from a perusal of its pages that it is not only doing good work, but is doing it on a very moderate outlay. It is to be hoped that the Council will be able to carry out further undertakings by means of the subscriptions, which should flow in wherever value is given for the money.

The exhibition of gas apparatus at Birmingham brought out the manufacturers of gas-cooking apparatus in force. Amongst the novelties deserving mention was a cheap workman's stove for cooking in the workshop—medal to Mr. Prust, Birmingham; and a "most cheerful and effective gas-fire"—medal to Mr. Ball, Birmingham. Some of the kitcheners were stated to be capable of cooking breakfast, dinner, tea, &c., for a large family at a sum which is very often doubled, if not multiplied when practically tested. Messrs. Crossley's silent gas-engine obtained a medal; and the 2 horse-power Baxter steam-engine and boiler, heated by gas, exhibited by Mr. W. A. Comber, also obtained a medal. The General Engine and Boiler Company also exhibited small vertical boilers heated by gas, and fitted for burning mineral oils if desired.

Maidstone museum and library was, on Sunday week, opened to the public during the afternoon, Upwards of a thousand visitors passed through the rooms, the Mayor, Mr. T. Wells, Prof. Corfield, Mr. Morrell, and several members of the Corporation being present.

An improved form of Gatling gun was tried recently at a range of 1,000 yards, the canvas target being torn to shreds, whilst many of the bullets passed through the two-inch oak planks at the back. At 800 and 600 yards the bullets struck with marvellous precision, and, according to Sergt. Mayer, who was in the marker's retreat, it would have been impossible for a sparrow to have traversed the line of fire in safety.

Cornish pumping-engines, once models of economy, have sadly fallen off in duty. According to "Lean's Reporter," the number of engines reported last month was sixteen, consuming 1,775 tons of coal, and lifting 13 million tons of water ten fathoms high. The average duty is thus under 50,000,000lb. raised 1ft. high for a consumption of 1cwt. of coals. This result is below the average of former years, and far inferior to the duty of the best engines, which, however, it is stated, are not now reported.

Prof. Newcomb has published, as a supplement to the American Ephemeris, instructions for observing the total eclipse of the sun on July 29, with lithographic maps of the districts on the line of totality.

A marine zoological station is to be established during the summer at Fort Wool, on the coast of Virginia, mainly for the use of students at the Johns Hopkins University.

According to Mr. Blyth, pieces of gas cinder placed in a jelly can, and covered with water, form a microphone which dispenses with a battery, and which serves as both receiver and transmitter. The connections are made by placing strips of tin-plate between the cinders and the side of the can, two strips, of course, being used in each.

The inductophone is the name given by Mr. A. J. C. Adams to an apparatus for increasing the volume of the sounds received from a telephone through an induction coil and battery. Two discs of tinfoil connected to one end of the secondary coil and separated by a third connected to the other end, nearly doubled the sound. Further experiments led to the conclusion that true telephonic sounds are based on Faraday's dia-magnetism.

In the chemical works of Ludwigshafen (we learn from *Ch. Centralblatt*) explosions have often happened in dissolving large quantities of zinc in muriatic acid for production of chloride of zinc, and this without the air of the workroom coming in contact with fire. They were proved, indeed, to be spontaneous. M. Hofmann explains the phenomenon thus:—The hydrogen gas developed raises the zinc, made very porous by action of the acid, above the surface of the liquid, so that the finely-divided zinc, in contact with air and hydrogen, causes, like spongy platinum, the inflammation of the gas mixture. A similar experience was had in the chemical works of Schering, in Berlin, some years ago, but was not explained. It is recommended to effect the dissolution of large quantities of zinc in dilute acids in open, rather than closed, vessels, so as to weaken the force of any such explosions.

At a recent meeting of the French Academy, M. Cornu, Professor at the Polytechnic School, was elected a member in the section of physics, in room of the late M. Becquerel. The other candidates were MM. Mascart, Le Roux, and Quet.

From an interesting paper by M. d'Haussonville, in *Revue des Deux Mondes* (June), on the vagabond and mendicant youth of Paris, we learn that in 1875 there were estimated to be nearly 20,000 children in Paris (including Saint Denis and Sceaux) between 6 and 14 years of age, who did not attend school, nor receive any instruction at home. The number of children under 16 arrested last year for vagabondage, mendicity, theft, and various other offences, was 1,716 (and it has been much the same in each of the last four years). Of this number only 419 were ultimately put under correction; a large indulgence being shown towards many of the others. It appears that the children arrested, and then set at liberty without any punishment, form a large element of the army of young vagabonds, and many are repeatedly arrested. The number of illegitimate births in Paris seems to be on the decrease: last year it was 14,616—in 1866 it was 15,510. There is one illegitimate birth to every 2·78 legitimate births in Paris! Among the principal causes of youthful vagabondage, M. d'Haussonville reckons instinct, bad treatment at home, miserable condition of the parents, and small attractiveness of the family abode. He gives some instructive particulars about the lodging-houses of Paris.

In ordinary colour printing, it is known, as many plates or stones have to be used as there are varieties of colour. M. Greth, of Zurich, has (according to the *Württ Gen. Bl.*) recently invented a process in which all the colours are printed at once with one stone. The colours used are fusible in heat. The most prominent colour is first poured on a perfectly even marble plate, and the parts not to be covered with this colour are cut out with a vertically held knife down to the surface of the stone. A second colour is now poured in, and the parts not to be covered with it are cut out, and so on, till the colours required are complete. The thickness of the colouring mass is determined by the number of impressions (1 ctm. for 1,000), and after each impression the plate is raised about $\frac{1}{100}$ mm. The paper is moistened with turpentine, and the impressions may be made with nearly the same rapidity as impressions with one colour only. The number of colours has a quite insignificant infl

the price of the prints, whereas the number of stones, in the ordinary method, raises the price enormously. M. Greth has produced pictures with 400 colours on one plate. The invention has been utilised in Paris for calico-printing; and in Alsace for imitation of Persian shawls.

In manufacturing cast manganese with known weights of the substances employed, it is always found that there is a considerable loss of the metal which is not recovered in the scoriæ. M. Jordan has lately investigated this, and he has been able to demonstrate a very great volatility, not before suspected, in manganese at a not very high temperature. (His researches are described in *Comptes Rendus* for June 3.)

In a lecture recently delivered to a society in Hagen, M. Springmann takes up the history of the introduction of the steam-engine into Germany (giving the results of his own inquiries). It seems the credit of having set the first steam-engine going in that country belongs to the mining authorities of Mannsfeldt; this was on 25th August, 1785, by mining-assessor Bückling, for the Friedrich-Wilhelm mine at Hettstedt. This was soon followed by a second engine in Upper Silesia (on April 1, 1788, at the Friedrich lead mine, Tarnowitz), and then several in Schönebeck, Langenweddingen, and the Anhalt mines. The beginning of steam-engine manufacture in Germany may be dated from 1819, when M. F. Harkort (who also produced the first puddling works in Westphalia) established his engine works at Freiheitweller, employing English workmen.

The bending of hard wood, especially beech, is effected at present by means of hot water or steam—a process somewhat costly as regards fuel, and taking a long time. A patent has recently been taken out in Germany by MM. Bahse and Haendel for making sieve-hoops and like objects by a dry process, more cheaply and in shorter time, from cut wood. Two rollers are used, one above the other, and having less velocity, so that it acts by holding back, while the lower extends the wood fibres. When the board, thus bent, leaves the rollers, it is fastened in the mouth of the sieve. The upper roller is fluted, the under one smooth. If two smooth rollers were used a very much greater pressure would be necessary.

The fermentation of dextrine has lately been studied by M. Barfold. He finds that a solution of pure dextrine may enter into alcoholic fermentation under the influence of yeast alone. The process is slow—much slower than with sugar. It is also slower at a low than at a high temperature, but may continue long. The gas liberated is almost exclusively carbonic acid. It cannot be proved that in the mixture in fermentation the dextrine is transformed into glucose. There must then be double decomposition between the elements of the dextrine and the water.

In a report on the last eruption of the giant volcano Cotopaxi, on June 26, 1877, M. Wolf states that the masses of water and mud which then devastated the neighbourhood did not come out of the volcano (as has been hitherto supposed), but were produced by melting of the huge masses of snow that lay on the mountain. The summits of the mountain presented numerous fumaroles (at 150°) of hydrochloric acid gas. This appears to confirm Deville's observations on Vesuvius and Bunsen's theory, which represents that a volcano gives out different gases according to the state of activity in which it is. Chlorine indicates the most intense stage of the outbreak, while sulphurous gases indicate a weakened state, and carbonic acid the dying out of the volcanic action.

It is a known fact that the absorption bands of a substance, when it is dissolved in different solvents, have not always the same position. Kundt said the law was that the bands lie further towards the red the stronger the refractive power of the solvent; and this certainly applies in many cases. M. Vogel has lately, however, brought forward cases, in which the variation of the solvent sends the bands neither towards the red nor the violet, but the whole character of the spectrum is quite altered, and this without any chemical action of the solvent on the dissolved substance.

LETTERS TO THE EDITOR.

[We do not hold ourselves responsible for the opinions of our correspondents. The Editor respectfully requests that all communications should be drawn up as briefly as possible.]

All communications should be addressed to the Editor of the English Mechanic, *31, Tavistock-street, Covent-garden, W.C.*

All Cheques and Post-office Orders to be made Payable to J. Passmore Edwards.

*** *In order to facilitate reference, Correspondents, when speaking of any Letter previously inserted, will oblige by mentioning the number of the Letter, as well as the page on which it appears.*

"I would have everyone write what he knows, and as much as he knows, but no more; and that not in this only, but in all other subjects: For such a person may have some particular knowledge and experience of the nature of such a person or such a fountain, that as to other things, knows no more than what everybody does, and yet, to keep a clutter with this little pittance of his, will undertake to write the whole body of physicks: a vice from whence great inconveniences derive their original."—*Montaigne's Essays.*

COMES TO ζ ORIONIS—EYEPIECE-DIALLING—TESTS FOR A 3IN. OBJECT-GLASS—POWER OF AN EYEPIECE—PSEUDOSCOPIC VIEWS OF LUNAR DETAIL—AERATED BREAD—MEAN TIME OF A STAR'S TRANSIT—MATHEMATICS AND OBSERVATION.

[14476.]—I regret to say that, after hunting through a considerable number of books, I can give no definite reply to the question with which Mr. Burnham commences letter 14416, on p. 313. We do not possess a copy of "Stargazing Past and Present" in the Library of the Royal Astronomical Society, and I am consequently indebted to Mr. Burnham for the first intimation of the existence of this new comes to ζ Orionis. My impression in the outset would probably have been that the compiler of "Stargazing" had merely made one more blunder; but, as I see from the advertisements that the book was got up "with the assistance of G. M. Seabroke, F.R.A.S.," and as Mr. Seabroke's general knowledge of astronomical subjects is unquestionable and unquestioned, I think it possible that a new comes to ζ Orionis *may* have been discovered. Should I come across any other reference to it, I will let Mr. Burnham know.

"A Poor Student" (query 33095, p. 325) must determine accurately the Solar focus of his object-glass, and tell the optician of whom he orders his eyepiece what this focus is; intimating that he requires an eyepiece to magnify 200 times. The eyetube only need be sent for the purpose of having the eyepiece fitted.

In the absence of a table of log. tans., I can give "Argent Sable" (query 33112, p. 325) no formula for obtaining the Latitude of the place for which a dial has been constructed; but should he have access to any ordinary volume of trigonometrical tables, the calculation is a very simple one. It may perhaps be best exemplified by working out his own particular problem. He tells us, then, that 2 hours—*i.e.*, 30°, are represented on his dial by 25°,

so that from log. tan. 25° 9·668672
we subtract log. tan. 30° 9·761439

which gives us log. sin. 53° 52′ 8″ 9 907233

the Latitude of the place for which the dial was originally constructed. I fancy, however, that there must be some slight error in your correspondent's measures of the various hour angles, inasmuch as the results from them are by no means concordant, inter se. How, by the way, I should like to ask "Argent Sable," does he know what the thickness of the missing gnomon was? because I have seen them made of sheet brass at least as thin as a playing-card; and the separation of the two halves of a dial, constructed for such a gnomon, to an appreciable extent, might sensibly affect the accuracy of its indications.

If "Texan" (query 33138, p. 326) can practically divide λ Ophiuchi with a power of 170 his object-glass needs very little more testing. He may, though, try 270 P XVI., π Aquilæ, P XX., 376 Equulei, 33 Pegasi, 42 Ceti, and ι Cassiopeiæ. Some of these are very severe tests for an objective of the size of "Texan's."

In reply to "Eyepiece" (query 33139, p. 327), the one accurate method of obtaining the power of an eyepiece with any object-glass has been given over and over again in these pages. It simply consists in accurately measuring the diameter of the little spot of light (which is an image of the object-glass) seen upon the eyelens, when the eye is removed about a foot from it, and dividing the diameter of the objective by such measure. For details, "Eyepiece" must consult your back indices. The figures which puzzle your correspondent simply mean that a first-rate object-glass will bear a power (on a star) of 100 for each inch of its diameter. Thus, an objective of 2¾ (*i.e.*, 2·75) inches may be used on a fine night with a power of 275.

In connection with letters 14390 (p. 290) and 14459 (p. 343) it may be worth while to remark that copic view of the Moon may nearly always ed by using a tolerably high power with a reflector, such as is employed for solar on.

t my inability to answer the questions put hbert" in letter 14471 (p. 345) categorically. always stay with one friend when I visit and it is at his house that I eat the aërated can only presume that it is invariably ob- m the same depot. I have never noticed rence in the quality of the sort (white l bread) with which I am alone familiar.

difficulty experienced by Mr. Squire (query . 352) has its origin in the fact that he he simple circumstance that the R. A. of nifies its interval from the First Point of *idereal* hours, minutes, and seconds; and interval must be converted into *mean* time can be used for the purpose for which he to employ it. For example, suppose that to know the Greenwich Mean Time of of Arcturus, on the night of June 21st, may obtain this in two different ways. The most simple is this :—

	h.	m.	s.
R.A. of Arcturus on June 21st	14	10	8·68
the Sidereal Time at Mean Noon	5	58	11·80
et	8	11	56·88

val of *sidereal* time after mean noon, at cturus souths. Then, turning this into ne by the aid of the table on pp. 484 and *Nautical Almanac*, thus :—

	h.	m.	s.
8h. =	7	58	41·3635
11m. =		10	58·1979
56s. =			55 8471
0·88s. =			·8776
that Arcturus will South at	8	10	36·2861

Now let us take Mr. Squire's method. The Arcturus on June 21st is, as I have said, . 8·68s., which, as before, we must turn time.

	h.	m.	s.
14h. =	13	57	42·3862
10m. =		9	58 3617
8s. =			7 9782
0·68s. =			·6781
	14	7	49 4042

an Time of Transit of the First Point of une 20 is 18h. 2m. 46·88s. (*i.e.*,

	h.	m.	s.
	6	2	46 88
rning of the 21st). If, there-	18	2	46·88
	14	7	49 40
s by our first method,	8	10	36·28

t a time has elapsed since I answered the of query 33197 (p. 352) in these columns st really refer "W. S." to some of your ices. With reference to his concluding I need only say that the *Nautical Almanac* the best one to consult for the purpose servation, either general or particular. *'s Almanac* is a very excellent one, and is half the price of the national ephemeris, any purposes the latter is almost indis-

w of the Royal Astronomical Society.

ELESCOPIC APERTURES.

—THE following should have appeared in tter :—To find the power to the *inch* of f a telescope, square the linear power, and product by the *square* inches (and parts) of the O.-G.

8½in. O.-G.

ERENCE OF SOUND IN TRAINS.

Mr. Allen and Mr. Clements.

—HAD the experiment proposed by Alfred" (page 147) been of a dangerous I would have commented upon it more but it being merely an ordinary experiment ulphur in oxygen gas), absurdly misunder- elt justified in using a little mild chaff. I accept Mr. Allen's correction (page 316), so as it gives me an opportunity of back our chemical contributor, and for will try to treat preposterous replies with ity and solemnity. As I have not at cess to Frankland's recent work I must ying to Mr. Clements' letter (page 314).

ften noticed, while being passed by a train, y perceptible diminution in the noise occurs ddle of the train, the sound increasing in owards the ends, and venture to suggest henomenon is due to interference in the the train. There will be many sound- ocking about in all directions, and thus rference may occur, whereas the waves y the engine and last carriage will not be o interference, and their intensity will not impaired. I would be glad to have the our acoustical correspondents on this

Wm. John Grey.

hill, Chester-le-street, Durham.

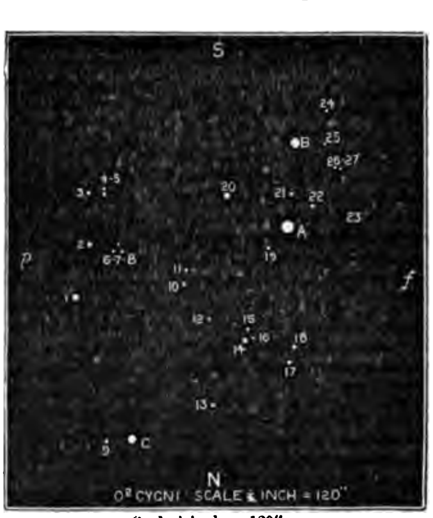
SUNSPOTS.

[14479.]—I AM much pleased to see that you have other correspondents interested in sunspots. But I think I have been more fortunate in seeing them than they have. My telescope is about a power of 40, having six lenses, nearly 3ft. long when drawn out. I put small pieces of coloured glass (red and green) before the eye-glass when I look at the sun—two or three pieces, according to the brightness of the sun. I send you sketches of my poor originals, as I call them, for my telescope is not of great power. Fig. 1, May 27, morning; 2, May 28, evening; 3, May 29, evening; 4, May 30, midday; 5, May 31, morning; 6, June 1, morning; 7, June 2, morning; 8, June 3, morning.

James Durrant.

O² CYGNI.

[14480.]—THE accompanying diagram of the small stars near O² Cygni, as shown with the 18½in. refractor of the Dearborn Observatory, can be of interest only in furnishing convenient light tests for a great variety of apertures. The principal stars, A, B, and C, constitute the following double stars:



Scale ½ inch = 120″.

♅ VI., 10.
,, VI., 33.
Σ 50 App. I.
S 672
O Σ (App) 204.

Sir John Herschel noted the small companion *n p*, A (No. 19), making the double star, H 1945, and called it of the 17th magnitude. Many of the stars shown in the diagram are much fainter than this. Some of the nearest were measured in angle and distance, and the places of others fixed by position angles from two points of reference. The remaining small stars were carefully marked in with relation to these and the large stars. Of course there are many stars just outside of these limits, and I am by no means certain none have been omitted near the large stars, as the night was far from good. Certainly there is not a single star shown that is at all difficult with the aperture used. I have not attempted to indicate the relative brightness of the fainter components by the sizes of the discs representing them. The star between A and B, and the still fainter one, *s f* A (Nos. 21 and 22), are fair samples of the small stars. The large stars, comparing Struve's measures with late observations, appear to be relatively fixed, and there is probably no change in Herschel's companion; but he largely under-estimated the distance. He found P = 332·8°, and D = 20″±. My measures give 321·7° and 36·82″.

Chicago, May 28. S. W. Burnham.

GAS ENGINES.

(*Concluded from page 347.*]

[14481.]—No. 2334 (1877), James Robson, of North Shields, Northumberland, "Improvements in Engines Operated by the Combustion of Gas or Vapour."—The first arrangement, according to this invention, consists in employing a piston and rod, working in a cylinder closed at both ends. I use the instroke of the piston to draw in at one side of it a charge of gas and air. On the return stroke this charge is forced through passages into a combustion reservoir, and there retained until the piston returns to the back end of the cylinder. The reservoir is then made to communicate with the back or opposite side of the piston; the gases in the reservoir are then exploded by a flame, their expansion drives the piston forward, which, by its rod and connecting rod to the crank, turns the shaft and fly-wheel. On the return of the piston, the products of combustion are allowed to escape. Two reservoirs can be used, each communicating with each alternate stroke of the piston. Another arrangement consists in drawing into a pump, worked by the engine, a mixture of gas and air; then, by the return stroke of its piston, forcing the mixture into a reservoir, which is in communication with a cylinder, in which works a piston with a rack gearing into a toothed pinion running free on the fly-wheel shaft, when the piston ascends, but grips and turns the shafts when the piston descends. On each side of the cylinder is fixed another cylinder, with a piston and rod working therein; the tops of the rods are attached to a cross-head fixed to the rack. When an explosion takes place in the reservoir from the gases being lighted, the expansion thereby caused drives the rack piston, cross-head, and side vacuum pistons rapidly to the tops of their cylinders; the pressure of the atmosphere on the side pistons forcing them and the rack down again to the bottom, at the same time turning the shaft and fly-wheel; thus the energy of the explosion is absorbed in the up-stroke of the vacuum pistons, and given back in the descent of the same. Instead of vacuum cylinders, indiarubber, metallic, or other springs may be attached to the rack for the purposes above described. In another arrangement the pump piston has a rod passing through a packing-box on the cover. The bottom of this pump is constantly in communication with the bottom of the rack cylinder. The pump's charge is fired when its piston is at the top. The expansion drives the rack piston up as in the last described arrangement. This patentee has been anticipated in his first arrangement by W. R. Lake, No. 432 (1872), and by G. Haseltine, No. 2209 (1874), both inventions being communications from G. B. Brayton, Boston, U.S.; and in his second arrangement by C. T. E. Lascelles, No. 1961 (1876).

No. 2749 (1877), Louis Simon, "Improvements Connected with Atmospheric Gas Engines."—In this invention air is compressed by a pump and stored in a reservoir, from which it is withdrawn and utilised in fixed quantities by suitable valves under control of the moving mechanism after the engine is first started. In connection with the inlet valve chamber, which is of a given dimension, is another valve by which coal gas under the ordinary town pressure is caused to enter the chamber of the air-pump, that the two agents may become thoroughly mixed, and in certain proportions, for obtaining the best results from explosion and consequent expansion within a cylinder in which a piston is fitted, as in ordinary gas engines. A separate compression pump for gas may also be applied, so that the gas and air may be compressed separately, and allowed to mix under pressure at any convenient time before entering the explosion chamber. The coal gas—or it may be other gas, such as that known as benzoline gas—can be injected into the air-vessel or reservoir of the air-pump at the same time as the air, or alternately with it, so that the two—i.e., the air and gas—not only become thoroughly mixed, but put under pressure. The air gas thus compressed is conveyed to the working cylinder of an engine by pipes, a distinct pipe taking either ordinary coal gas or benzoline gas into the cylinder after each charge has exploded, by the remains or refuse of which, atmospheric air being admitted by a separate pipe to sustain this flame, a light is produced for exploding the fresh main charge, which is directly after the exhaust admitted to the cylinder. By this means the explosion of one charge takes place by a light left burning after the previous, and so on alternately. In lieu of the coal or benzoline gas being of the ordinary kind it may be had by a distinct pipe from the contents of the reservoir, in which case a constant light can be maintained. I purpose using a carefully-balanced fly-wheel with this class of engine, to insure the return of the piston by its momentum, and thereby exhaust the explosions always happening while the crank is effecting the forward or upward thrust, and the exhaust of each expended charge on the return. One of the great objections to gas engines as hitherto made, and a cause of their great relative cost, has been the great dimensions necessary to obtain adequate power. By admitting the air and gas under a pressure varying, say, from 20lb. to 80lb., I obtain sufficient power from explosions in a small cylinder, and the other parts of the engine are small in proportion.

No. 3024 (1877), E. C. Mills and H. Haley. "Improvements in Motive-power Engines Worked by the Explosion of Gas." Our invention relates especially to improvements upon that arrangement of gas engine patented by us Jan. 23, 1875, No. 265, but applicable also to engines of other construction as will be pointed out. One subject of our present invention is to obtain a greater amount of power with a given size of cylinder, and this we accomplish by the employment of arrangements which enable us to work each single stroke with explosive force on one side of the piston and a partial vacuum on the other. Another part of our invention relates to a method of governing gas engines such as those now described, the object in this case being to make the number of explosions in a given time proportionate to the work required of the engine. In carrying out our invention we use a cylinder, piston, and crank, but no fly-wheel, as ordinarily applied, for the reason which will hereafter appear. The cylinder is provided with valves at each end which, when the piston has moved a certain distance, and when an explosive charge has been drawn in receive a sudden motion for cutting off the supply, and at the same time injecting the igniting flame alternately at each end of the cylinder. These motions we propose to effect by a cam acting upon suitable rods and spring connections. The explosion having taken place the piston is driven forward by the expanded gases to the end of the cylinder. Immediately the crank has turned the centre the piston begins to move back by atmospheric pressure only, there being a partial vacuum on the other side thereof due to the attenuated gases which have expended their elastic force, and this motion continues until the explosion takes place as above described, but now at the other end of the cylinder and then there are two forces employed, one arising from the expansion of the heated gases, and the other due to the partial vacuum on the other side of the piston, and in this manner the engine continues to work. There is an exhaust valve at each end of the cylinder which, by a slight motion imparted from the crank shaft, allows the residues of the exploded gases to escape, but which prevents the atmosphere from entering. According to the second part of our invention we cause the motion of the piston and connected parts to be controlled at certain times by an effort required to drive water or other fluid through an orifice which may be contracted in area. In practice we propose to place a cam or other such apparatus on the crank shaft which, when the piston is starting from the cylinder end, pushes a roller which can only yield according to the flow of a liquid from a small cylinder provided with a piston, and therefore by adjusting the aperture of egress the speed of the main piston during a part of its stroke can be governed. When the explosion takes place, the aforesaid roller having reached the end of the path on the cam, the piston is free to move rapidly by the force of the explosion on one side thereof, and the pressure of a partial vacuum on the other, and the above operation takes place at each end of the cylinder. The regulation of the orifice may be effected by an ordinary governor or other such apparatus in the case of the arrangement patented by us as aforesaid by the pressure existing in the air reservoir, or by manual arrangement. The fluid which is necessarily discharged from the small cylinder may be used continuously. In some gas engines we adopt a system of governing, by which, the number of explosions in a given time remaining constant or nearly so, the amount of mixed air and gas exploded for each stroke may be varied according to the work required of the engine. In this case the amount of air and gas measured, mixed, and delivered for the use of the engine must also be variable. For this purpose we propose to employ an ordinary governor driven from the main shaft, and which actuates an arrangement of star wheel and screw by which the moment of release from the control of the aforesaid hydraulic cylinder and the simultaneous moment of explosion are made earlier or later. The star wheel and screw operate so as to allow the relative positions of the crank and the governing and valve cams. Another part of our patent relates to an improvement upon a patent granted to C. T. E. Lascelles, No. 1961 (1876), and consists in a method of what may be called an elastic connection. A fly-wheel is mounted on a crank shaft, or upon a secondary shaft, and attached to the said fly-wheel is a chamber with a fixed abutment or division, and in the said chamber is a vane carried by the crank shaft, which as it revolves carries round this vane, and compresses the air enclosed between it and the first-mentioned abutment, by which agency, therefore, the latter is driven, and the required elasticity obtained. We propose to employ an arrangement, the object of which is to receive the force of the explosion at its most advantageous point, and to redeliver the stored-up power at the end of each engine stroke. For this purpose we employ a spring, one end of which is attached to a wheel, and the other end to the frame, by means of an oscillating case. The said wheel gears into another of twice its diameter fixed upon the crank shaft of the engine. The patentees of this invention in their first part seem to forget that in every double-acting gas-engine, or where the gaseous charge is exploded on each side the piston alternately, both the direct acting explosive force is utilised, and also the vacuum produced by it, the amount and duration of either being determined by the time of the explosion and exhaust, the length of the piston stroke being an important element in the calculation; and it is hard to see how the action of the gaseous mixture employed by the patentees differs in their apparatus from similar action in the ordinary double-action arrangement of Hugon and Lenoir. The second part of the invention is a direct copy of the governing apparatus patented and described by F. Wirth, No. 1520 (1876).

No. 3123 (1877), G. A. Wilson, G. Duncan, and W. A. Wilson, engineers, all of Liverpool, "Improvements in Gas Motors."—This provisional specification proposes, "First, to insure a thorough mixture of the inflammable gas to be exploded in the cylinder, we so arrange the engine that one stroke of the piston shall cause propulsion of vessels by reaction, enabling the suppression of the engine's paddle wheels as at present employed. Secondly, for operating direct acting lift and force pumps for draining, irrigating, fire-engines and vessels, air pumps for vacuum and compression. Thirdly, the replacement of ordinary steam-engines by these same apparatus working hydraulically, and permitting the transmission of power in all directions and to all distances. The jet was the only means at our disposal for utilising directly the expansion of vapour. With this incomplete means only the vis viva or live force of steam was utilised, and no advantage was derived from its weight, its pressure, or its expansive power. In the arrangements which form the object of this invention the steam jet is also utilised, but this acts in a stagnant condition upon the water which plays the part of piston. The steam employed is by preference superheated steam, as experience has demonstrated that in presence of a cold liquid this superheated steam only gradually loses its heat. Condensation is slower still if the walls are non-conductors. In short, I will say that practically steam, when separated from water by an isolating bed, no longer condenses." This is pitiable as the wildest ravings of insanity, and can only be explained by Young's assertion, that human nature was made first, then French.

Leicester. **Jno. F. Dickson.**

THE ORIGIN OF LANGUAGE.

[14482.]—Electricity, astronomy, chemistry, and many other sciences have their able exponents in your letter columns, but this, the latest, and assuredly not the least fascinating branch of scientific inquiry, is rarely brought into notice. However, I cannot but think that among my fellow-subscribers there are some zealous disciples of Max Müller who will not be unwilling to take part from time to time in discussions bearing on this subject.

One of the most debated, as well as oldest, controversies among linguistic students is that of the origin of language. There are some who maintain that the human race *ab initio*, had the faculty of speech fully developed as an innate faculty, but it is to be hoped the number who hold so unscientific a view is very limited. Those who take a scientific view of the origin of speech may be divided into three classes—1st, those who believe language to have been intentionally and arbitrarily formed by prehistoric man; 2nd, those who suppose men gradually and unconsciously connected particular sounds with particular sensations and ideas; 3rd, those who suppose language originated in mimicry, and to whom Müller has given the homely name of the "Bow-wow Theorists."

I propose to place before your readers a few ideas bearing upon a modification of the first of these theories. Let us, however, first glance at what I conceive to be a popular error. It is too readily taken for granted that the most natural mode of communication between human beings is by means of the voice. Now I contend that this is not the case, but that the most natural way of representing what we wish to convey to our fellows is by means of gesture, and I believe that this method preceded speech. So inbred is it in the human race, that long before a child can express itself by means of articulate words, it can make known its wants by signs. If the little one is hungry it will go to its mother, and opening wide its mouth, show that it is empty; if it desires to go for a walk, it will put its hand on its head to denote that it wants its hat, and in a hundred ways by these mute gestures of its own devising it establishes a perfect understanding between itself and its mother or nurse. And note that these motions are not learned by the child in the same manner as it learns to utter its first inarticulate attempts at talking, for in the latter case it is simply trying to imitate what it hears all those around it doing; but in making its dumb appeals it is speaking its own language—a language doubtless handed down from its remote ancestors. And this mode of expression does not cease when the vocal organs have become habituated to their office, but continues as a subsidiary language during the whole life. What would become of the orator were his hands bound and his features prevented from having free play? How often is the thought that is struggling for utterance conveyed in its broad outline to the audience by gesture before the tardy words can follow? And in many instances where there is not this overmastering desire for speed we find ourselves preferring a sign made with the hands or head to the oral expression of our needs. Then, again, in nations far sunk in barbarism, this visible language is very highly developed, and there appears a certain reluctance to use the vocal organs, so much so that we are told that among some tribes of Hottentots spoken language seems on the point of dying out, and a man will rather run a hundred yards after another whom he wishes to stop, than exert himself to call him. On reflection, many other examples will present themselves to those who give a little thought to the subject, proving that gesture is a perfectly natural mode of communication between man and man. But I go farther, and not only maintain that this method is a natural one, but that communication by speech is most unnatural, and bears every sign of being an artificial system.

What resemblance is there between a sound and the thought it represents? None whatever, any more than there is between a sound and its written sign, and it seems to me that the same arguments that can be used to prove that writing is an invention, may be employed to show the same of spoken language, the only difference being, that in the case of writing historical evidence can be adduced, whereas speaking is prehistoric. And notice the inferiority, as far as universality is concerned, of spoken language to gesture; the former is only of use to those who have been initiated into its mysteries, whilst the latter is common to all men—nay, to some extent it brings men into communication with the rest of the animal kingdom. The above-mentioned case of the Hottentots is again suggestive. Men do not forget what is natural and instinctive, but what is artificial. As a nation sinks from civilisation to barbarism, one by one the marks of cultivation are lost, invention after invention, custom after custom are forgotten, until man sinks to the state of the savage, and retains in extreme cases only what is natural to mere animal existence. Naturally language, the most constantly exercised of the arts of civilisation, is the last to go.

There is, then, nothing absurd in the idea of the human race having advanced some distance in their development, and having attained some degree of social intercourse, while intercommunication was restricted to outward and visible signs, doubtless aided by sundry purely mimic cries and interjectional sounds. Those who doubt whether this could have been possible, would do well to learn how much is achieved by signs and gestures in the case of the deaf and dumb, altogether apart from the use of alphabetic signs.

Let us, therefore, assume a community living in this manner—not, be it observed, like pigs in a sty, but as intelligent beings, with an elaborate, though inadequate, method of communication—what more probable than that it should occur to one of these, our ancestors—one more largely endowed than his fellows—to connect certain sounds of his vocal organs with particular portions of his gesture language? He would have something to suggest the idea, certain interjectional and other cries, which still exist in every language. The case would be pretty much the same as it doubtless was with writing. Caligraphy did not spring suddenly and fully fledged into the world. Significant marks of many kinds must have been used long before alphabets were invented, and as we have remnants of the prehistoric gesture-language among us, so we have relics of what must have preceded the invention of writing. The scores at the illiterate publican or tradesman chalks up his door is an example. And just as writing, once vented, soon spread amongst the various nations the earth, so, only more quickly, because less aborate, would the art of speech.

The significant sounds at first would naturally be w, and confined to the most common necessities—a undred signs, nay less, would be all that our hypo- etical inventor would require to fix; and these few bitrary sounds once agreed on, their further evelopment would follow of necessity. If any one inks I have underrated the number of signs at rst requisite, let him remember that even now a ouple of hundred words or so form a vocabulary fficient for the necessities of many a farm labourer; d children, with even a smaller number than this, an express all their little wants. These primary rds would be broad in their meaning, being the presentatives of gestures which it is evident must ways have been without that definiteness which is aracteristic of spoken words.

Now a slight examination of any large class of nguages shows us that language originally did ssess these two characteristics—viz., a limited cabulary and words with wide signification. Let take the Indo-European or Aryan branch. We d that the thousands of words which go to form e dictionaries of the languages included in this oup are all variations and combinations of a com- ratively small number of original "roots"—*i.e.*, stead of the almost innumerable arrays of words at now exist in that family there were originally ly a few hundred, and these simple in form and ide in their application. As an example of the tter characteristic I take the root "mar," as ven by Max Müller in his "Science of Language." his root had the primary meaning of "to pound crush," and it is shown how this idea is found in e following words:—Mill, milling, meal, the reek múlos, the Latin molares, then the Homeric márnamai," meaning to fight, the Sanscrit mrinâmi," to smash or kill, the Greek "mólos reos," the toil of war, and the Latin "mors," ath, and "morbus," illness, and "mora" delay, d very many others. In all cases the root word d originally a material concrete meaning, the stract and more highly metaphorical meanings ming afterwards. And these roots, as the same thor mentions, exist in clusters, each cluster ving a marked family likeness, shades of meaning ing shown by slight modifications of sound. Thus, to go would be expressed by 'sar,' to creep y 'sarp,' to shout by 'nad,' to rejoice by 'nand.'" an we not picture to ourselves the old father of oken language forming his primary root, and then rying it slightly for the various shades of meaning?

I have referred to writing as in some cases a rallel to speaking, and there is one point further orth noticing. Every one who has given any ought to the subject knows the intense repugnance hich nations have to any additions to their alpha- ets. When deficient in its power to express the sounds a language new forms are not invented, but com- inations of the old letters are made to answer the me purpose—combinations which are sometimes dicious, but as often not. It is precisely the same ith language. Nations will combine and recom- ine, will borrow from other languages, but will not eate new words. What more striking proof than is that language-making is not an instinct? For so once, why not now? Never was there a time hen there was more need for creating new words an now, but rather than do this men will string gether the most barbarous combinations of Latin d Greek words when they desire to baptise their ventions and discoveries.

I hope in these few remarks I have shown that it not altogether unreasonable to hold the opinion at language, like writing, is a human invention.

Edmund P. Toy.

THE PARIS EXHIBITION.

[14483.]—The Paris Universal Exhibition, on the hamp de Mars, is the most magnificent display itherto seen of the natural and artificial products om almost every civilised nationality. Suffice it say that the Trocadéro Palace is one of the randest edifices in the world, and therefore throws l the other Exhibition buildings in the shade. ntering by the Trocadéro France occupies the left lf, while England and all other nations occupy e right in narrow belts across the Exhibition, rallel with the river. Proceeding from the Troca- ro, Great Britain and Ireland occupy, so to eak, the torrid zone of the foreign department, aving the temperate and frigid for the United tates, Norway, Sweden, Italy, Japan, China, pain, Austria, Russia, Switzerland, Belgium, olland, Portugal, &c., together.

Exhibitions now appear to have become univer- lly recognised as the most advantageous invest- ent for the surplus energies and resources of a ountry. French vanity loves to excite the admira- ion of mankind, and it is well that the acmé of heir desire should take the form of grand industrial ather than warlike enterprise. The Exhibition of 851 at London inaugurated the exposition of the products of different countries side by side, so that comparisons could be formed, and defective workmanship improved. Previous to that era exhibitions were local or national in their character, but now they are cosmopolitan. And the differences in workmanship and feeling are gradually disappearing as the peoples of different countries become more intimately acquainted.

The mineralogist may revel in one of the finest collections of minerals ever brought together. The specimens represent the natural wealth of France, as well as that of other countries and England and her colonies. Although I have frequently visited the collection of minerals at the British Museum and the Royal School of Mines, I was much impressed with the variety and superiority of the specimens, many of which I noted.

There are sufficient metallic ores to engage the attention of the metallurgist, as well as the metals derived from these, and the processes adopted in the extraction. The metallurgical collection is simply magnificent.

The collection of models illustrative of descriptive geometry far surpasses anything I have ever seen before in the French section. The Belgian models are also very fine.

Those who take up machine construction would do well to pay a visit to the French and English sections, and the architect can with peculiar advantage, study building construction, for almost every variety of structure and design is represented. You afford abundant opportunities in the pages of the *Building News* to those desirous of learning more about this section, but I may just say that the Trocadéro is byzantine in style commingled with Lombardo-Gothic.

The Prince of Wales's Pavilion is in the Elizabethan style of architecture, and the other English buildings represent styles illustrative of other periods of English architecture. The French illustrate various styles, and so do all the other countries that take part in the exposition. The student of physics will see a profusion of instruments and apparatus illustrative of sound, light, heat, electricity, and magnetism. Again, the geologist will find plenty of fossils and rocks.

The student of botany, biology, and physiology will find ample scope. The French Forest Department contributes specimens of almost all varieties of wood. There are also stuffed animals and dissections of plants and animals. The anatomical collection is small, but the models are very well executed. This collection is certainly worth a visit, but those who cannot bear to look at hideous deformities or the representation anatomically of appalling diseases, had, perhaps, better not enter this place, which is shut off from the general gaze. There is also a large show of educational works and appliances.

The collection of chemical apparatus and products did not equal my anticipation, but it is well worth an examination.

Agricultural appliances, manures, and products are represented on a vast scale. Every English agriculturist should study this department, for France is decidedly an agricultural country. Its agriculturists and savants have been endeavouring to discover the secret of the earth's fertility, and they have been in a great measure successful in their efforts, for they have found by experiment that certain artificial manures produce certain plants in perfection. In fact, they have found the manure best suited for many plants. Phospho-guano contains about 18 per cent. of soluble phosphoric acid, while the superphosphate contains only about 11, and Peru guano only about 3 per cent. in the soluble state.

Mr. Lawes and Dr. Gilbert, in this country, have been making agricultural experiments for upwards of 30 years. They have raised the same crop from the same plot of land without manure, and find that the amount of produce gets less and less, while the amount of produce can be maintained up to the standard on an adjacent piece of land by manuring. This experiment shows that, without manuring, the land would become sterile, because some one or more of the elements which the plant required for its growth exist in a minimum in the soil, and are exhausted. The other elements exist in the soil in a maximum state, and are practically inexhaustible. And the elements supplied by the atmosphere to plants can never be exhausted, so that if a normal amount of those elements that exist in any soil in a minimum state that are essential to the growth of any plant were supplied by artificial manures, the fertility of the land might be maintained for ever. And as farm-yard manure supplies in a great measure those elements which are withdrawn from the farm it is a very essential manure.

Phosphorus is an element which generally exists in a minimum state in soils, and considerable advantage is derived from its application as calcic, sodic, potassic, or magnesic phosphate.

All kinds of corn crops remove this element largely from the soil.

There is a very large collection of French phosphatic minerals exhibited at the exposition, as well as of manures. These phosphatic minerals are largely found in our own country in the eastern counties. In these phosphatic minerals the phosphorus cannot be appropriated as plant food, since it exists in the insoluble state as tricalcic phosphate. By the action of sulphuric acid this compound is converted into the monocalcic phosphate, which is soluble, thus: $2H_2SO_4 + Ca_32PO_4$ (insoluble) $= 2CaSO_4 + H_4Ca2PO_4$ (soluble).

Again, lime should be applied to soils deficient in it, and to clayey or peaty soils. And potash and soda salts are advantageously applied in soils requiring them.

Potash and soda exist largely in most soils, but generally in the insoluble condition, so that they are unavailable as plant food. Hence the advantage of turning over the soil so as to expose fresh portions to the action of the carbonic anhydride and moisture of the atmosphere, which converts these elements into the soluble condition.

From the above considerations it will be evident that, if the farmer knows the composition of the soil of his farm, and also knows the manures to apply, he will raise a far larger produce from his land than the farmer who manures at random. For instance, phosphates produce no result when there is already sufficient in the soil, or when the soil is deficient in some other essential element.

M. Collet, engineer of M. Pictet, gave me a lengthened description of his machinery for the production du froid et de la glace, which produces ice in large quantities. There is one of these machines at Chelsea, and another at Manchester.

Hugh Clements.

HEATING BLAST OF CUPOLA FURNACE — COMPOSITION OF TEA — WORKS ON ANALYTICAL CHEMISTRY.

[14484.]—"Cupola" (query 33156, page 326) will probably find it worth his while to communicate with Mr. Arthur Cooper, the Bessemer manager to Messrs. Brown, Bayley, and Dixon, of Sheffield. He is the inventor of a process for heating the blast of cupola furnaces by the hot gases from the Bessemer converters. I believe the plan has proved very successful after a trial on a large scale of some twelve months' duration. I think it is stated that the consumption of coke in the cupola is reduced to 1¼ cwt. of coke per ton of pig iron melted.

Mr. Hugh Clements, in his letter on the "Analysis of Tea" (No. 14470, page 345), does not seem to understand what I am driving at. He corrects the tannin, but adheres to his statement that the ash of tea averages 5 per cent., to say nothing of his estimate of the usual moisture. Will Mr. Hugh Clements be surprised to learn that a genuine tea of ordinary character never yet yielded 5·0 per cent. of ash, and that if a sample gave that amount it would at once call attention to its suspicious character? The real proportion of ash in undried genuine tea is 5·66 to 5·75 per cent. Of this from 3·0 to 3·5 per cent. is soluble in water. Hence in normal tea the ash insoluble in water is about 2¼ to 2¾ per cent. The age of the leaf and character of the tea do not affect the proportions of ash in a sensibly greater degree than above stated. Possibly Mr. Clements may say that ¾ per cent. is a trifling variation to make a fuss about, but he will see the importance of it when I say that the Society of Public Analysts fixed 3·0 per cent. as the lowest amount of soluble ash natural to genuine tea, any deficiency pointing in the direction of an admixture of previously-infused leaves. As Mr. Clements says, "Of course, if we analyse artificial mixtures of tea-dust, dirt, and sand, we obtain remarkable results." If Mr. Clements or other of your readers care for further information on the subject of the composition of genuine and spurious tea they will find it in "Chemical News for 1874," Vol. XXIX., pages 167, 189, and 221, and Vol. XXX., page 2.

The following works on chemistry will be found useful for acquiring a knowledge of analysis. Commence with Church's "Laboratory Guide," confining yourself first to the qualitative part. Then try your success with simple methods of quantitative analysis, taking care to understand all you do. You may afterwards examine more complicated mixtures qualitatively, using Valentin's, Dittmar's, or Clowes' "Qualitative Analysis." Further advance in quantitative analysis may be made under the directions of Fresenius.

Sheffield, June 15. **Alfred H. Allen.**

DETERMINATION OF WATER IN LARD.

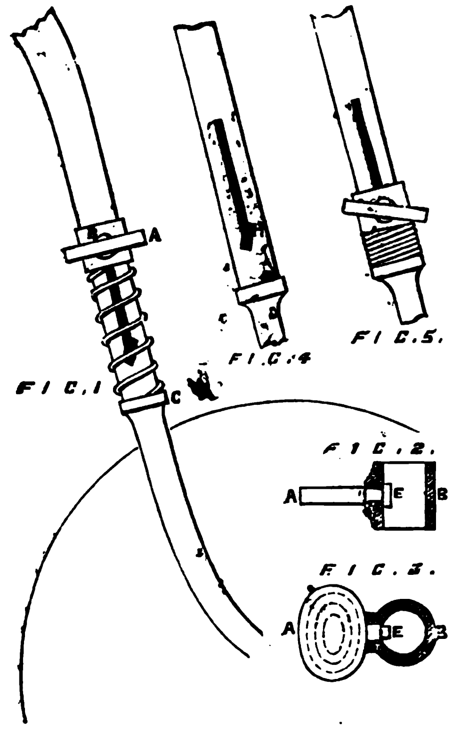
[14485.]—In reply to Mr. Alfred H. Allen (letter 14435), for the determination of water in lard, the process that I have been in the habit of using is as follows: A weighed quantity of lard is taken and placed in a counterpoised porcelain dish over a low Bunsen gas flame, and stirred with a thermometer at a heat not exceeding 230 F. until all the water is driven off, which can be seen by the melted lard remaining quite still upon the surface; the whole is then allowed to become cold and weighed, the loss calculated to percentage of water. Would Mr. Allen kindly give his method of absolutely and rapidly drying fat? Also, will he give his opinion of the amount of fixed oil of mustard, as it is generally thought to be about 35 per cent. of the seed (through some error in my article it was stated at 25)? I should like to have Mr. Allen's opinion upon the same. **Albert Smith.**

BICYCLE STEP.

[14486.]—In a recent issue a querist speaks of the difficulty he has in mounting his bicycle, the reason being the awkward distance of the step from the saddle; but if he lessens this distance by raising the step he increases that of the step from the ground, and so does away with one trouble by making another. As, no doubt, there are many more bicyclists who are companions with him in this difficulty, I hope you will think a step which I have just designed to supply their want worthy of a place in your columns.

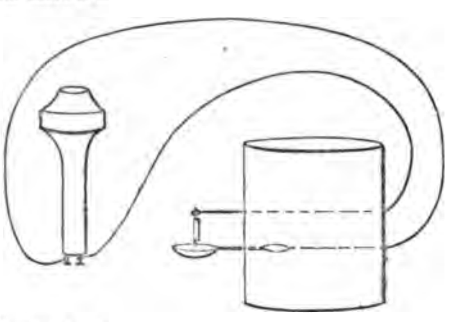
A side elevation of the step in its position on the backbone is shown in Fig. 1. A is the step fixed to a collar, B, which slides up and down the backbone; C is another collar welded on to the backbone, and between these two collars is a spiral spring. The step, A, has a short spindle projecting from it, which fits into the sliding collar, B (see Fig. 2). At the end of this spindle projecting through the collar there is an oblong head, E. Fig. 3 shows this construction in plan. Up the side of the backbone there is a groove, represented in Fig. 4, and in this groove the oblong head, E, slides, preventing the collar, B, from turning round, and at the same time keeping the plane of the step normal to the backbone. Now, before mounting the machine, you take a firm hold of the backbone with both hands, and with your foot push the step down to the bottom of the groove, which at the same time compresses the spiral spring. When there, you just turn the step slightly on its spindle, which locks it by allowing the oblong head, E, to fall into a recess at the bottom of the groove, shown in Fig. 4, at H. Fig. 5 shows the step in this position. When mounting you can keep your foot on the step as long as you like without undoing the catch, but when you lift your right foot from the ground, by a natural movement of your left foot, you turn the step back to its position normal to the backbone, immediately liberating the spring which lifts you and the step to the top of the groove, from which position getting on to the saddle ought to be an easy matter. **A. A. Watkins.**

Alton, Hants, June 8th.



MICROPHONE — WHERE DOES THE POWER COME FROM?

[14487.]—Last week I was working with a pair of home-made telephones when it occurred to me to make a microphone. In ten minutes it was completed, thus:—Through the side of a bandbox I poked the handle of a table-spoon, so that the bowl projected with its concave side up. Round the handle I twisted one of my circuit wires, and the other I shoved through the box some 2in. above the spoon, and bent the end into a small ring. I then pointed both ends of a piece of lead pencil, placed one point in the spoon, and kept it in an upright position by placing the other point inside the little ring. Having now introduced a small cell of Smee's battery into the circuit, the arrangement worked admirably. The tick of a watch, the slightest touch on the box, and the sound of singing were distinctly heard at the other end—the words and voice of the speaker being sometimes distinguished. So far there is nothing remarkable, except the ludicrous simplicity of the apparatus. The important thing is, that I removed the battery, and the sounds were transmitted about as clearly as ever. Articulation was hardly so distinct, but musical notes and even the touch of a feather on the bandbox were perfectly audible at the terminal telephone. To my probably half-informed mind it seems that this result runs counter to the existing theories of the telephone. It is conceivable that the vibration of the pencil in the spoon could act as contact-breaker for a battery or any other current, but I fail to see how it could produce such a current, or, if produced, could give it any special direction. I shall be glad to have the opinion of some of your readers on the matter. **R. M.**

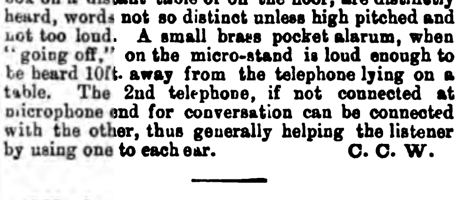


MICROPHONE.

[14488.]—I have, like many others, tried my hand at a microphone. My stand, two sides of a thin deal packing box, carbon blocks, the size of breakfast sugar lumps, picked up in gas works, and stuck on, unshaped, with sealing wax, wires inserted in small holes and plugged in with tinfoil, battery, pint jampot, as made by "C. O. G." in page 200 of the English Mechanic. My first contact-maker, a rough stick of coke, pointed at both ends, and placed between the two blocks as by Prof. Hughes, answered fairly, but on making a second, filed into neater shape, it obstinately refused all circuit, as have done other blocks which I have tried. After many trials I found a piece of thick bell wire hooked on to upper block and lightly resting against the lower most effective, but many spots on the blocks will not transmit the electric current, as if the grain of the coke had much to say to it. With 50 yards of line, the watch ticking, camel's-hair brush, whistling 10ft. away from micro, musical box on a distant table or on the floor, are distinctly heard, words not so distinct unless high pitched and not too loud. A small brass pocket alarum, when "going off," on the micro-stand is loud enough to be heard 10ft. away from the telephone lying on a table. The 2nd telephone, if not connected at microphone end for conversation can be connected with the other, thus generally helping the listener by using one to each ear. **C. C. W.**

ON A METHOD OF RESOLVING AMPHIPLEURA PELLUCIDA, &c.

[14489.]—Having read with much interest the admirable paper on the "Resolution of Amphipleura Pellucida, &c.," by Mr. Williams, in the English Mechanic of June 7th, I trust he will pardon me if I suggest a plan by which those who already possess a Darker's revolving selenite stage may adapt it to the purpose, and thus greatly simplify his method so far as the supplementary stage is concerned.



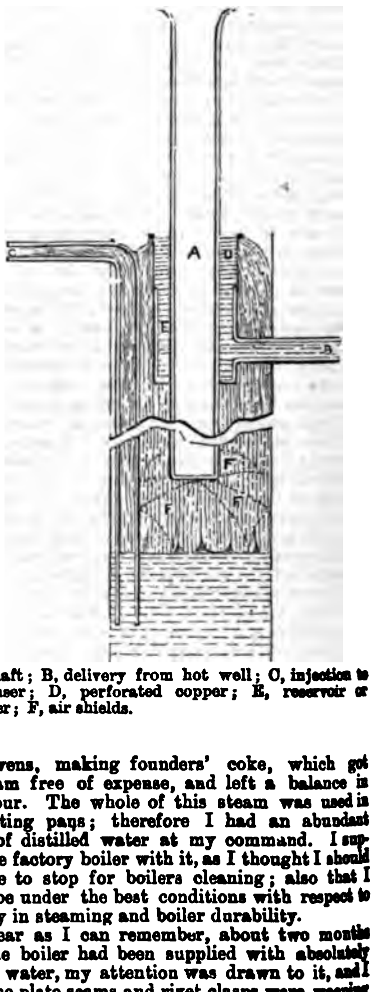
All that is necessary is the tubular disc-holder, which should be made so as to fit tightly into the revolving fitting of the selenite stage, and the apparatus is complete. As the depth of this fitting is but small, a slit in the lower part of the disc-holder will give it spring, and cause it to be held more firmly. When the objects are required to be viewed by ordinary sub-stage illumination, the disc-holder can be removed, and the disc dropped into its place—a spring ring, as mentioned by Mr. Williams, being used to keep it steady.

In the figure, A A represents the selenite stage; B the revolving fitting; and C the tubular disc-holder.

June 8th. **W. H. P.**

AIR SURFACE CONDENSATION.—NO. I

[14490.]—On reference to various chapters in your magazine headed "Workshop Practice," which appeared in Vols. XX. and XXI., from February to July, 1875, it will be observed I especially directed my reader's attention to the wasteful habit of discharging the exhaust steam from the engine into the atmosphere, or, in other words, coaling for an atmosphere of steam. In many places water cannot be obtained except through the usual company's supply, and, of course, the price would preclude its use for condensation, if it had to be passed away as usual; but this is not imperative, for not only can it be cooled down effectually, but also the boiler supplied with water in a proper condition as to the prevention of deposit, and the durability of the plates, and economy of fuel, &c. Perfectly pure or distilled water is a great mistake, for it rapidly acts upon the iron; the better the material the quicker the action. This I can prove by vast experience, as I had a boiler driving my factory engine, as also another in the same premises I put up to supply a chemist with steam at a rental night and day. This boiler I fired with two coke ovens, making founders' coke, which got the steam free of expense, and left a balance in my favour. The whole of this steam was used in evaporating pans; therefore I had an abundant supply of distilled water at my command. I supplied the factory boiler with it, as I thought I should not have to stop for boilers cleaning; also that I should be under the best conditions with respect to economy in steaming and boiler durability.



A, air shaft; B, delivery from hot well; C, injection to condenser; D, perforated copper; E, reservoir or arrester; F, air shields.

As near as I can remember, about two months after the boiler had been supplied with absolutely distilled water, my attention was drawn to it, and I found the plate seams and rivet clasps were weeping in every direction under the water line, not in streams or channels, but in minute globules, and evidently in a week or two it would have been rendered useless. The fact is, pure water, as I have said before, is a solvent when in perfect contact. In my case I turned in a feed dose of the usual water, and the whole of the leakage took up in a few hours, and ever after I took care to have a slight mixture of the usual, that the iron should be protected by a film of deposit.

I will now inform you how far I succeeded. As I before stated I had a ten-horse engine driving my factory, steam about 40lb. per inch expanding and condensing. My premises were in the Spa-road, Bermondsey, and a deep culvert or sewer came in the locality and drained my well. To meet this difficulty it became necessary to go lower with the well for the needful, or introduce some mode of cooling the water and work it over continuously. I chose the latter alternative, as I had an idea some time before of an arrangement I wished to try, and now the time came to make the experiment. I made

atus and found it answer all that was
I inclosed it in the well from observation,
it time I had some idea of protecting the
ent, but through a severe loss I sold the
ny plant to meet my liabilities in preference
n in difficulties, and I have not had a chance
ntroduce the affair.

ice the temperature of water by air a great
s required, and a constant circulation of
ow you will observe how I obtained this :
ence with I had 22ft. of ascension pipe in
this was the injection, and connected with
nser and air-pump. Of course there is no
quired to raise this water, as it flowed into
, and was a constant. Now, of course I
y disposal a fall of water 22ft. for surface
circulation; the return water, of course,
the hot well of air-pump, and led to an
corrugated chamber round the ventilating
'his chamber is perforated about half its
he reason for this is that the lower half
ly dirt or foreign matter from interference
colander surface; the holes are numerous,
6th of an inch in diameter, and punched in
er plates. In my case the diameter of the
was about 22in., and the same height. The
are required to be arranged slightly on an
out of the perpendicular, that the jets may
ere with each other's path. My well was
. 6in. diameter; consequently I had a con-
wer in the annular space between the well
l the air chimney. This shower caused a
ulation of air down the well and through
. The air-pipe terminated about 1ft. 6in.
surface of the water in the well; on the
f this pipe from the outside radiated five
shields, upon which the water fell,
free channel for air-escape under them and
haft. The water in the well was about 4ft.
l to keep this to about that level it
lied by a ball-cock, as there may be a
kage in the well, and also a trifling evapo-
always going on. I steined my well with
cement at the bottom, and live lute up the
ow, the steam being condensed with this
d its being worked over again, there are
impurities due to the first charge, except
quantity to make good for atmospheric
on; it will be found about right for boiler
though almost by necessity I made use of
cast or wrought iron could be used for the
, taking all things into consideration, the
of brickwork, and the articles being
y comeatable, I believe it cannot be done
an by sinking a kibb steined with cement
as high as the standing reservoir; the
e work would do in good mortar. My well
t 100ft. from the condenser. In many places
d where the springs have failed, the cause
ted to the want of forest absorption, as
we had immense tracts of woods, and
gradually disappeared. Also to a certain
nay be in many places occasioned by land
but certainly our springs are not what
formerly. I can call to mind many places.
wo engines in Wokingham (high pressure),
red only 90 gallons of water per hour, and
ly had to lay pipes for condensing sur-
t some of this back again, and this was in
that had been at work with a condensing
Also a quantity was obtained for other
uring purposes but a few years prior, and
same well that I had to contend with.

Robert Crickmer.

nt-street North, Poplar.

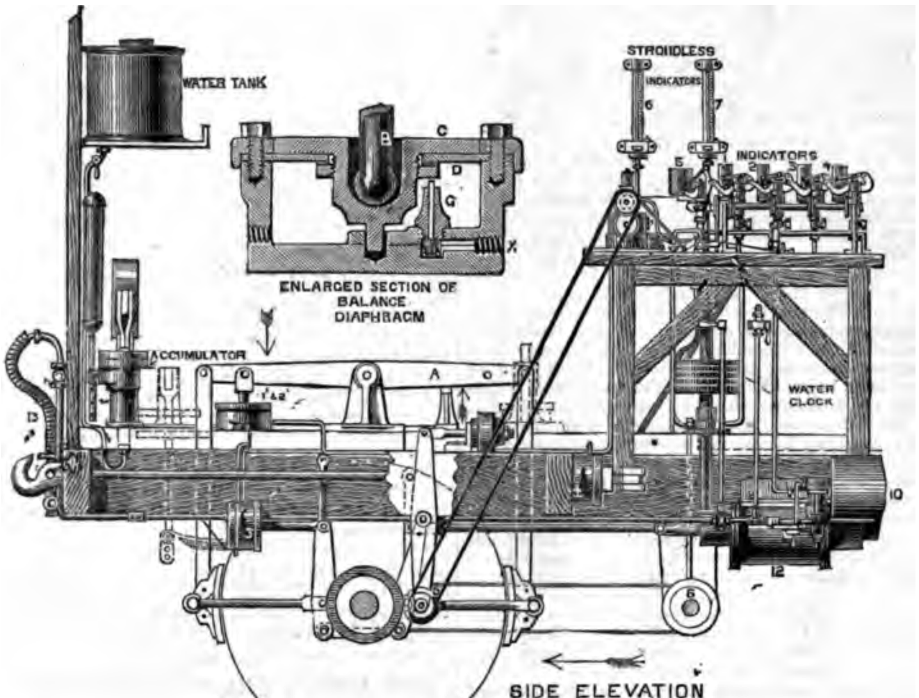
UOUS BRAKES—THE EXPERI-
AL VAN ON THE BRIGHTON
WAY.

]—In my lettor of last week I described
rimental van now being used on the
Railway, but such an ingenious apparatus
fully understood and appreciated unless
has either seen the real van or a diagram
otographs and engravings of the interior
an have been taken, and through the
f those who are conducting the experiments
bled to send a plan and side elevation,
not fail to be of great interest to your
l readers. A comparison of my last letter
present diagram will make the subject per-
ar.

, 2, 3, 4, 5 are the indicators, and 6 and 7
lley's speed indicators. The water clock
he indicator drums is seen beneath the
5′ is the friction wheel driving the speed
; 3′ is a cylinder and diaphragm which
indicator No. 3, the force in pounds per
h with which the brakes are applied; at
n the similar cylinder by which the strain
w bar is transmitted by hydraulic pressure
responding indicator. At the end of the
s the accumulator, with its weighted lever,
plies water under pressure to the clock
here as required. The wheels, 6′ and 7′,
o drive the Stroudley indicators.

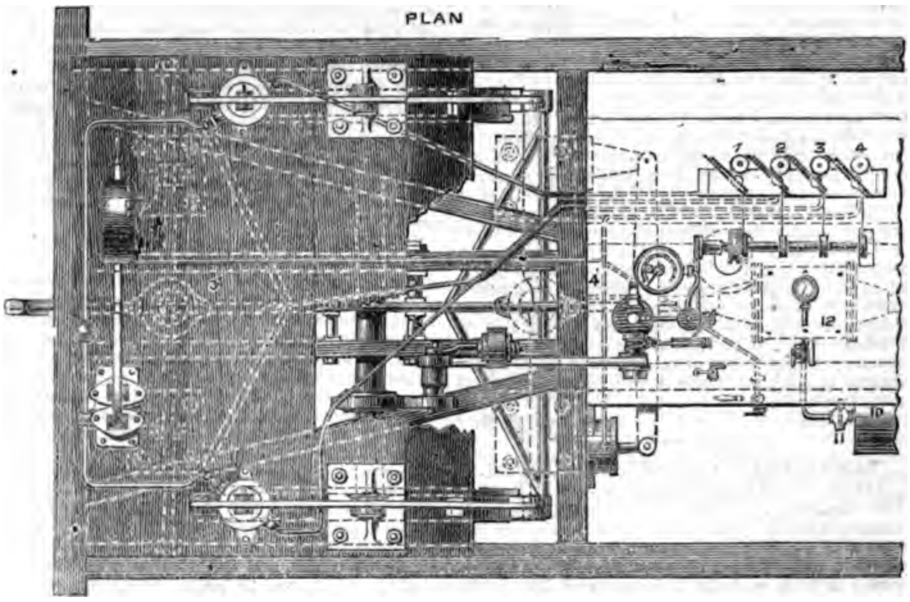
The most important part of the apparatus is that intended to register the tangential strains on the brake blocks. This is shown by A A, which are the two balance beams, at each end of which a brake block is hung; when the brakes are put on these balance beams tend to move in the direction of the arrows, but their movement is controlled by the resistance of the water in the cylinders, 1′ and 2′, one of which is shown in enlarged section in the detail drawing. The spindle, B, takes the strain of the lever and transmits it to the moving head, C, and leather plate. The movement required to send the indicator piston, from the top to the bottom of its cylinder, does not exceed 1·75in. As it is absolutely essential to the accurate working of the apparatus that these diaphragm cylinders should be kept full, they are automatically supplied in the following way:—A small pipe runs from X to the accumulator. F is a small valve held up by a spiral spring. When the diaphragm, C, falls, because of leakage, through a small distance, it bears on the point of the rod, G, depresses it, and admits water from the accumulator, which restores the diaphragm to the proper height.

Fig. 10 is the auxiliary reservoir; Fig. 11 the triple valve; Fig. 12 the brake cylinder, and Fig. 13 the coupling hose. The two Stroudley's speed indicators, Figs. 6 and 7, are fixed against the side of the van. There is a small brass box or case, in which a fan revolves by means of a cord from the axles of the van, the faster the fan is driven the higher the water, with which the case is filled, stands in the gauge glass. A graduated scale is fixed by the side of the water-gauge, which indicates the speed per hour.



SIDE ELEVATION

PLAN



I have had opportunities of observing these speed indicators in use; although they are so very simple in construction, I have found them to be very exact in practice. Mr. Westinghouse has ascertained by recent experiments that certain modifications may be made in the apparatus with advantage, and these are shown by the dotted lines, and will be readily understood.

The wheels of the van are fitted with Mr. Stroudley's improved brake rigging, which only weighs 80lb. the set. The thrust rods putting on the brakes are of gas tubing, and every portion of the apparatus, which has been fully adopted by the London and Brighton Company, is tested to 200lb. on the square inch, water pressure, or rather more than double the maximum working pressure, before a train is allowed to take its place in service.

Captain Galton's paper is being watched for with great interest, and as soon as possible after it is read I shall send a copy of it to the English Mechanic.

June 10. **C. E. S.**

CONTINUOUS BRAKES—BARKER'S HYDRAULIC.

[14492.]—Barker, Harris, and Co., page 315, contradict my statement upon page 269, that the train fitted with Barker's hydraulic brake, which runs daily between Bedford and London, is the same train which ran at the Newark brake trials in 1875. My first proof is, that the carriages now stationed at Bedford are numbered exactly the same as when at the Newark trial. Secondly, at Bedford last year, Mr. Barker himself pointed out to myself and others the "improvements he had made in this train since it ran at Newark."

There are on the Midland two engines (Nos. 132 and 135) and 24 vehicles (*vide* the last Parliamentary return) fitted with this brake. Both engines and the 24 vehicles are stationed at Bedford to run to London and to Northampton, as I explained upon page 269.

The only excuse for the contradiction of my facts is that one of these engines and two carriages happen to have gone away from Bedford for repairs, but they will have returned before this letter is in print.

All readers of the MECHANIC are fully aware that when locomotive engineers speak of an engine as running daily over a certain portion of a railway, they do not think it necessary to state "except when under temporary repairs." One of the firm of Barker and Co. was present at the trial referred to in my letter, when the brake failed to stop the train, running at 50 miles an hour, in 15 seconds, and within 200 yards. I must repeat a question which has often been asked, Why did not Mr. Harris claim this stop for Barker's brake in any of his speeches before the Society of Arts when the discussion upon Capt. Tyler's paper on continuous brakes was being heard? It was quite expected that he would repeat the statement made in the *Times*. Had he done so, he would have been asked to let the society see a similar stop made again. It was the opinion of those present that had such a good stop ever been made, Mr. Harris would not have lost such a grand opportunity of making it public. As to the words, "estimated speed," every one is well aware that it is impossible to estimate the speed of a train accurately enough to be of much use at a brake trial unless a speed indicator is used. At this very trial some persons estimated the speed at 45, 50, and 55 miles an hour; while one gentleman affirmed "that the speed was over 60." I have before stated in the MECHANIC that I am not connected with, nor have I any private interest, in any brake company whatever. I have opportunities which few can have of observing the merits of continuous brakes. I have worked every kind of continuous brake used in Great Britain, and it is my desire to lay the results of my experience and study fairly before the readers of the ENGLISH MECHANIC. Each inventor has a private interest in his own brake, and considers it the best. It is, therefore, quite impossible for me to write a letter which can please all these gentlemen. Barker and Co. will at once disagree with me when I say I am of opinion that the Westinghouse automatic brake is decidedly the best in use.

Smith's Vacuum Company have entirely objected to my statement upon page 148—"That Barker's brake stops a train quicker than the vacuum," and to my saying, on page 315 that the Sanders "is the best of the vacuum brakes." On the other hand, the Sanders Company consider theirs not only the best of the vacuum brakes, "but the only brake worthy of consideration."

I could give the opinions of many other brake companies, but these will suffice to show, as Captain Tyler said in his paper, "There is no other subject so hotly contested in the railway world. Not only are there diversities of opinions, but there are also prejudices and feelings, and interests at stake, which tend to prevent the plain truth and simple common sense from gaining a hearing." In conclusion, may I ask Barker, Harris, and Co. whether they have a train at work which fulfils the necessary conditions laid down by the Board of Trade? I would also suggest that if Barker's brake can make the stops claimed by its proprietors, they should have a public trial, and, of course, let all the results be accurately taken and published. I have no doubt that if Barker's brake could be made to do all its inventor states, it would be one of the brakes of the future—instead of being, as it now is, very little used for fast main line traffic.

June 11th. C. E. S.

SINGLE AND COUPLED ENGINES.

[14493.]—I HAVE read the letter of "C. R. M.," New Zealand, with great interest, and he certainly treats the subject of single and coupled engines in a very able and unbiased manner. The high speed of the G.N. expresses is in a manner forced upon them, owing to their route to Liverpool and Manchester being so roundabout. The L.N.W., having the direct route, have no need to attain such high speeds, and, although they make a good many stoppages on the way, average 4h. 45m. from Manchester to London, and at the same time do not run nearly so fast between stations as the G.N. If it were necessary all the L.N.W. trains between Manchester and London, and vice versâ, could be accelerated without taking off any of the stoppages, and I do not think the G.N. or Midland could do the same. "C. R. M." shows pretty conclusively that the run made by No. 1334, from Leicester to Kentish-town, was open to objections similar to those urged against single engines—viz., of running fast down banks, and losing time up. I have recorded one instance of a Midland coupled engine getting into trouble (Vol. XXV., p. 389), and may say that No. 1314, a Midland bogie engine, took 32¼m. to run from Marple to Miller's Dale, with a load of one long bogie, four composites, two vans, and one horse-box, thus losing 4¼m. in a journey of 17¼ miles, rails in excellent condition, and signals right all the way. Considering the light load, the great tractive power of those engines, and the immense weight available for adhesion—viz., 26 tons 17 cwt —this ought not to have happened. If you look at the running of the G.N. newspaper express, you see that the G N. engines run it from London to Retford, 138 miles, in 3h., or an average of 46 miles per hour. From Retford to Manchester, 64 miles, the M.S.L. bogie engines take 100m., or, deducting 5m. for stoppages, 95m., or a speed of about 40 miles per hour.

As for coupled engines running pretty equally up hill and down, I have timed a Midland bogie engine, 1316, between Miller's Dale and Marple, and found the first 4½ miles were run, on two occasions, in 10¼m., and the next 9¼ miles to New Mills were run in 11m., exclusive of slackening at Bugsworth and New Mills.

"W. J. S." (letter 14433, p. 315) is rather hard on the L.N.W. directorate. Referring to his statement that "the L N W. would have gone on for ever running from Manchester to Liverpool in one hour," &c., I may inform him that long before the Cheshire lines route to Liverpool was opened, an express service of trains was established between Manchester and Liverpool, performing the distance in 50m. Judging from his letter "W. J. S." is probably not aware that it is entirely owing to the enterprise of the M. & L.R. Co. that the line from Manchester to Liverpool has been so soon opened for traffic. If Sir Edward Watkin had had his way it is highly probable that a half-hourly service would have been inaugurated by now, but it is problematical how it would answer. I may inform "J. W. S." that no Midland engines of any description whatever are used between Manchester and Liverpool, and that the coupled wheels of the Precedent class are 6ft. 6in. in diameter. If "W. J. S." would kindly send a few details of his splendid run with Penrith Beacon it would interest a good many. It is rather seldom that we hear of such a splendid performance in everyday work.

I beg to thank "Egeria" (p. 169) for his kindness in sending me the list of engines. Would he kindly say if the 861-871 class that run the Manchester newspaper train come from Rugby or Crewe? How is it they do not return before 2 p.m. L. L.

SUSTAINING THE VIBRATIONS OF STRINGS.

[14494.]—THE following note, referring to an invention which "received provisional protection only," may interest those amongst your readers who are experimenting with strings, tongues, &c., with the view of obtaining sustained tones of equal strength throughout the duration of a note. The invention is that of Mr. Ed. Tyer, 2,763 of 1877, and is described as applicable to pianofortes and like musical instruments, in which notes are produced by the vibration of elastic strings, wires, springs, or other sounding bodies when they are struck by hammers, or are strained and let go. Notes thus produced, it is well known, become gradually weaker after being struck, and are almost of necessity of short duration.

The object of this invention is to provide means of sustaining such notes for any desired time, with a strength uniform, or nearly so, and the inventor effects this by placing the sounding body in the condition of the vibrating tongue armature sometimes employed in connection with an electro-magnet. For instance, in order to sustain the notes of a pianoforte in which steel wires are used as the sounding bodies, near the middle of these wires is placed an electro-magnet, the coil of which is connected with a battery or other source of electricity through a contact-maker acted on by the wire itself. This contact-maker is so arranged that when the wire is at some distance from the magnet the electric circuit is completed, and the magnet being thereby rendered active attracts the wire towards it. As the wire approaches the magnet, contact is broken, the attraction ceases, and the wire recoils, again completing contact so as to become again attracted and so on, the wire being thus caused to vibrate, or having its vibrations thus sustained as long as the electric force is maintained. When a key of the instrument is depressed, it causes the hammer to strike the string, and the damper to be relieved in the ordinary way; the same movements are arranged so as to make connection to the source of electricity, and thereby to bring the string that has been struck under the influence of the sustaining magnet, causing its vibrations to continue as long as the key is held down. On releasing the key the electrical connection is severed, and the damper stops the vibrations. A like arrangement applies to other sounding bodies, such as steel springs, or iron or steel bells, and can also be made appplicable to bodies made of other metal or material by attaching to them pieces of iron forming armatures, which can be attracted to magnets employed as above described.

It must be remembered that the information here given is obtained from the provisional specification, and is therefore presumably not so complete as Mr. Tyer himself would be able to impart; but, assuming the possibility of sustaining the vibrations of strings, tongues, &c., by means of electro-magnets, it may be doubted whether the effect produced will be worth the cost. I have, too, a suspicion that the electro-magnet while "sustaining" the vibrations might interfere with them in such a manner as to produce anything but a musical note. **Stringplate.**

AMERICAN ORGAN MATTERS.

[14495.]—I AM much afraid that "Eleve" will not feel inclined to give a chapter or two on the construction of "some of the more elaborate instruments," though I, for one, should be glad to see a sectional drawing and instructions for making a two manual. If I answer some of "W. H. Gnikrod's" questions (letter 14465) I suppose he will not think it an intrusion. A one manual instrument might very easily have 5½ rows of reeds. For instance, referring to the diagrams on p. 69, Vol. XXVI., it will be seen that a half row is mounted on the top of the tubeboard; that might be a whole row. and it might have another row at the back, so that there would be four sets of reeds, as it were, in the one block and over the one set of pallets. They might be (I merely suggest) three sets of 8ft. and one of 4ft. At the back of the board, instead of sub-bass, there could be a whole row of 16ft., with an extra half of 16ft. or 8ft., or even both, making altogether six rows. I suppose such a tubeboard would have to be specially made, because I believe it is very rare that a complete set is placed on the top of another. They are usually half rows. If three rows would be sufficient (and a one manual rarely has more) they might be 16, 8, 4, or 16, 8, 8, as "W. H. G." or any one else may prefer; but some would keep the 4ft. with the super-octave coupler, in order to get the 2ft. tone. "Eleve," in his letter on p. 92, did describe the æoline and the vox humana (reed stop). The former is a soft-breathing stop, made with light reeds in small channels; the vox humana is intended to resemble the human voice, and has that reediness which is much admired. "W. H. G." should take "Eleve's" advice, and hear it in one of G. Wood's organs. The difference of tone in Mason and Hamlin's organs is simply due to the voicing. Those styles with the figures are, I think, soft-toned, and have ivory-fronted keys; those indicated by letters have plain fronts to keys, and are loudly-voiced. What does "W. H. G." mean by a "comprehensive treatise?" If I can answer any question I will, but surely he does not want a treatise like that by Mr. Warman, which is a work for all time, and is studied by professionals as a textbook. **Organon.**

NEW MUSICAL NOTATION.

[14496.]—I HAVE seen with great pleasure the philosophical system of musical notation described by your correspondent, Mr. Robert Wark. It is best to point out an objection first to the new notation. I think it will be found more difficult to read notes on what I will call the seven-line notation than on the ordinary five-line notation, but this is a small matter compared with the enormous advantages to be gained by the adoption of the new notation. First, as regards harmony, the position of notes on the stave always shows the distance of the intervals in sound. In the ordinary notation notes distant only from a line to a space may indicate an interval of only half a tone, or they may indicate a whole tone and a half—that is, three half tones. Again, in playing on any ordinary manual instrument with a keyboard the notes in the bass will occupy the same position as those in the treble; at present players have to read two languages at the same time. With several instruments it is exceedingly difficult in the present notation to read any passage marked 8va; this difficulty disappears in the new notation. In music for the violin and English concertina passages are generally written on ledger lines up as high as five or six above the treble stave; the difficulty of reading notes on them is exceedingly great. The thick lines placed above them, as indicated by Mr. Wark, obviates the whole difficulty, for the reader would read down from the top line, instead of up from the top of the stave. Many other advantages may accrue, which I do not wish to occupy your space by enumerating.

June 11. J. B. M.

MUSICAL TONES.

[14497.]—"G. P.", (let. 14402), rightly concluding that C♯ is lower than D♭, desires to know how the values of these notes are determined. The right way to answer this question appears to me to be this:—The values of all notes in their relations to a selected key-note are determined by precisely the same rule as that by which those of the notes of the simple diatonic scale are determined, which we have seen is the simple continuous procession or evolution of the two kinds of concord—that is to say, the accretion of concords to the constituent notes of already determined. To find, therefore, es of these two notes, which are developeyond the limits of the diatonic scale, we st find what notes of the scale can supply that embrace them. In the case of C♯, it it that the note, A_2, supplies a harmonic which embraces it—viz., A_3, A_1, E, A, $C\sharp^1$ gnisable as the source of the major triad, E^1. Now, as the ratios of a harmonic conform with the arithmetical series 1, 2, 3, 4, ollows that the ratio of C♯ to A is 5 : 4; ee the ratio of A to C^1 is 6 : 5, the ratio of is equal to $\frac{5}{4} \div \frac{6}{5}$, or 25 : 24, which result otherwise expressed thus—$C\sharp^1$ being a major gher than A, it is necessarily a chroma her than C^1.

in the case of D𝄫, the hypharmonic concord found to supply it, thus—F^2, F^1, B𝄫, F, D♭, ch, it may be seen, is the source of the minor :, D𝄫, F. Now here, as the ratios of a hyp concord conform with the reciprocal ical series, 1, ½, ⅓, ¼, ⅕, ⅙, it follows that the to F is ⅕ : ¼ = 4 : 5; and since the ratio is 4 : 3, the ratio of D𝄫 is $\frac{4}{3} \div \frac{5}{4} = \frac{16}{15}$. d in words, without the use of figures, D𝄫 r third below F, and consequently a semi) above C.

erefore evident that D𝄫 is higher than C♯ fference between $\frac{16}{15}$ and $\frac{25}{24}$; that is, $\frac{16}{15}$ $\frac{128}{125}$.

o notes whose values are thus obtained are he names that are most nearly related to C. There are, however, it should be ther notes of the same names or signatures in changes of key, which are not truly the es, but differ from these in value, in instances, by one or more commas.

Fred. J. Jackson.

ROPERTIES OF NUMBERS.

—Perhaps "P. G." (letter 14441) would ow an unfailing rule for arranging any oddre of numbers in arithmetical progression, thmetical progression plus a constant &c. My father discovered it when I was howing me the peculiar properties of the nine digits. I do not remember ever seerint, but it is probably not new.

-sided square is necessary, so that there central position to be occupied by the m of the series, and the rule will not apply -sided square.

le a square with any odd number of sides, the central division, say, with a small dot; the first term of the series in the division y below this, and arrange the following onally towards the bottom right-hand he square. Each term to be placed one ther to the right, and one row lower down term immediately preceding it, and this rrangement to be continued throughout course is clear. But the bottom of the be reached, and so will the right-hand ome divisions will have been previously ell, in the first instance, when a term n an imaginary division below a column, the top division of that same column, and nd instance, when a term would fall in an division beyond or to the right of a row, the first or left division of that same row. a term essays to occupy a division ed, to borrow a figure, let the angle of qual the angle of incidence, when the ll two positions below, and in the same the preceding one. Again, the central series will be found to fall in the central d also the terms on either side of the will have arranged themselves adown the gonal. Now, the next term will essay to naginary division partaking of the nature side and bottom ones, being really an of the central diagonal row. This term aced in the extreme left division of the from the top, which will always be ng for it, and the remaining terms are to according to the foregoing.

with ordinary care any odd-sided square filled on this plan from that of the nine ny size whatever, and the columns, cenls, and rows would be found to add up to tal.

S. Hunt.

-As the subject of properties of numbers quares has been brought forth in your aps you will allow me space to show one t remarkable (so far as my knowledge ave ever been published. So simple are truction, that I could write off at hand , 2, 3, 4, &c., up to 1024, forming a cells in a side, and containing the same of numbers as in the accompanying square, which will be found to contain the following curious and remarkable properties of numbers:—The sum of the terms in each row, whether vertical, horizontal, or diagonal, is 260; and the sum of any term, or number of terms chosen from the square (irrespective of their position), added to the corresponding term or terms, which are equidistant from the centre $= \frac{\text{number of terms} \times 260}{8}$. The sums of all the terms contained in each quarter of the square, and also the sum of the middle 16 terms, are equal to each other—viz., 520. The diagonal of any quarter is equal to the diagonal that lies at right angles to the former, in the opposite quarter. The diagonals of the middle 16 terms are equal. The odd terms of the top horizontal row added to the even terms of the bottom row = 260; this applies to the 2nd and 7th, 3rd and 6th, and the 4th and 5th horizontal rows. The odd terms of any vertical row added to the even terms of any other vertical row = 260. The sums of the odd, and the sums of the even terms in each vertical row, are respectively 128 and 132. Take any two rows, either vertical or horizontal, or one vertical and the other horizontal, and add each alternate term of one row to each alternate term of the other row; the sum will be 260. The diagonals of each group of 4 terms are equal—the square thus forming 16 such groups. If the sum of each of the 4 groups in each row were added together, as in an ordinary square of 4 cells in a side, they would form a perfect square, as shown by the small one, in which each term = the sum of its respective group. The sum of each row in the smaller square is 520. The key of this square will follow, if in the meantime some one does not anticipate me.

64	60	17	21	33	37	16	12				
56	52	25	29	41	45	8	4				
2	6	47	43	31	27	50	54	232	92	156	40
10	14	39	35	23	19	58	62	32	164	100	224
3	7	46	42	30	26	51	55	36	160	96	228
11	15	38	34	22	18	59	63	220	104	168	28
61	57	20	24	36	40	13	9				
53	49	28	32	44	48	5	1				

Joseph Jewsbury.

Brookfields, Birmingham.

[14500.]—In reference to "P. C. D.'s" article in your last (14441), there is only one way of arranging in the nine holes that number of figures in arithmetical progression so as to produce what is known as a magic square.

816
357
492

With larger numbers there are found to be a great many arrangements. Thus, 16 holes (4 × 4) gives some hundreds. The three following can be transposed by writing the top row below the bottom, and still be magic; and if the second and third row in succession be similarly transferred, or if in its original or any of the transposed forms the right hand row be transferred to the left, and the second and third in succession, the square is still perfect:

1	14	11	8		1	14	7	12		1	8	13	12
12	7	2	13		8	11	2	13		14	11	2	7
6	9	16	3		10	5	16	3		4	5	16	9
15	4	5	10		15	4	9	6		15	10	3	6

The following, in 25 holes, possess the same property:

1	10	14	18	22
19	23	2	6	15
7	11	20	24	3
25	4	8	12	16
13	17	21	5	9

1	25	19	13	7
14	8	2	21	20
22	16	15	9	3
10	4	23	17	11
18	12	6	5	24

In all these forms, and doubtless, in many others, the order of the natural numbers, 1, 2, 3, &c., is found to trace a line governed in each case by a law easily seen and remembered.

J. G. F.

A POLARISCOPE SPOT LENS.

[14501.]—Herewith I beg to inclose you a description of a new piece of apparatus for use with the microscope. My friends think that it ought to be called a polariscopic spot lens or paraboloid, inasmuch as it combines the two in one. It consists of a polariscope with a spot lens fixed in the upper part of the polariser, though it is quite immaterial whether it be fixed either at top or bottom. If at the top, the selenite must be placed below, just above the polariscope, in a slit provided for it. Of course if placed below, the selenite is placed on the stage in the ordinary way. One notable peculiarity about it is, that instead of rotating the polariscope, the spot lens must be fixed in a loose cell, capable of being rotated like an ordinary polariser.

There is yet another peculiarity about it which I should like discussed in the pages of "ours," as it fairly puzzles me and every one else to whom I have shown it; in fact, I never shew it to any of my unscientific friends for this reason. Looking at an object in the usual manner you see the object viewed on a black ground in the centre, with the most gorgeous polarisation round it. This is obtained by revolving the spot lens. Now, if the polariser be rotated, the black ground and the polarised light are seen in the most glorious confusion — commonly called muddled. Stop this, and rotate the analyser. Lo! another unaccountable transformation. The black ground has retreated to the edges, leaving the polarising going on in the centre. Can any reader explain this?

For the information of Mr. Albert Smith, A. H. Allen, and others interested in the detections of adulterated food, I would say that it would prove o great value, as the starch of arrowroot appears green, while the starch from the potato appears brown. Milk, when pure, is bright yellow, while that containing water is quite blue. This is with a red and blue selenite. Many other objects appear in totally different conditions than to an ordinary observer.

At the next meeting of the Royal Microscopical Society a paper will be read on this curious and, at present, bewildering instrument.

I shall be happy to show any of your readers its curious effects on the objects mentioned if they will advertise their address.

B.

CASSEGRAIN REFLECTORS.

[14502.]—Of reflectors the Cassegrain was my first love, but experience has somewhat modified my affection, more especially as the grandest expression of that form, the Great Melbourne does not appear to have equalled the "great expectations" entertained by many of what the performance of a 4ft. speculum might be in the pellucid atmosphere of Australia.

The Cassegrain has, I now think, a speciality—a defect which renders it less convenient—less pleasing to use than the Newtonian. This is the necessity of observing through the end instead of through the side, and so when an object is vertical or nearly so, we have to lie flat under the instrument or inconveniently crane our necks, whereas objects in a vertical position are just in the most convenient situation for observation through the Newtonian. Of course, with the former instrument we can use a star diagonal, but this is to add another reflection to a combination which, perhaps, has already one too many.

Neither is lying on the back nor craning the neck the best method for holding the head when we desire the expression of our most accurate seeing. The Arab in the desert, the Indian on the prairie, the sailor on the ocean never throw the head back when regarding distant objects—just the reverse; they lean the head slightly forward. I am sure some of the fanciful markings occasionally seen or supposed to be seen by earnest observers on the planets, and especially the disagreements regarding the colours of fixed stars are the result of fatigue to the eyes, principally caused by a necessity of looking through the telescope in a manner not the best for clear seeing, and giving less repose to the eyes than they would have, had we employed them in the position we ordinarily see farthest without instrumental aid.

If it were not requisite to silver glass mirrors so frequently, reflectors would be infinitely more in favour, but this constant tarnishing is a great drawback. If Mr. Lancaster or some other ingenious optician would turn their attention to this matter they might perhaps invent some lacquer either to combine with the film of silver or to spread over it, of such tenuity as not to interfere with the figure. I hope our gracious friend will find time to give the suggestion some thought. I recollect reading how Ramsden or Short, I forget which, ground a mirror back and front so as to cover the back with tin and mercury as our looking-glasses are made; such a method was, at least, durable and brilliant.

E. B. Fennessy.

Coins Going Out.—The year's Mint report shows, as usual, no coinage of crowns. There has been no issue of crowns, we believe, since 1851, nor of groats or fourpenny pieces (except for Maundy money) since 1856. Half-crowns shared the fate of crowns for some years after 1851, but in 1873 the Mint issued a circular to bankers asking their opinion whether it would be for the public convenience that the florin, first coined in 1849, or that the half-crown should be the coin adopted, or that both should be in circulation; and about two-thirds of the answers received were in favour of having both in circulation. The coinage of half-crowns was thereupon resumed, and above four millions of them have been coined in the course of the last four years, and about as many florins also. The crown is a handsome coin, and the groat is sometimes convenient.

REPLIES TO QUERIES.

⁂ *In their answers, Correspondents are respectfully requested to mention, in each instance, the title and number of the query asked.*

[31976.]—**Compound v. Single-Cylinder Engines.**—Mr. Langton takes my well-intentioned banter au sérieux, and stands on the dignity of his "experience." If I had felt inclined to be sarcastic I assure him he has afforded abundant opportunity in both of his letters. In his note on p. 296 he writes plainly enough that "for one charge of steam we get *two* vacuums. In the single-cylinder we can only get one vacuum: hence the disadvantage." In his second (p. 347) he states that the loss of pressure between the high and the low pressure cylinders "is correspondingly gained by increased piston area." To any one acquainted with merely the outlines of the theory of heat in the steam-engine such an assertion will appear extraordinary, and as for me I can only congratulate Mr. Langton on finding so easily "in loss a gain to match the far-off interest" on his coal bills (I beg Tennyson's pardon). Seriously, if Mr. Langton will only refer to Vol. XIX., and read the history of the compound engine there printed, and will state all the conditions (dimensions, &c.) of two rival engines, one compound and the other single, I will endeavour to show him where the superiority really lies. As he puts the matter, any one could easily retort that it would be more advantageous to use the steam in a single-cylinder the diameter of the low-pressure one, than to have two, and lose pressure in the transit from one to the other: for it is obvious that there is only so much "work" in the steam, and if some of that is lost it will puzzle you to regain it. Another thing Mr. Langton may consider: how is it that there is a gain over the single engine when the steam from the high pressure is taken into an intermediate receiver before entering the low-pressure (where, in fact, the exhaust of the high-pressure closes before the valve of the low-pressure opens)? What has become of his second vacuum then? Perhaps he will be surprised to hear that a single-cylinder engine, steam-jacketed and clothed, with Corliss valves, and not too much expansion, will run the best compound very close indeed; but under any usual conditions of working, the compound must be superior, if other things are equal. Let Mr. Langton work the problem out by figures, taking due account of the difference in temperature of the steam at the two ends of the strokes, before he again ventures to say, as he does in p. 296, "but were it only a matter of difference of heat, I should incline to belief in the simple engine." "Assoc. Inst. C. E." thinks "J. B. C." will be surprised to hear that the combustion of powder in a cannon produces a vacuum. "J. B. C." is not surprised at anything, but he is amused that "A. I. C. E." should have omitted to state the theory upon which such an assertion is based. Perhaps that gentleman will not mind pointing out at what part of the bore, and at exactly what time the vacuum is created. If he will also explain how the "report made is principally due to the air rushing in to fill the vacuum," he will confer a great favour; and if at the same time he will attempt to explain how it is that those gun-cotton rockets mentioned on p. 329 make reports so loud, he will probably find reason to mend his rather dogmatic assertions. Somebody will say next that it is the air rushing in to fill the vacuum that drives a cannon back when it is fired!—J. B. C.

[32269.]—**Systematic Memory.**—*Many* of us would be glad to avail ourselves of "G. G. P.'s" offer on p. 320, and learn a little more of "systematic memory." I cannot quite clearly follow him in his explanation of the subject; but I dare say another letter from him may elucidate the matter. In a system I attempted to learn some three or four years ago, "cabbage" would not have represented the date Jenner discovered vaccination, but two years later—viz., 796. "Caper" would have been the key-word, and I suppose the best association would be the figure of an infant cutting a "caper" whilst being vaccinated. But that would only give the date of the discovery, and a fresh association would have to be formed for the name of the discoverer. "G. G. P.'s" second illustration of the quadrant, so far as I can see, only enforces the fact that a quadrant *has* degrees—a thing by no means difficult to remember—but leaves us completely in the dark as to 1740 being the date of Godfrey's invention of it. What I consider to be the greatest drawback to the science of mnemonics is the large number of artificial links required to bind masses of information together in one complete chain. I should like a hint or two on how "G. G. P." avails himself of mnemonics when wishing to acquire information of a very accurate and detailed character—such, for instance, as mathematics or languages. Suppose that in the former we take Euclid, algebra, or trigonometry, does not he think that the large number of associating mental pictures which would be required to fix the different rules in the mind would be perfectly bewildering? Or suppose you take in the latter French and German, in what manner, and to what extent, would he consider it desirable to use mnemonics?—Richard Temple.

[32269.]—**Systematic Memory.**—Mnemonics being such a valuable aid to the memory it is rather surprising the subject has not received more attention in your columns. I did not approve of Maclaren's *phonetic* memory table, so made one for myself, a copy of which may be interesting to some of your readers. The cipher, 0, is represented by *k*, *ck*, or *q*. 1 by *b* or *p*, 2 by *c* or *x*, &c; the 5 vowels with *w* and *y*, and also the aspirate, *h*, represent no numbers. The key stands thus:—

	0	
	k, ck, q	
1	2	3
b, p	*c, x*	*d, t*
4	5	6
f, v	*g, j*	*l*
7	8	9
m, n	*r*	*s*

The numbers from 0 to 99 are represented by the following words, compiled from the above key:—

	0	
	(Key)	
1	2	3
boy	cow	hat
4	5	6
ivy	Jew	owl
7	8	9
ham	hare	saw

10	20
book	cake
baby box boat	cab couch cat
beehive bag bowl	cave cage coal
piano bureau bush	chain chair cheese
30	40
duck	eavehook
tube watch date	fop fox vat
dove dog dahlia	fife fig file
dome door dish	oven fire fish
50	60
jockey	lake
gap juice goal	elbow lace lady
glove gig eagle	loaf log lily
gun jar goose	lion lyre lash
70	80
ink	ark
map mace net	rope arch rat
muff image nail	roof rug reel
onion mower mouse	urn arrow horse

90
sack
shop sauce shed
sieve sage shawl
snow sower sash

Some of the words might doubtless be improved upon; and I should be glad to see more suitable words suggested for the numbers 40, 52, 54 (the letter *l* having no business there), and some others. To be of use the whole table, or even a part, must be learned *very perfectly*. As to the manner of applying it, we will suppose it is desired to learn mnemonically the heads of the Sermon on the Mount. Commencing with the beatitudes, we have to associate them with the word "boy," which represents number 1: picturing to the mind a boy receiving his father's blessing would answer the purpose. Picturing a "cow" (the second word) would recall to the mind (the second head) "Ye are the salt of the earth." A lawyer with a wig under his "hat" might be associated in the mind with the words "to destroy the law." A sheep eating poisonous "ivy" leaves might be pictured to connect "ivy" with "Thou shalt not kill," and so on to the end. Next day, or any number of days after, the word "boy" will recall the beatitudes; the word "ivy" will recall to the mind the words "Thou shalt not kill," and so on. Should any one doubt the fact, a fair trial will soon convince them, if they will first learn a few words, say 10 or 20, quite perfectly. The same plan pursued whilst listening to a sermon or a lecture will enable one to remember the heads of the same, or any striking illustration or other details. "Practice makes perfect," but even the tyre in mnemonics will surprise himself as well as others by the new power his memory has acquired.—W. P. Iron.

[32300.]—**Soap Substitute (U.Q.).**—I have known a mixture of ammonia (solution) and oil to be sold as a cleansing liquid, but I do not recollect the proportions in which they were mixed. Should recommend "A Fuller" to try a few experiments with ammonia, borax, and oil. He will soon discover the right quantities. I do not think the liquid I have seen contained anything else but ammonia and oil. There is no art in the mixing—they merely require to be shaken up together. If borax is used it should be dissolved in water.—Os.

[32313.]—**Microscopical.**—Although this is addressed to a well-known correspondent I reply, as it is about being consigned to limbo. "Carpenter on the Microscope" is a good book for a beginner. If you want standard specimens of starch procure samples from reliable sources, or prepare them yourself. You could prepare rice, wheat, potato, or sago starch. You will be able to get a sample of pure arrowroot from the wholesale people.—Os.

[32316.]—**Gold Shell (U.Q.).**—I do not know whether you mean that unused gold shells are kept in a glass case, and that they fade while in the case, or that you have used gold shell to gild some article, and the colour of the article fades. The latter can be obviated by giving it a coat of varnish, which will keep it from contact with the air.—Os.

[32323.]—**Herepathite (U.Q.).**—Would advise you to try again and again; you won't succeed with this in a hurry.—Os.

[32679.]—**American Organ.**—May I ask "
Gnikrod" whether it is an American organ
harmonium that he has altered? I presume the
But has he altered the keyboard from F to
from C to F? What I want particularly to
is if, in shifting the reeds, he found the
adapted for the lengths of the new channels.
think it would make much difference on a
nium, but I can see a difficulty in the An
organ, especially if the notes added were at b
The price he mentions is a long way beyond
nium reeds, so I am in doubt if it is an An
organ he has been altering, although he sp
"my harmonium keyboard."—Organon.

[32789.]—**L. B. and S. C. Engines (U.Q.)**
following are a few of the principal dimension
above engines:—Diameter of leading, drivin
trailing wheels, 3ft. 11½in.; diameter of cyl
13in. × 20in. stroke; wheel base (total), 12f
tubes, 1¾in. diameter—length, 8ft. 3½in.;
surface of tubes, 470 sq. ft.; ditto fire-box, 55
grate area, 10 sq. ft.; tractive force for ever
effective pressure on pistons, 71·15lb., which
is very low for a six-coupled engine. Howev
can take 200 tons up an incline of 1 in
E. L. P.

[32799 and 32853.]—**London University**
culation (U.Q.).—These correspondents
apply to the Registrar, London University, in
a stamp for reply.—Os.

[32810.]—**Grinding Dry Soap (U.Q.).**—
be managed in a mortar. The powder will o
require to be sifted.—Os.

[32821.]—**Pygidium of Lacewing**
"Chrysopaperla" will find two near the ex
of the abdomen. I cannot say if confined t
sex, but probably not, as both male and fem
have them.—D. Allen.

[32826.]—**Midland Drivers and Fire**
"Young Fireman," in answering this que
evidently not acquainted with the subject.
quite right when he states each one takes
from cleaner to fireman, and fireman to driv
when appointed fireman, wages, first twelve
3s. 6d., after, 4s., until passed for driver, wh
wage is 4s. 6d. per day, until appointed
driver, then it is 5s. 6d. first six months, sec
months, 6s. 6d., next twelve months, 7s.,
years since appointed; after another five
service, 7s. 6d., or seven years since made
Then he says that they have always two dr
shunting engines, which is not the case, as
kept in case of extra traffic, and to wor
drivers' trains who are off on leave or ill,
out on the main line with a passed cleaner wi
In the late Mr. Kirtley's time, when clean
appointed, they had to be from 18 to 22 year
height 5ft. 7½in., but I do not think there
rule to that effect at the present time, as t
some mere lads, and some, I should think
looks, 30 years of age.—Joseph Green.

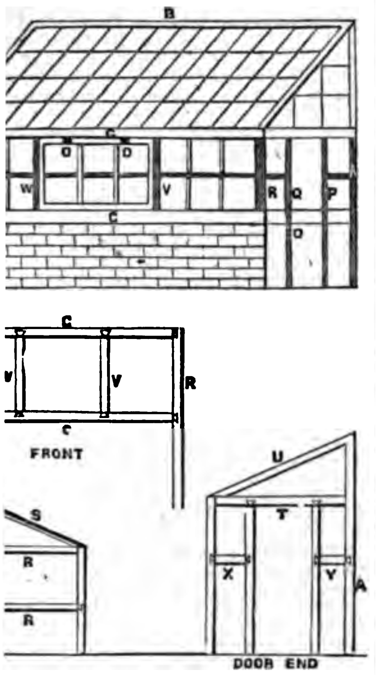
[32841.]—**Tapper Bells (U.Q.).**—You
what is termed a "switch board," by means
the battery can be connected with any of t
bells—a small board, into which four pieces
are fastened. These are respectively connec
the line-wire of each bell. A brass arm work
pivot is connected with the line-wire of batte
can be connected with any bell by placing
on its respective brass terminal.—Os.

[32862.]—**Boiling Glue.**—If "O. C." ca
a look at the "Supplement" to the Sixth
Report of the Local Government Board, he
much information in the report of the medic
on the manufacture of glue. The best boiler
lieve, a steam-heated one; but open pans
quently used, heated by fire, though these
fitted with means of heating by steam. W
open pan with fire is employed, a clear spa
bottom is kept by means of a false bottom
and a removable vertical framework in th
divides the pan into two parts, with a clea
way in the middle. The quantity of wa
depend, to a certain extent, on the qualit
materials; but, as a guide, it may be state
large works a charge consists of 12 tons of
to 1 ton of water, and the produce should
of glue.—J. T. M.

[32866.]—**Greenhouse.**—The height
should be at least 8ft., and as much more
as you can make it, for the greater the
smaller may be the scantling of the bars, an
will be the liability to injury from hail. I
seen, too, that the greater the pitch the
the glass cost; but there will also be mo
The bars can be obtained ready moulded,
3in. deep by 1½in. or 2in. wide—the main fr
4in. by 3in. stuff; but a good deal depends
exact position. Put it together with bed
sinking the heads deep enough to cover th
dowels. If the mortices and tenons are w
and greased with a mixture of pure fat a
lead, together with the screws, it will co
easily after being up ten years. Paint w
coats, letting the priming dry in well. N
time to start, so as to get the benefit of an
dry the frame) that we may have. They
coming.—S. M.

[32866.]—**Greenhouse.**—Perhaps this
"Gardener." The wood that you require
quartering, of which the whole of the fr

to be made—4in. × 3in. will do. The fol- e the pieces out of ground:—Four pieces, for P Q R S; three pieces, 12ft. long, for wo pieces, 7ft. 6in., for A at back; three ft. 9in., and two pieces, 5ft. 3in., for U; two pieces, 3ft. 1in., for V W; two t. 3in., for X Y; O O are hinges. Be sure the dovetails fit well, or else the house be firm, and will be constantly breaking



e sure to ram the posts in ground well ick or two, and keep the house away from Do not fix anything to it at all, and, if you int to leave at any time, remove the house hs beforehand or before you give notice. t make the roof overlap in front. To do must begin at the bottom, and work The back should be 1ft. higher than the Put the glass in last of all previous to —TELESCOPE TELE.

—**Clock Gongs**—Can be had in various ing different tones. Where? Look in the ! or take a walk and inquire at some of s in Clerkenwell. As to the plates for boxes, try Little Britain. I forget the but Directory again.—S. M.

—**Cutting Gauge Glasses.**—Take a rat- that is, a round taper one—and insert the he hole in the glass, scratch the glass in the h the file at the place all round, and the come off, and with practice any length from i. as rapid as you have a mind for. I have same file for the last six years, and no AN OLD ENGINEMAN.

—**Caking Colours.**—Perhaps you have l sufficient gum, or not pressed the cakes cient force. Are you sure the mass was d?—J. B.

—**Gasholders.**—I do not wish to enter eless argument on this question. Suffice that I know two firms who make and sell y of these gasholders, and they are in every le of zinc, as being the most lasting; and my own actual experience confirms I do not see any reason why Mr. Waite presume" that I have "made a great My replies are dictated by either actual e or common sense, and I do not let my ion run wild when answering a simple and I did not see any reason either for r space with details which any mechanic d make the machine, and knew its use) able to supply. Mr. Waite says a large small one will not give a better supply of the small one. All I can say is, try it. gas from a small pipe, and to another e same size join a short length of larger burn the gas from this. He will, I think, ger flame, and, if this does not mean a pply, perhaps he will be kind enough to say oes mean? Mr. Waite recommends the dent to make a conical regulator, &c., hich he can work his pressure to a hair's " and, if I omitted to say anything about , he certainly has not told us how to make cal regulator."—Os.

—**Paraffin Candles.**—Paraffin wax costs . retail; paraffin candles cost the same; the latter are something more than paraffin a, and, as a fact, I believe they usually contain amount of stearine. If "Civis" wants he had better try the wax, which, I pre- i be had at less than 1s. per lb. if bought in —ERos.

[32886.] — **The Pulsometer.** — Will "Black Witch," who answered this query on p. 274, kindly explain how the pulsometer may be "driven with exhaust steam, so as to actually cost nothing in the working"? I am thinking of purchasing one, and such a demonstration of its advantages would settle the matter at once. I can't conceive, though, how it is possible to force water up a pipe at a cost of "nothing."—MINE-OWNER,

[32888.] — **Washing Powder.** — I cannot give "C. S." any details of the method of preparing washing powders; but they are mostly made from soda ash, probably with a little of the best soda. The mixture is coarsely ground, and treated with a size or gummy liquid, to preserve it from the effects of the atmosphere. It is then dried, finely ground, and packed in boxes covered with paper. A "washing liquid" would be a solution containing soda, borax, and perhaps ammonia, together with a little turpentine. The latter has a wonderful effect on dirty clothes.—J. L. K.

[32892.]—**Slates.**—I would recommend "C. O" to read "Slate and Slate Quarrying," by D. C. Davies (Lockwood). The mere prices and sizes can be found in the "Builder's Price-book."—LLANDEILO.

[32894.]—**Canary.**—I have kept and bred canaries for some years, and send the following notes, which may be of use to those whose experience is less extensive. The cage should be kept scrupulously clean, and be thoroughly overhauled at least once a week. Cages with wire fronts and wood sides, back, and top are the only ones adapted for birds. The bottom must be strewed with sand, renewed at least once a week. The perches should be scraped with a knive whenever coated with dirt, and frequently changed. The sides, back, and top of cage should be limewashed every six weeks. The birds must have a cold bath every day; they instinctively know when to use and to avoid it. One of those shallow pots in which potted shrimps are generally sold makes the best bath; this half filled with water. should be placed in the cage every morning. Give the birds plenty of green food and fruit—such as apples. Allow them to have an occasional "out" in any available room or attic; they will soon learn to find their way back to their cage. Let the birds have plenty of sunshine and fresh air.—T. S.

[32447.]—**Electrical Indicator.**—I am extremely obliged to Mr. Wadkins, Dudley, and the other friends who have so very kindly given me their assistance. My friends and I have very much admired the ingenuity and cleverness shown in the electrical devices put forward. One of them, however, had that blessed thing called the "patent sounder" on the brain, and stuck so persistently that it was just the thing, and the only thing we wanted, that (after seeing the description of the apparatus in the ENGLISH MECHANIC) we allowed him to fix one up on trial, and we are quite satisfied that he has been right all along; we are, therefore, preparing a patent sounder, and as it was described by a correspondent two weeks ago I need not repeat his description. We are, however, preparing four different indicators, and as they are very interesting as low-pressure gauges to every mechanic I send sketch of the four. No. 1 is the usual siphon mercurial gauge, and every foot the tide rises the indicating column of mercury will rise ·44 of an inch. No. 2 is an arrangement where the indicating column will rise nearly double as much as No. 1. No. 3 is quite a novelty, and I believe quite an original invention by my infatuated friend before-mentioned. I think it is a particularly clever contrivance to make the mercury travel a great distance along the scale by inclining the indicating arm at an angle. You see, it does not matter what shape you make a mercury gauge—the difference of the levels of the columns of mercury will always be the same perpendicular distance from each other for each foot pressure of water. Thus, in No. 1 indicator one column of mercury rises and the other falls exactly the same distance; therefore the indicating column can only show half this travel. In No. 2 the perpendicular distance will be the same, but the column of mercury with the larger area scarcely falls, and the motion takes place in the columns of small diameter—therefore the indications are nearly twice as long as No. 1. No. 3 is, however, arranged that for the mercury in the small arm to reach its perpendicular height it has to travel a long way along the sloping arm. No. 4 is the style often used for barometers, for which purpose it seldom gives satisfaction; but in our case, where the variations are much greater, we hope it will act better.—AN OLD READER.

[32899.]—**Injecting Tissues.**—If "D. A. N." has the recent back volumes of this serial, he will find several methods of injecting tissues described, together with different fluids.—NORTON.

[32901.]—**Boiler Feeding.**—If sufficient water can be passed through to supply all the boilers, by all means do so. But are you sure you can raise the water to the same temperature when supplying all the six? If not, it would be a calculation as to which method was most economical.—H. K.

[32904.]—**Stone.**—The light-coloured is probably York, the dark Lias. It is an absurd system, for, when unevenly worn, pedestrians are liable to slip on the elevated edges.—WATERLOO.

FIG. 1

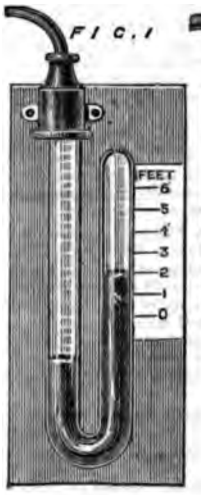


FIG. 3

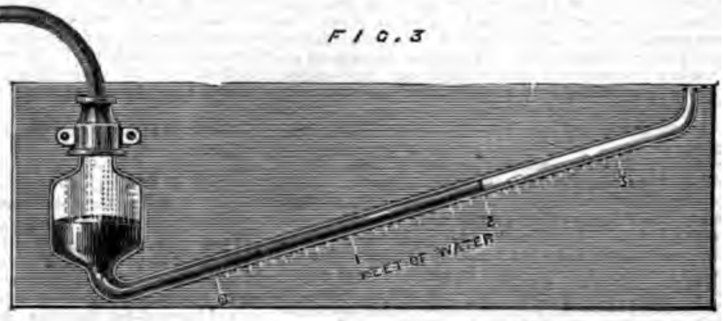


FIG. 4

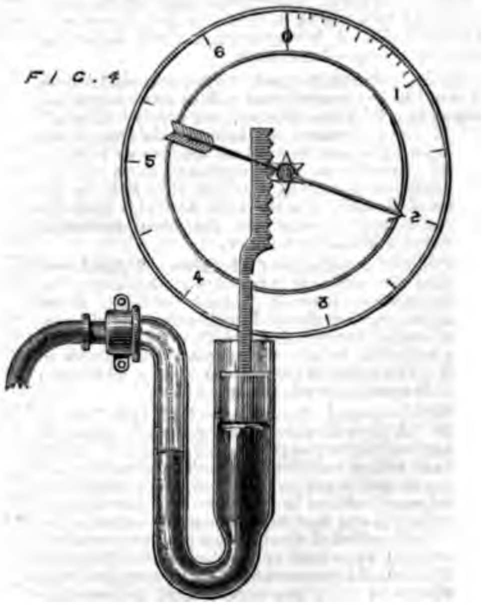
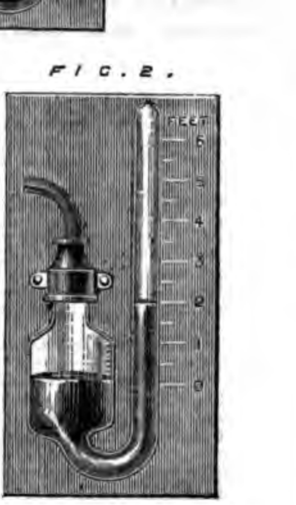


FIG. 2



[32942.]—**Interest.**—I was very pleased to see the letter from "A Fellow of the Institute of Actuaries." Will he kindly say how he arrives at his deduction of 4·278 per cent. from the other two rates, and who is the publisher of Lieut.-Colonel Oake's "Tables of Compound Interest."—A BANKER'S CLERK.

[32945.]—**Aperture.**—I have always understood that wideness of angle and penetrating power are not inconsistent with each other, especially when either are not carried to their extreme limits. However, many opticians construct their lenses with extremely wide angles (140° or 150°). and prompt us to purchase them by expressing their higher prices and resolving qualities. The tyro is prone to think that a £5 of 140° is necessarily superior to a £3 of 70°; whereas its speciality consists in resolving diatoms, and revealing minute surface markings; whilst for physiological investigations it is much inferior to the cheaper objective with lesser angle and more penetration. There are exceptions to this rule, and some gems may now and again be picked up at high prices, which unite in lucky combination that exquisite resolving power with the necessary penetration. I do not think Mr. Herbert will succeed in taking 50° from the angular width of his objective, and giving this 50° to its depth of penetration. He can, however, take off the front lens, and unscrew the next one (half a turn). Then add a small back-stop, and his ¼in. shall have become a ⅛in. of probably fine definition, penetration, and light. Again, Mr. Herbert may take off the front glass of his 1in. objective, and over the remaining glass secure the ¼in. combination. He will now have a high power—a ⅛ or more—and although consisting of eight glasses, like Ross's old objectives, may afford satisfactory results. With such an arrangement I have seen the markings in diatoms far beyond the resolution of my ¼in., and I have observed the protoplasm moving in the hair of a nettle. I would like to know what our learned friends Mr. Lancaster or Mr. Wenham will say to this arrangement.—E. B. Fennessy.

[33001.]—**Marriage Charge.**—This will depend on the way in which the charge in favour of the wife is effected, and the person in whose favour it is made, whether for the wife alone, or for other persons as well. In any event, I must say, however, that it is improbable that such a settlement would contain provisions which would enable the wife to release her charge during her lifetime. But have not the trustees power to sell the land and reinvest the proceeds? Such a power would have been inserted in a well-drawn settlement, I think.—Sperans, Lincoln's Inn.

[33043.]—**L. C. and D. R. Engines.**—The distance from rail to centre line of boiler is 7ft. 2in.—H. L.

[33044.]—**Parrots.**—If "C. O." will procure some "insecticide" and a bellows for applying the same he will, in a short time, have his bird all right. In two months I have got my parrot into good health and perfect feather by the following treatment:—One day I powder the bird thickly with the insecticide (which is perfectly harmless to the bird), and the next wash freely with lukewarm water, putting it where it will dry quickly, and repeat this every alternate day. Avoid hemp seed, and give milk-sop mixed freely with cayenne pepper; a little milk of sulphur occasionally instead of the cayenne, plenty of vegetables, and keep the bird warm. Oil the feet every other day, as they seem to be troubled as much as the body. I have cured small birds affected with the same disorder by the same treatment. On the birds recovering they should be put into fresh cages, as the complaint is infectious. In my opinion the complaint is like the itch, as I have never been able to find any insects on the birds.—F. L.

[33052.]—**Flexible Composition**—For grotesque faces may be made by mixing glue and glycerine in a water bath. A few experiments will determine the proportions.—Americus.

[33054.]—**Sulphuretted Hydrogen.**—Although it is not to be expected that each of our readers has access to a first-rate library, yet surely "Kappa" might have obtained his information from some work on chemistry instead of sending so trivial a query. In reference to the replies given on p. 324, I may mention that Sb_2S_3 will not yield SH_2 by the action of dilute HCl in the cold, and also that the poisonous properties of the gas seem somewhat overrated.—Wm. John Grey.

[33059.]—**Phosphate of Alumina.**—This mineral is called *Wavellite.* It is found in slate and granite, in Devonshire, Cornwall, Ireland, Scotland, Bohemia, Saxony, Greenland, Brazil, and Pennsylvania. The chemical formula is:—$3AlO_3 + 2PO_5 + 12HO$. It is infusible, brittle, transparent, and soluble in acids. The colour is grey, green, yellow, or brown; but it is sometimes colourless.—X. Y. Z.

[33061.]—**Legal Question.—A Hard Case.**—Surely "A Poor Nephew" does not really expect to get any satisfactory answer to his question? If his long and rather rambling statements of as to what he knows and what he is informed do refer to a "hard case," or one in which he has been unfairly treated, it is one that requires careful examination and consideration of details, such as cannot possibly be attained by means of queries in the English Mechanic. At the same time, it requires but little experience to make one very careful in accepting every such a story as really describing a hard case. No doubt "A Poor Nephew" thinks it is such, and very probably his so thinking, entirely apart from his being not fully informed, leads to his telling (with no intention to make any misstatement) a story in which some to him apparently trivial, but in reality very important particulars are omitted. I am afraid that if Mr. Editor admits these long statements of grievances as to family property, he will find a large supply ready to his hand, but will not have the consolation of obtaining satisfactory replies for his correspondents.—Sperans, Lincoln's Inn.

[33062.]—**Zincography.**—I have been away from home or would have answered this query before. If, after having obtained your transfer, you had gummed it up with gum water, "sonsed" with phosphoric or nitric acid, and then carefully washed all the gum off again with clean water, taking care to damp the plate with a sponge before each application of the ink roller, you would not find the ink to adhere to the bare metal. Another cause of failure may have been the imperfect cleaning of the zinc plate from grease before using. Care should be taken not to handle the plate with the fingers, as they have always some grease on them. You ought to have mixed your ink with thin litho varnish, and not olive oil, which is quite unsuitable. A 5 per cent. nitric acid solution is the proper strength for damping tracing: when the tracing paper is laid on the plate it should be pulled through the press twice, damping each time, and using considerable pressure. Its position should now be reversed, and it must be pulled through twice more, damping with water: six pulls will be enough. There is no need to apply turpentine (or, in trade parlance, turps) to your plate unless you want to clean it off; any dirt on the plate can be removed by a scraper, moistening the part scraped with acid to prevent its inking up again. The anastatic process is used for the reproduction of ordinary prints of any description, letter-press, litho, or copper-plate. It is rather different from zincography in working; and if any one would like particulars of it I shall be happy to supply them.—Ernest A. Nuth.

[33066.]—**Legal Question.**—The question asked by "Non Lex" involves the construing of a doubtful clause in a will. To answer it would involve a search into text-books, and very probably into many decided cases, and it could not be undertaken with hopes of a certain opinion without seeing more of the will than is now before me. When it was all done, an anonymous opinion in a paper would be of little practical value to "Non Lex." If the matter is of importance to him, I advise him to lay the case before a solicitor, who will either give him an opinion himself, or advise him to instruct him to take the opinion of counsel on the matter.—Sperans, Lincoln's Inn.

[33068.]—**The Microphone and the Violin.**—In my reply last week I am made to say that "the vibrations would *not* be so strong as to cause the carbons to make and break contact." The "not" is an interpolation. It is well known that intermittent currents of electricity are incapable of conveying the quality of a sound.—Shelford Bidwell.

[33070.]—**Protecting Iron from Nitric Acid.**—The Silicic Paint Co., Buckley, have a powder which resists the action of all acids, except hydrofluoric. If "W. D." can, therefore, find a medium to mix, it will answer his purpose.—Corcyra.

[33077.]—**Zinc of Fuller's Cell.**—I am sorry I cannot recommend anything better to "P.O. Telegraphist" than Chatterton's compound, as the acid does not act on the guttapercha as it does on sealing wax. Guttapercha itself would do very well, dissolved in coal-tar naphtha, and painted on. It is advisable to put as little acid at first to the bichromate of potash as will do the work required, and, when the solution gets weak, add a little at a time.—John Earl Clare.

[33089.]—**Removing Mildew from Paper.**—Thoroughly dry your paper, and you can then rub your mildew off; but it will leave a nasty stain.—A. Smith.

[33090.]—**Arithmetical Rule Wanted.**—Add the circumference described by centre of crank-pin to circumference of driving wheel. The two circumferences added together are equal to the length of curved line described by centre of crank-pin. The curved line would very much resemble an archery bow when unstrung if the driving-wheel made one revolution, starting with the crank-pin at its lowest point.—Factory Lad.

[33091.]—**Telescope.**—With a 2¾ O.-G. you can easily see a shilling at a thousand yards distance—that is, if your O.-G. is even of ordinary goodness. A bullet mark is an indefinite expression, as the bullet may be that of a rifle or a cannon. It is as loose a term as "the time by a church clock at ten miles off," the size of the dial not being mentioned. E. B. F.

[33093.]—**Filling in Letters on Metal Plates.**—If the letters are much worn you cannot do better than paint them in with Brunswick black, and emery. It will set very firm, and the sun hardens instead of softening it, as it does the wax. Of course you must let it get thoroughly hard before cleaning it.—A. Smith.

[33094.]—**Cleaning Bicycles.**—Any rust should first be removed by paraffin, after which Cadby's Preservative will polish without injuring the steel. Directions for use are upon each tin, price 1s.—J. W. S.

[33098.]—**Telemeters or Range-Finders.**—Nolan's and Watkin's are both in use in the Royal Artillery. Major Nolan is bringing out a new range-finder, which will probably prove superior to any at present in use.—Field-Gunner.

[33102.]—**Wire Joints.**—Will find no difficulty in soldering copper wire if the ends are scraped clean with a knife. Scatter on them a little powdered rosin, and solder with a tinman's soldering-iron, which should not be too hot. Solder required is composed of equal parts block tin and lead. Insulate with same material rest of wire is insulated with. If in a dry place, a little silk twisted round will do. The joints are more liable to rot if soldered with acid. This also answers query 33109.—Smeeton.

[33102.]—**Wire Joints.**—The method in use at the G P.O., London, is merely to twist the wires together, and apply a little muriate of zinc, and solder with ordinary soft solder, and insulate them with gutta percha ribbon warmed with a spirit lamp, and carefully pressed and worked with the fingers, which must be perfectly clean.—Jones.

[33102.]—**Wire Joints.**—Ordinary tinman's solder is as useful as any for this purpose. The flux used is made by dissolving zinc in hydrochloric acid until it will dissolve no more, then dilute with about 3 times its bulk of water. The wires, scraped clean, should be slightly twisted together, and moistened with the solution. The solder is best applied by means of a soldering iron (copper), which should be well tinned. This is done by heating it, filing the point clean, wetting it with the above solution, and then rubbing some solder on it. To solder the joint, heat the bit again, and just touch it on the wire; if everything is right the solder from the bit will "flush" all through the twisted wires, forming a very neat joint. For small wires, say above No. 22, a thick piece of copper wire tinned, is handier than the copper bit. Do not attempt to solder very thin wire with a spirit lamp or any other flame, as it is certain to burn the wire, unless carefully used. To insulate, cover one side of a bit of silk with thick shellac varnish, and wind neatly over the joint; once round is sufficient.—J. E. Floyd.

[33104.]—**Bicycle Query.**—Why not have two steps, one on the right-hand side, some 6in. above the other? An ordinary sliding or roller spring could, of course, be fitted, but you would lose the elasticity of the universal spring. You might be able to mount more easily were your step at a more suitable height. In this case send it to the London Bicycle Company, who would fit their patent adjustable step. Dedicoat, of Coventry, also supplies a spring step at about 13s. 6d., which lifts the rider clean into the saddle.—56in. Superb.

[33106.]—**Coal Waggon.**—There is less wear and tear on six than on eight or ten-ton waggons, and they are certainly better with spring buffers, especially with laminated springs under body of waggon, but a six-ton waggon takes as long on a journey as a ten-ton—hence many people prefer the latter. The G.W. and L. and N W. do not provide waggons for coal traffic, but I believe the Midland, G.N., and South Western do.—Draw Bar.

[33114.]—**Electric Bells.**—The electro-magnet is only composed of soft iron, and is only magnetic during the passage of the electricity. See that the wires are perfect.—Smeeton.

[33122.]—**Mineralogy.**—Perhaps the following may to some extent serve "A Would-be Mineralogist:"—*Roselite:* Found at Schneeberg, in Saxony, and appears to be an arseniate of lime, associated with talc. *Euchroite:* Found in the cavities and fissures of micaceous schist at Libethen, in Hungary. Chemical composition, according to Wöhler, black oxide of copper, 48·09; arsenic acid, 33·22; water, 18·39. *Erinite* (from Ireland): Found with oliverite in Ireland, and consists of black oxide of copper, 59·44; arsenic acid, 33·87; argillaceous earth, 1·77; water, 5·01. *Margarite:* Found in Tyrol and other places; consists chiefly of silicic acid, argillaceous earth, lime, and talc. *Fayalite:* Found at Horta and Ponta de Espalamanca, in Fayal, and other parts of the Azores, consists chiefly of silicic acid, proto-oxide of iron, argillaceous earth, and oxide of lead. *Fluellite,* so named by Wollaston, is found with wavellite and uranite in quartz at Stenna-Gwyn, in Cornwall.—A. W. E.

[33122.]—**Mineralogy.**—The following is taken from Nicols' "Elements of Mineralogy":—"*Roselite:* Vitreous, rose-red. Chemical composition, arsenic acid, oxide of cobalt, lime, magnesia, and water. Schneeberg, in Saxony. *Euchroite:* Rhombic, transparent or translucent, vitreous. Emerald or leek-green. Chemical composition, 47 copper protoxide, 34 arsenic acid, and 19 water. Libethen, in Hungary. *Erinite* Emerald or grass-green. Chemical composition, 59·9 copper protoxide, 34·7 arsenic acid, and 5·4 water. Said from Limerick, but probably Cornwall. *Margarite:* Rhombic, translucent, pearly. Chemical composition, 30·1 silica, 51·2 alumina, 11·6 lime, 2—6 soda, 0·5—3 magnesia, and 4·5 water. Sterzing, in Tyrol; Asia Minor and Greece, with emery; and in Pennsylvania. *Minium:* Massive or earthy. Chemical composition, 90·7 lead and 9·3 oxygen. Schlangenberg, in Siberia; Badenweiler, Anglesea, Grassington Moor, and Weirdale, in Yorks. *Fayalite:* Chemical composition, 29·4 silica, 70·6 iron protoxide, and 2—8 manganese protoxide. Fayal and Mourne mountains. *Fluellite* consists essentially of fluorine and aluminium. Stenna Gwyn, in Cornwall."—Henricus.

[33123.]—**Brown Coal.**—Brown coal differs from common coal in many ways—its colour is different, it is not so hard or brittle; it is occasionally used for fuel, but gives out an unpleasant odour; it is a hale, occurring largely at Kimmeridge, re, in the beds known as the Kimmeridge ng to the oolitic formation. It is largely with iron, and burns with a brisk . Fuller particulars will be found in Geology of Weymouth and its Neigh- —56IN. SUPERB.

Brown Coal.—There are a number of is material, which may be classified as bituminous wood; 2, ordinary brown or coal; 4, laminated or paper coal; 5, 6, earthy brown coal; 7, alum coal. nsist generally of carbon, oxygen, and varying proportions. Analysis of No. 1 ar Cologne, and of No. 2 at Uttweiler, in

... ...	77·100	... 54·970
... ...	19·354	... 26·467
en	2·546	... 4·313
combinations ...	1·000	... 14·250
	100·000	100·000

ight, No. 1 = 0·50—1·4; No. 2 = 1·28; —1·3; No. 4 = 1·1—1·2; No. 5 = 1·2—1·3; —1·7. No. 1 is found at Salzhausen and also in Stiermark; No. 2 is the most all the kinds, and is largely found at in the Rhine valley near Cologne, in Saxony, and Bohemia, in the Paris basin, e, Isle of Wight, London basin, and in . 3 in Hessen, Saxony, Austria, England, and Siberia; No. 4, Saxony, near Bonn, e, in Sicily, France, and Austria; No. ia, Tyrol, in the Rhine valley, in Hessen, , in Ferro, and in Greenland; No. 6, in uringia, near Leipsic, and also in the ood of Cologne; No. 7 in Brandenburg, c, in Bohemia, at Friesdorf, near Bonn, ngary. No. 2 is largely produced near d formed under great pressure through ed nozzles into brickets, and sold to the out 6s. per 1,000, or 9d. per hundredweight y purposes of house-heating, cooking, &c., utes a most excellent fuel. The brickets ½in. long × 3in. broad, and 1 3-16ths of ick, weighing about 12oz. each. The uite glossy, hard, and smooth from the of the tarry matter during the process pression.—A. W. E.

-Eye-Cups for Short Sight.—These ically by increasing the convexity of the t the effect soon passes off, and leaves the e than before. Let me seriously warn spondent against their use.—J. W. S.

-Eye Cups for Short Sight.—With "Blindworm's" first query, I have seen good cures, and I have also seen the The principle of their action is the ordi- apping. They are very simple in construc- you can easly make them yourself. They an ivory or lignum vitæ cup, with a stem hich is attached a stout indiarubber ball, k to it. To make one, proceed as follows: ave a lathe, turn out of some hard wood a as Fig. 1, and let the diameter of the top

C. 2

FIG. 3

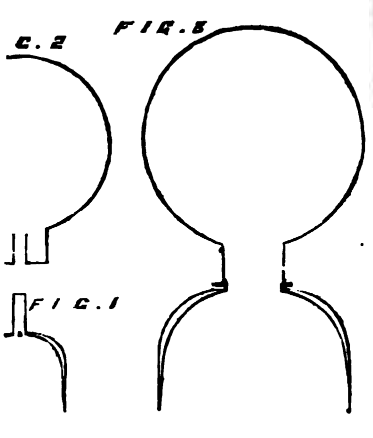


FIG. 1

at it will fit exactly in the hollow of the nd of the cup should have a stem about ½in. ugh the centre of which a hole should be to this attach the indiarubber band—see Fig. 3 represents the eye cup complete. To ress the indiarubber ball gently with the d place the cup over the eye, then release , and the cup will adhere. They should be r about 1min. They are worth a trial, but advice and apply very cautiously.—

—Lightning Conductors.—Any kind of ch is secure is sufficient for a lightning . No insulation of the rod is required. It efficient either inside or outside of the shaft, and should terminate at a point uch above the top of the shaft as is the f the shaft in feet at the top. The connec- rod with the ground is most important. be sunk 4ft. or 5ft. perpendicularly into if possible where the earth is moist. The a drain or a surface gutter is always an . An iron rod or iron tube will be equally efficacious. Iron rod ½in. diameter is a good size, and affords certain security.—E. WHEELER, No. 48, Tollington-road, Holloway, London.

[33133.]—**Bicycling.**—In my reply, read: Wel—well; Hamber—Humber; Cower—Carver.—CAPTAIN V.A.B.C.

[33133.]—**Bicycling.**—1. Yes, but great caution should be exercised before purchasing, or you may get taken in. The best way is to apply to some first-class agents or manufacturers—the London Bicycle Company, for instance—if you do not feel confident of your own powers of perception. 2. Inferior materials throughout, want of care (therefore a saving of time) in fitting, unskilled labour, and omission of parts make a cheap bicycle. Another reason why some towns turn out cheaper articles is that labour is cheaper. I have not heard of the "Mercury;" who makes it? 3. The bearings should be tried with a file to see if they are properly hardened, spokes tried, tires examined carefully, both as to condition, quality, and security, and all other parts tried to see if secure. 4. It is possible to learn on a modern machine, but the steed (and very probably the rider too) wouldn't be worth much afterwards. Get a "boneshaker" with rubber tires, and a pliant spring, and you will soon get on.—56IN. SUPERB.

[33136.]—**Siphon.**—A siphon would not in any way be an advantage to "Reheraf," as the water in one leg would exactly counterbalance that in the other. His fall is very small. I should advise him, therefore, to have the hole in his fountain nozzle no larger than that required for an ordinary pin to slip into.—A. A. WATKINS.

[33137.]—**Glass Reeds for Harmonium.**—Suppose toughened glass could be made into reeds for harmoniums, how could they be tuned? Any abrasion of the surface would cause them to fly. Besides, glass is not sufficiently elastic.—HENRI ÉTIENNE.

[33141.]—**Mathematical.**—The labour in this question may be reduced by the following abbreviations:—Put $a + b = s$ and $a - b = d$

$$b + c = s' \qquad b - c = d'$$
$$c + a = s'' \qquad c - a = d''$$

then the three equations become—

$$\frac{x}{s'} + \frac{y}{d''} = s \quad (1)$$
$$\frac{y}{s''} + \frac{z}{d} = s' \quad (2)$$
$$\frac{z}{s} + \frac{x}{d'} = s'' \quad (3)$$

From (1) and (3) we get—

$$\frac{x}{s'd'} + \frac{y}{d'd''} = \frac{s}{d'}$$
$$\frac{x}{s'd'} + \frac{z}{ss'} = \frac{s''}{s'}.$$
$$\frac{y}{d'd''} - \frac{z}{ss'} = \frac{s}{d'} - \frac{s''}{s'} \text{ by subtracting}$$
$$\frac{y}{d'd''s''} - \frac{z}{ss's''} = \frac{s}{d's''} - \frac{1}{s'} \text{ dividing by } s'',$$
$$\frac{y}{d'd''s''} + \frac{z}{dd'd''} = \frac{s'}{d'd''} \text{ dividing (2) by } d'd''.$$
$$\frac{z}{ss's''} + \frac{z}{dd'd''} = \frac{s'}{d'd''} + \frac{1}{s'} - \frac{s}{d's''}$$

by subtracting, whence

$$z = \frac{sd\,(d'd''s'' + s'^2s'' - ss'd'')}{ss's'' + dd'd''}$$
$$\left.\begin{aligned} y &= \frac{s''d''\,(s'dd' + s^2s' - ss''d')}{ss's'' + dd'd''} \\ x &= \frac{s'd'\,(ss''^2 + sdd'' - s's''d)}{ss's'' + dd'd''} \end{aligned}\right\} \text{substituting for } z \text{ in (2) and (3)}$$

Substituting the values of s and d the expressions expand to a length quite unsuitable for your columns, but it will be found that the quantities within the brackets are each equal to the denominator, and the answer is:—

$$x = b^2 - c^2$$
$$y = c^2 - a^2$$
$$z = a^2 - b^2$$

—L. SMITH.

[33141.]—**Mathematical.**—Expanding the two first squares, the first expression becomes:—

$$4 + \frac{a^2}{b^2} + \frac{b^2}{a^2} + \frac{b^2}{c^2} + \frac{c^2}{b^2} + \left(\frac{c}{a} + \frac{a}{c}\right)^2 \quad (1);$$

multiplying the two first factors, the second expression becomes:—

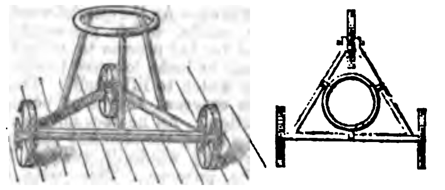
$$\left(\frac{a}{c} + \frac{c}{a} + \frac{b^2}{ac} + \frac{ac}{b^2}\right)\left(\frac{a}{c} + \frac{c}{a}\right)$$
$$= \left(\frac{a}{c} + \frac{c}{a}\right)^2 + \frac{b^2}{c^2} + \frac{a^2}{b^2} + \frac{b^2}{a^2} + \frac{c^2}{b^2}. \quad (2.)$$

Subtracting (2) from (1) we get (1) − (2) = 4.—L. SMITH.

[33147.]—**Patent Leather.**—Burnt umber, 8oz.; true asphaltum, 3 or 4oz.; boiled linseed oil, 1 gall. Grind the umber with a little of the oil, add it to the asphaltum—previously dissolved in a small quantity of the oil by heat—mix, add the remainder of the oil; boil, cool, and thin with a sufficient quantity of oil of turpentine.—AMERICUS.

[33154.]—**Harmonium Reeds.**—Estève's are the best reeds that "J. F." can get. The broad give more volume, the bent reduce the harshness; but quickness of speech depends on the tuner.—HENRI ETIENNE.

[33153.]—**Hobby-Horse for Crippled Child.**—I hope the sketch I send may be of some use to "Distress." The frame should be made light, so as to be easily moved, and the little fellow will be further provoked to attempt standing, as he shall require to lift it and change the direction. The ring must be nicely padded, so that it embraces the waist and chest, and prevents the child slipping through.—E. B. F.



[33155.]—**Bicycle Brake Cord.**—Gut covered with copper wire is good, millband brake cord is better; "Lion" leather, or the "Challenge" brake strap is best, sold by Singer and Co., Coventry. Better than all, have a brake on front wheel, and do away with the cord entirely. Very good preparations for preventing bright parts from rusting may be obtained from Denne and Co., Sittingbourne, Kent, and Williams, chemist, Paradise-street, Coventry. If these are objected to, take care to keep well oiled at all times by rubbing over with a rag saturated with oil.—56IN. SUPERB.

[33155.]—**Bicycle Brake Cord.**—Catgut, covered with copper wire, is very durable.—HENRICUS.

[33156.]—**Cupola.**—If you look through Iron and Steel Institution *Journals* in one of the earlier numbers you will find a discussion on melting pig iron for mechanical puddling, and, I believe, the information you require about cupola. As to "blowers" for a large plant I should strongly advise putting down a small blast engine (inverted vertical type) similar to those general in Cleveland blast-furnace plants—only of course much smaller. This would be more reliable and less troublesome in every way. Fuel economy is due, in great part, to continuous working, I imagine, but in large foundries systematising the working details, weighing carefully in and out, and keeping accurate accounts, have a decidedly good effect. I am told few concerns are more thoroughly well managed than that of Messrs. Abbott and Co.'s, Gateshead-on-Tyne, and I believe they make a *working* average of under 2½cwt. of coke per ton of castings. Although less than 200lb. is *claimed* to be worked to by many, I think it would be difficult to prove over a year's commercial working. If desired, blast ought to be readily heated by a small blast oven or system of pipes exposed to the escaping products of combustion of the cupola itself.—F. W. S.

[33162.]—**Soap Bubbles.**—Make a strong solution of Castile soap, and add one-fourth of glycerine. This will make up a capital solution. The exact thickness of solution may be easily obtained by blowing a bubble occasionally, and adding either water or soap solution. The bubble should rebound from the arm once or twice before bursting.—W. J. LANCASTER.

[33163.]—**Works on Chemistry.**—Fresenius's "Qualitative and Quantitative Analysis" will be good books to work with, also Valentin's "Miller's Inorganic" (large Vol. II.), and, if you can get them, the journals of the Chemical Society.—W. J. LANCASTER.

[33169.]—**Renewing Grenet Cells.**—I should strongly recommend you to convert the Grenet's into Léclanché's. The Grenet cell is not a good one, and besides is troublesome when out of order. Take them to pieces, remove the bags, and make new ones about the same size, well wash the carbon, and gently wash the peroxide of manganese, then put them into bag, and place in jar, clean the zinc plug, amalgamate it, and put in cell, then put in charge of salt and water, and seal top over as before. As cement you may use common sealing-wax dissolved in spirits of wine.—W. J. LANCASTER.

[33173.]—**Electricity.**—20 or 30 cell Stohre's would be most useful in cases of acute rheumatism, but I cannot tell you how to apply it unless you again write, stating the part of body affected. Let me have this information as soon as possible, and I will tell you how to make and use the battery.—W. J. LANCASTER.

[33179.]—**Phonograph.**—The length of the cylinder need not be limited to 4½in. The point may be made to traverse the indented tinfoil from 10 to 20 times without much deterioration. Since the pull of the spring is counterbalanced by the tension of the silk thread a very small force is sufficient to move the point through a short distance. It is advantageous to have the spring much stronger than one might at first sight imagine desirable.—SHELFORD BIDWELL.

[33179.]—**Phonograph.**—The cylinder may be any length, but the most useful length is about 4½in. If you have a brass cylinder you may have 20 threads to the inch, and at the rate of one revolution per second you will have sufficient for a speed of 1½ minute. Of course, when once used the tinfoil is useless.—W. J. LANCASTER.

[33183.]—**Purifying Nitrate of Potash.**—The best way is by repeated crystallisation from hot saturated solution.—F. W. Woodman.

[33183.]—**Purifying Nitrate of Potash.**—It may be purified by redissolving and crystallising several times.—Albert Smith.

[33184.]—**Raising Water.**—As the querist wants to effect this without waste, which presumably means loss of water, and for the process to be self-acting, it would seem that he looks forward to some mode of persuading the water to lift itself. That cannot be done. Some external source of power must be brought into action. As he does not want to pump the water up by hand, the simplest plan he can adopt is to set up a small windmill, such as is frequently used for the purpose. This, with a suitable pump, will continue raising a small stream of water whenever there is wind, and by using an elevated cistern of suitable size the required supply can be maintained, allowing the extra quantity lifted to run back again to the lower cistern, or by means of a ball cock arrangement disconnecting the pump if desired.—Sigma.

[33189.]—**Luther's Chorales.**—One of the best, if not the best, collections of Lutheran chorales is "Natorp-Rinct's Choralbuch fur Evangelische Kirchen," published by G. D. Bädeter, Essen, 1870. It contains 269 chorales, most beautifully harmonised, and as used in the Lutheran Church. In addition to this work, the same publisher has issued a companion book of preludes, entitled, "Ch. H. Rinct's Präludien." Both works are oblong quarto, well printed, and inexpensive. I think these are just what Mr. George Bell requires.—G. A. Audsley.

[33190.]—**Picallili.**—If "Hannah" will pour off the vinegar from the pickles, and add a small quantity of flour to it, and then boil it, she will obtain the permanent consistence desired.—Acidum Aceticum.

[33193.]—**Iron Pianoforte.**—The soundboard is screwed from the back, but as there is first glued next it a slip of hard wood, 1in. by ¼in. thick, this forms a sufficient hold for the tap of the screw, the more especially as the pressure exercised by the strings helps to keep it in place. I find it, indeed, a good plan to remove the greater number of these screws after the strings are on, as not only are they no longer required, but are apt to cause a jar, as they get loose when the pressure comes on. Under the hard wood slip must be put a slip of felt or very thick and firm baize, these together raising the soundboard about ½in. above the level of the iron back, and at the same time forming a perfect insulation. Great care must be taken that the soundboard in no part touches the iron, as contact would result in a harsh unpleasant tone, to say the least. To this end it is advisable to leave a space of ⅛in. all round. A bedding of glue here would be worse than useless, but a mixture of glue and whiting is requisite for the wrest plank and linings. In reply to the question as to the effects of a "reverberating soundboard," I may say that claimed is a greater sympathy with the strings, and a more sustained vibration, but as it requires among other things great nicety in its manufacture, I am afraid from Mr. Hardisty's description of his tools, that he would not be very successful. I will, therefore, describe one that will probably be quite as efficacious and much easier to make. It is known that a thin soundboard, with light traverse bars is considerably more sensitive than one of heavier make, but as these bars are depended on as an element of resistance to the down bearing of the strings, it would be dangerous to attempt this unless the pressure were counteracted in some other way. This can be effected by placing strings at the back of the wrest plank, having a bearing behind the lower bridges. These will not only insure the soundboard against undue yielding, but place it under such conditions that an immediate response is made to the slightest sound, and in connection with the iron bars of the back greatly reinforce and sustain the vibration of the strings proper.—W. H. Davies.

[33195,]—**Dying Intestate.**—1. Letters of admini tration should be taken out by the widow. 2. The widow is entitled to one-third of her husband's property for her own use, and the remainder belongs to their child. She may do whatever she pleases with her third; but the application of the daughter's two-thirds in the ways mentioned would not, I think, be proper. 3. The deceased's father and brothers have no claim to the property. 4. Nor are they in any way legally liable to support the daughter under any circumstances.—Sperans, Lincoln's Inn.

[33196.]—**Bar Magnet.**—When a 5in. magnet of ¾in. steel will pick up 1¼oz. of iron you may safely assume it to be saturated. Practically, you cannot determine when a magnet is saturated, and often the magnet is in a condition of over saturation, and loses power on keeping.—W. J. Lancaster.

[33200.]—**Legal.**—The information possessed by "R. O." seems to be of the vaguest description. I advise him to make further inquiries amongst those people by whom "the Court of Chancery is said to have advertised," and to try and find one of the advertisements, and this will probably give him the information he wants. Any other search is rather liable to be like hunting for a needle in a bottle of hay. Such of A. B.'s property as consisted of real estate would go to his heir-at-law, and the remainder, in certain shares, to his next of kin at his death.—Sperans, Lincoln's Inn.

[33204.]—**The Phonograph.**—Tearing of the tinfoil may result from three causes: either the foil is too thin, or the point is screwed up too tight, or the point is too sharp. The end of the point should be well polished. A polished ruby point, as recommended by Mr. Lancaster this week, would undoubtedly be better than steel—it would run more smoothly and last longer. If you wish to prevent tearing the foil by pressing against the mouthpiece it would be easy to have a stop, regulated by a screw, against which the frame of the diaphragm might rest. I had one at first, but I gave it up because I found it advantageous to be able to vary the pressure, without trouble, according to circumstances. Thus, a woman's voice requires less pressure than a man's; laughter, cheering, &c., come out best, when the furrow is rather deep. Changes of temperature also seem to affect the adjustment. After all, it is quite unnecessary to touch the mouthpiece when you are speaking. The paper diaphragm, if properly constructed, will give far better results than the iron one. Try again.—Shelford Bidwell.

[33206.]—**Electric Light.**—The two carbons, being of course in opposite polar states, have an attraction for each other, and would therefore have a small tendency to approach each other if perfectly free to move. The quantity of carbon transferred is variable, and I do not know of any exact measurements of its ratio to the total loss; some, of course, is burnt, and some dissipated in powder, and probably in vapour.—Sigma.

[33207.]—**Capital Investment.**—For such cases as that put by the querist a well-managed building society would probably be the best mode of employing savings. I do not think they are good sources for borrowing money, except in those cases in which it would be difficult to obtain it by other means, and where by this means a small payment in addition to rent by degrees purchases a house. But just because the interest paid by borrowers is high and the security generally very ample they give a good and safe return to that portion of the subscribers who do not desire to take up a loan. They have also the advantage of providing an investment for small periodical savings, provided only shares are taken on which it is probable the payments can be maintained, and that additional savings are kept in reserve in a savings bank ready to meet such occasions as might interfere at times with the required regularity of payment.—Sigma.

[33208.]—**Dynamo-Electric Machine.**—I will send drawing and description of a simple machine in the course of a few weeks. Just now I am too busy to give all the details I would wish.—W. J. Lancaster.

[33211.]—**The Phonograph.**—See my reply to "Stultus" (33096, p. 350). I suspect that the main reason why perfect silence resulted from your attempt was that you screwed up the second point till it pressed "firmly" at the bottom of the furrow. My words were "lightly but steadily." The point should barely touch the bottom of the deepest indentations. Perhaps, also, you screwed up the first point too tight. The furrow should be well defined, but not deep. Mr. Lancaster mentions 1-50in. as the proper depth: I should think that is about right, but have no means of measuring exactly. Do not be satisfied with a diaphragm which has a bulge in it; it will never work properly, and you can make another in five minutes. If you have any difficulty in making the paper diaphragm sufficiently tight strain it over the end of the "spout" (first wetting it), and keep it in its place by a tightly-fitting band of brass or tin ¼in. wide. I have lately adopted this plan; not, however, because I find it any better than the other, but simply that I may be able to remove the diaphragm more easily for experimental purposes. If, after carrying out these suggestions, you still fail, try a weaker spring. Clock springs of the same size may vary considerably in power.—Shelford Bidwell.

[33212.]—**Prussiate of Potash.**—1. There are two so-called prussiates of potash—the red, or potassium *ferri*cyanide, and the yellow, potassium *ferro*cyanide—the symbols of which are, respectively, $K_3FeC_6N_6$ and $K_4FeC_6N_6$. 2. $K_4FeC_6N_6$ is made by first calcining animal matter rich in nitrogen—as horn clippings, feathers, &c.—with caustic potash and scrap iron; the $K_4Fe(CN)_6$ is then crystallised. $K_3FeC_6N_6$ is made from solution of $K_4FeC_6N_6$ by passing Cl, $Cl_2 + 2K_4FeC_6N_6 = 2KCl + 2K_3FeC_6N_6$, and crystallising. 3. This I must leave to an analyst.—F. W. Woodman.

[33212.]—**Prussiate of Potash.**—When a solution of cyanide of potassium is mixed with some iron filings at a moderate degree of heat the iron gradually disappears, and oxygen is absorbed from the air, and the solution contains ferrocyanide of potassium and potash 3KCy and Fe with O = KO, and 2KFe3Cy. The solution should be evaporated, and crystals of the salt will be deposited, and leave potash in solution. It is sometimes prepared by fusing dry animal matter with carbonate of potash and iron filings in an iron pot; it is afterwards mixed with water, and the ferrocyanide crystallised from the solution. The yellow prussiate of commerce is somewhat contaminated by sulphate of potassium, the presence of which may be detected in the following manner: Dissolve some of the salt in some distilled water, and add some chloride of barium, a white precipitate of sulphate of barium will take place. If sulphate of potassium is present the sulphate of barium should be well washed upon dried, ignited, and weighed. 116·6 grains phate of barium correspond to about 87·0 g sulphate of potassium.—Albert Smith.

[33215.]—**Arsenic in Violet Powder.**- Sirch possesses a microscope it will greatly in the analysis of his violet powder. First some of the powder over a glass slide, wit water, and examine with a ¼in. If the st covered with little crystals it should be examine following manner: A small quantity of the should be mixed with water and acidulate pure hydrochloric acid, and boiled in a fla some bright strips of metallic copper for abo minutes, when, if arsenious acid is present, crust of metallic arsenic will have been depose the copper; the copper should then be drie placed in a dry test tube and gently heated, minute crystals will condense round the cool the tube. The powder should be tested for s of lime, the violet powder should be burnt to a ash, and then dissolved in hydrochloric acid, brisk effervescence will take place; some d water should be added, and the lime thrown d oxalate of ammonia, and the sulphuric acid by of barium.—Albert Smith.

[33215.]—**Arsenic in Violet Powder.**— is easily tested for by those accustomed to chem but is troublesome to others. The simplest to put the powder in a filter of blotting pap taper funnel and wash it with boiling water. dissolves arsenic, and deposits it on cooling some starch might go through and mislead. white deposit forms it should be dried, mixed little powdered charcoal, put in a long thin tes and heated in a gas flame; arsenic will sublime form a black shining ring in the upper part o tube. The adulteration is hardly likely to fin way into the market again, however.—Sigma.

[33225.]—**Halse's Galvanic Battery.**— special feature of this is in the connections w give a double circuit to the battery current, so the action on the body is that of a continual cur from the 12 cells with the induced current from coil accompanying it. The coil itself is a very r and simple matter, composed of a single wir No. 20, cotton covered, and it is less than half apparent length of the coil. The regulator wor screw, which moves the core in and out of the and the remaining length of the coil, as it app is simply a space for this purpose. All the o parts of the apparatus are just the same as in o medical coils, and the same principles of actio be applied to any convenient form of construc There are two different lengths of wire which a used, terminals being provided as usual to t either half or the whole length of wire int circuit.—Sigma.

UNANSWERED QUERIES

The numbers and titles of queries which remain u swered for five weeks are inserted in this list, and i unanswered are repeated four weeks afterwards. We our readers will look over the list, and send what inform they can for the benefit of their fellow-contributors.

Since our last "Os" has replied to 32300, 32316, 32799, 32810, 32841; "E. L. P.," 32789.

32608. L. and N. W. "Bloomer" Engines, p. 127.
32609. L. and N. W. Cornwall, 127.
32610. G. E. 7ft. Engine, 127.
32614. Sailing Boat, 127.
32616. Agricultural Chemistry, 127.
32622. Ship Measurement, 127.
32627. Spoiled Brass Bedstead, 127.
32628. Butter Cleaning and Remaking, 127.
32633. Making Range Boiler, 127.
32634. Regulating Gas Meters, 127.
32641. Sizing, 127.
32646. Matt Sizing, 128.
32657. Civil Service Examination, 128.
32664. Artificer, 128.

32871. Reed Organ Pipes, p. 226.
32872. Making Steel Rifle Barrels, 226.
32873. Flue for Brickyard, 226.
32884. Water Engines for Organ Blowing, 226.
32887. Heat Regulator, 226.
32907. Attaching Red Rubber to Iron and Ebonite,

QUERIES.

[33227.]—**Green Pavement.**—Can any one tell simple way to remove the green colour from pave sets in my back yard? I suppose it is a kind of fine which grows upon the stones after being mois Smeaton.

[33228.]—**Adulterated Carbonate of Lea** Can any chemical correspondent inform me the best to detect the adulteration of carbonate of lead with or barytes?—J. M.

[33229.]—**Cobalt Oxide.**—Will any of your re tell me the difference between black oxide of cobalt prepared oxide of cobalt?—Cobalt.

[33230.]—**Phonograph.**—To Mr. Shelford well.—I made a phonograph some time ago, but not been able to get it to work satisfactorily. I can use one diaphragm at a time, as the stand is not enough to admit of another diaphragm the other sid the cylinder, unless I take off the receiving diaph fter it has been spoken into, and put the transmitter in s place. But I found a great difficulty in placing the oint of the transmitter exactly in the groove, and so dis- ensed with the ferrotype plate. The following are the easurements of the instrument—cylinder 4in. long, 4in. ameter, with square cut grooves, 1-20in. wide and 1-20in. p, made of lignum vitæ, and its brass spindle runs y accurately in screwed bearings. Diaphragm 2¾ dia., egetable parchment, stretched very tightly. The ng to which point is fixed is 2½in. × 3-10in., and ped between two pieces of indiarubber, leaving a r 2 inches. The point is not quite perpendicular to ng, but points slightly upwards, making an angle of t 80° with spring, and is a little sharper than a wool- le. On reverse side of spring, opposite to the point, is all lump of sealing wax, which presses against the hragm. The point is ¼in. above centre of cylinder. I thin sheet lead about one foot to the ounce, and the stations are very plain when I speak to the instru- t, but when I try to reproduce the sound all I can get squeak, like a slate pencil scratching. The diaphragm justed in the way you recommend. I shall be much ed if you will give me some hints by which I can s it work, as I do not want to give it up, having got so —Hesper.

231.]—**Bagpipes.**—I have a set of bagpipes I pre- e to be those called union pipes. There are five pipes; of them have four keys each, the third has a double s bend at the body part, and another single bend at top, ending in the flat ivory disc; the fourth is a plain e with an adjusting movement, I suppose for tuning. is ends in an ivory top with a small hole in it; the fifth a small pipe, with an adjustment, top lost. Can any of ours" give any information about this instrument, here to get the drones, how to place them, how the keys e played, &c.? In the part to which the bag is attached here is a small hole ¼in. diameter, with a plug in it. What s the use of it? Have been to many music shops but n get no information. The chanter has eight holes and ee keys, the bottom missing. What shape was it? What is a practising reed?—Old Oboe.

[33232.]—**Boot and Shoe Making.**—Wanted the tle and other particulars of any books relating to the ove, suitable for a beginner, or containing general in- rmation on the subject.—B. W. W.

[33233.]—**Cooking by Gas.**—During the summer nths I am desirous of superseding the ordinary kitchen ge by the introduction of an apparatus for cooking by s, but before trying the experiment which, I believe, ay turn out a comfort or the reverse, according to the nd of stove used, I would fain obtain the result of your aders' experience on the matter. Some of the stoves I ve seen are arranged so that the gas jets are above the at to be cooked, the heat being reflected, whilst others ve the jet below; some have boilers, some have not, ich, say the makers of those without, are liable to be nt through if not kept supplied; others, again, are d with fire clay, enamel tiles, or planished tin for nomising and radiating the heat, though I have an that the planished tin would not remain planished under the great heat required. On this and other ters your readers having experience will be able to se me, and others who believe in the greater comfort, omy, and cleanliness of cooking by gas. I may add the stove would be required to cook for nine persons. astronomy.

234.]—**Flute.**—Having become a tolerably profi- player on a flute of the old make, I am desirous of uring a better instrument. Will any experienced r help me in my choice by giving me his opinion on ollowing matters? I hear much of the Boehm flute, good deal of those manufactured by Carte, and of Siccama;" also I have been told that those made of te are preferable to either metal or wooden ones. In ree forms of flute I have named does the fingering from the old make of instrument?—J. Colling.

235.]—**Telegraphic Engineers.**—Will any one n me what are the necessary qualifications of a aphic engineer, and in what manner they may be ed?—G. S. Lee.

236.]—**Slide Rule.**—Would some one kindly ex- to me the meaning and use of the lines and figures e rules marked "Routledge, Bolton?" One part has are cylinder globe over various figures and names of s, &c., and can the lines marked C and D be used to e cubic contents of round timber?—Cotswold.

237.]—**Gas and Formula.**—Will some of your spondents kindly explain and show the method of g the value of the following formulæ, arithmetically, the per cent. of each, and how, by their specific ies, to obtain their respective weights? Formulæ: CO_2, CO and H_2S.—T. G. H.

238.]—**Observatory for Reflector.**—My re- , 8½in., is equatorially mounted on a strong timber on stand. I want to use it in an adjoining field; lescope I might carry backwards and forwards, but tand must have some proper protection from the er. My idea is to make a shelter something like a dog kennel, the roof to lift off, and the sides, which hook or bolt to one another, on being loosened to o lifted away. Have any of my brother amateurs such a plan, or can they suggest a better, which, protecting the stand, would not be nearly so ex- e as to build an observatory sufficiently large to inside?—B. O. S.

239.]—**Burnt Sugar in Coffee.**—To Mr. Allen. v can I detect chicory, burnt sugar, or mochard in fusion of coffee without the use of the microscope— a chemically?—One in a Fog.

240.]—**Colouring Solution of Clear Gela-** —Will a solution of bichromate of potash colour a on of clear gelatine? If so, how can I get a clear ble—in water—preparation of gelatine?—Americus.

241.]—**Glycerine in Beer.**—Would Mr. Allen state how I can detect glycerine in beer, glycerine ay, and traces of glycerine in drinking water, and n I detect the presence of adulteration in tea dust, so in the infusion of tea?—A Very Old Subscriber.

242.]—**Right Ascension, &c.**—Would . A. S.," or any other reader, kindly work the ing by examples? Having given R.A. and Dec. of ject to find its latitude and longitude, and vice mentioning at the same time whether the formula be the same when the object is between the ecliptic and the equator as when otherwise. Also having given R.A. and Dec. of two objects to find their angular distance, both when the declinations have the same sign and different.—Minn.

[33243.]—**Silverlike Polish on Brass.**—Will any of your correspondents tell me how to make the solution to produce the above appearance on brass and the probable cost? I allude to some liquid that is simply rubbed on with a cloth.—Nomdeplume.

[33244.]—**Ice Cream.**—Will any of your correspondents give me the full particulars how to make ice cream, both white and red?—G. W. Brand.

[33245.]—**Fancy Walking Sticks.**—Can some kind reader tell me how to polish the above to make them look a nice jet black colour or a dark brown?—A Novice.

[33246.]—**Chemical.**—Can any one inform me (*a*) what is the equation for the action between SiO_2, CaF_2, and SO_2Ho_2; (*b*) name of compound radical having symbol Fe_2o^6, and oblige—F. W. Woodman.

[33247.]—**Alum in Bread.**—To Mr. Allen.—One baker lately has been sending us bread that I think contains alum, and having heard of your great experience in detecting alum in bread as evinced by the great Selby flour case, I have taken the liberty of asking you if you would kindly tell me how to detect the alum in bread, not alumina. I know the logwood test: don't give that.—Cameron, Highbury.

[33248.]—**White Rats.**—"Jumper" would like for some one to tell her what food, &c., is suitable for the above tame rats, and the way in which they should be looked after. At present she feeds them on milk and bread, similar to a cat, with hay in the small box in which they are kept. Please tell me of anything better and oblige—Jumper.

[33249.] — **Lancaster's Microphone.** — In this most sensitive arrangement, described and figured on page 314 of E. M., I would like to ask Mr. Lancaster or "Wiseaf" if there is an actual necessity for using the telephone with it; would it not answer to have simply two microphones? Might we not send the message by speaking over the sounding-board of one and listening over the sound-board of the other, and *vice versâ*?—E. B. F.

[33250.]—**High Pressure Horizontal Engine.**—We have a high pressure horizontal engine that is much too large for its work. The cylinder is 20in. diameter, 2ft. 6in. stroke, making 57 revolutions per minute, working at about 15 indicated horse-power, and consuming about 16lb. of coal per horse-power per hour. Would it answer to case the cylinder inside to, say, 14in. bore?—H. L.

[33251.]—**Parallel Motion.**—Would some correspondent inform me the best mode of trueing the parallel motien of beam engines?—A Fitter's Apprentice.

[33252.]—**Induction Coil.**—I should be glad of a competent opinion on a coil I have just made. It consists of a core 7in. long by 1in. diameter, made of soft iron wires, two layers of No. 18 silk-covered primary wire, and 10oz. of No. 36 silk-covered secondary wire. The latter is wound in 20 layers, insulated with paper strips. When wound, the coil was baked, and soaked in melted paraffin for half an hour. The outer layer of secondary is about 4in. long and 2½in. diameter. The condenser consists of about 50 sheets of tinfoil, 5in. by 4in., insulated with paraffined paper. With one Bunsen's cell, 4½in. high, the coil gives a spark 5-16th of an inch in length; and with a battery of 4 cells, varying in size from 4½in. to 7in., a spark 9-16th of an inch is obtained. Sparks of this length, however, do not pass at each break of the primary circuit, but only occasionally. I notice that sparks can be drawn with the knuckle, from one secondary terminal, and only that one, no matter which way the primary current is passing. Does this betoken any defect in the insulation of the other terminal?—J. E. Floyd.

[33253.]—**Mechanical Bat.**—Will some correspondent give me instructions how to make the above? It is a kind of flying machine with a motion similar to the living bat.—Ellesmere.

[33254.]—**Electricity.**—I want to platinise a carbon block. How can I do it? Also I have two telephone magnets requiring to be magnetised. How can I do it?—D. S.

[33255.] — **Electroplating Birds' Feathers.** — Would some of "ours" kindly let me know how this is done, as I have seen one in the possession of a lady friend of mine, and it looks exceedingly beautiful.—D. S.

[33256.]—**Photographic.**—Would some of "ours" let me know by what means I could obtain prints of ferns, &c., so that I may have a jet black, and the fern standing out white?—D. S.

[33257.]—**Diaphragms in Telescope Tubes.**—In several of the replies which have recently been given in your columns to inquiries respecting the use of diaphragms in telescope tubes, instructions have been given to place them in such a manner that an eye placed in the focus of the O.G. may just be able to see its entire surface, but nothing beyond this. It appears to me that as the field of view of the eyepiece, especially with low powers, possesses considerable breadth, this should be taken into account, as otherwise only the centre of the field would receive the full benefit of illumination from the entire aperture of the O.G. As I am about adapting a set of diaphragms to a 6ft. tube, I should be much obliged if "F. R. A. S." or Mr. Lancaster would kindly state whether my view is correct, and also advise me whether any advantage in destroying the effect of extraneous light would be obtained by placing a stop in the sliding tube a short distance behind the eyepiece.—Observer.

[33258.]—**Methylic Chloride.**—Will Mr. Clements supplement the information respecting this gas given in a recent number of the English Mechanic (14437) by some further details respecting it? The boiling point is given as – 21°; is this by the Centigrade or Fahrenheit scale? What is the tension of this vapour at this and other temperatures, and what is its capacity for absorbing latent heat? This gas would appear to have been brought before the French Academy as an economical cold-producer (see English Mechanic, Nov. 2, 1877, No. 658, p. 184), and it would be interesting to many of our readers to know more about it as such, especially its commercial value in quantity, whether it is easily liquefied and at what pressure, and whether it would be likely to undergo deterioration by repeated changes of form. Apropos of artificial cold-production—a subject of some importance in view of the Cattle Diseases Bill becoming law—I hear that Professor Frankland has discovered a mode of producing ice in large blocks (presumably by saline solutions and pressure) in less than five minutes, and by a very simple process. Do any of our readers know anything of this discovery?—Handsworth.

[33259.]—**Japanning Stove.**—I have a stove used for japanning purposes, but it does not seem to act nearly so well as it should. It has undergone one or two alterations recently, but whether that has injured it or not I cannot say. Perhaps one of your practical correspondents could give a rough illustration of what they consider the best kind of stove for the purpose, and the best manner of fixing it.—Richard Temple.

[33260.]—**Screw Cutting.**—I should feel greatly obliged if some of our readers would give me a little help on change wheels for screw cutting. I understand the practical working of the lathe, but I am at a loss to finding change wheels. At present I am only able to use single gear, but I am going to make it so that I can use compound gear when I have ascertained the proper quantity of wheels I require and a good rule for finding them, so that I shall be able to cut any number of threads. With the wheels I have got I can only cut a limited quantity of threads—say from 1½ up to 24 threads to the inch. My wheels run as follows:—24, 28, 32, 36, 36, 40, 44, 48, 52, 56, 64, 72, 80, 88, 96. These are the number of threads I can cut to the inch:—1½, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 16, 18, 20, 22, 24.—Albert Latham.

[33261.]—**Crayon Drawings.**—What is the best mode of treatment to prevent these rubbing?—J. I. C.

[33262.]—**To Mr. Alfred H. Allen.**—Will Mr. Allen please answer query No. 32313, addressed to him, on page 636, last volume?—A Grocer.

[33263.]—**L.C. and D.R. Engines.**—Will some one give dimensions of the No. 148 class of tank engines working the trains between Herne Hill and Bromley or Bickley?—E. L. P.

[33264.]—**Centre of Gravity.**—Would "C. E. S.," or another, be kind enough to show me (1) by actual calculation how the centre of gravity may be found in a locomotive engine; (2) how the weights on the driving and trailing wheels are calculated?—Sartor.

[33265.] — **Punching Machine.** — Would some English Mechanic kindly inform me of any automatic feed motion he knows of for punching machines in actual practice? If convenient a sketch as well as details would be acceptable.—Sartor.

[33266.]—**Convertible Investments.**—Why do not the moneyocracy and tradesmen of this country invest their surplus cash in that very safe security—land, but prefer any other investment, even foreign bonds, Egyptian or Chinese, to the inevitable injury of their families in the long run? Is that much-coveted security, land, less convertible (it should not be), or will a banker not lend on it as readily? A reply from any one but a lawyer will oblige—Greenfields.

[33267.]—**Milk, Oh!**—Can any one tell me why the milk that is sent out from a first-class dairy at the West-end cannot be scalded without its turning into a kind of curds and whey? And why, if you fetch the milk yourself, and see it taken out of the can on the counter, it will stand scalding, and not turn into curds and whey? Is it true that there is a compound known in the trade that works a perfect miracle for the production of any quantity of milk if two or three old tin cans are rattled about at the shop door, and then put into a cart and taken to the Great Western Railway Station once or twice a day? I have been told that delicious cream can be made by mixing rape oil, known as olive oil, lime water and glycerine in proportions according to taste. This elegant preparation will stand scalding without turning into a sort of "Dredge's Heal All." What are milkmen to do who are bothered with so many kettle-drum customers who all want cream in their tea? Chemists and druggists kindly sell it ready mixed under the name of lime juice and glycerine, and bald people who think it will make their hair grow pay anything for it in proportion to their faith. There is, I believe, no glycerine in the mixture for external use. Now I really trust that, as I have kept nothing back about cream, some liberal-minded milkman will aid the cause of science by telling us what it is that requires so much knocking about in the old tin cans, and that eventually turns into milk that will not stand scalding if taken to the consumer.—T. Jinks.

[33268.]—**To Oculists.**—A few weeks since I suffered from a severe pain in the left side of the head, the focus of the pain being between the temple and centre of eyebrow. It lasted, without cessation, for about three weeks, and is now nearly gone, but has left an affection of the eye of which the following are the exact symtoms:—Incapability to open eyelid more than half the usual distance, sight very indistinct, every object seems at twice the ordinary distance, and when looking with both eyes simultaneously two distinct images are seen about 3 inches apart. Also when looking at anything perpendicular, such as a window sash, &c., with affected eye only, it seems inclined to an angle of about 60 degrees towards the left side. A bright light affects it very much, causing the eyelid to nearly close. When striving to open eyelid completely a dull aching pain is felt behind the eye. Have usually excellent sight; am 40 years of age; appetite and digestion good; liver slightly out of order; urine has the scent of strong new-made hay. Is there anything serious the matter with eye? Advice thankfully received by—Photo Cymraeg.

[33269.]—**To "F. R. A. S."**—Geometrical drawings are usually shaded to the angle of 45°, both vertical and horizontal. Required the days and hours that such shadow would be naturally correct on a building facing S. and latitude of London.—T. Shore.

[33270.]—**Length of Cylinder.**—The density of compressed air varies inversely as its volume. A cylinder is fitted with a piston, and the pressure inside cylinder is 20lb. on square inch. The piston is forced two inches and the pressure becomes 30lb. on sq. in. Find the length of cylinder.—Hortulanus.

[33271.]—**Leclanche and Other Batteries.**—Will some one say how, in the country, far away from dealers' shops, any batteries could be formed? For instance, I have heard that common flower pots will answer for a porous cell (but their shape is very inconvenient), and a piece of zinc, copper, or carbon could be made or formed, and chemicals might be procured at the druggist's. How then can a battery be made for temporary or other purposes at any time? Again, I have searched back numbers, and although I can find many notes on Léclanché batteries, I cannot find a full description of how to make one complete. Will some one do so kindly? Would it make any difference in a battery if the taper flower pot was put in a (say) preserve jar, or must the sides of porous pot be parallel? It is useless, as "Sigma," told me the other day, to say look in a dealer's window—I am 40 miles from such.—JOHN.

[33272.]—**Diseases and Shoeing of Horses.**—Will any one kindly name a book or two that will be useful to a young shoeing smith, plainly stating the anatomy of the foot and the most approved shoes for the different complaints and lameness that the horse is subject to?—YOUNG FARRIER.

[33273.]—**Defective Lathe.**—The spindle of a small lathe (back geared), with plain brasses, throws the work eccentric; that is, a fixed tool placed to the edge of face plate will scrape one half of the diameter only, no matter how much is turned off from the edge. The spindle and face-plate when put between the centres of another lathe runs true, I am told, but have no other lathe myself to test it. Will any one kindly suggest a remedy?—J. D.

[33274.]—**Telephone.**—I should like to know if this instrument has been used as a means of communication between targets and firing points in rifle shooting, and, if so, particulars as to size of connecting wires, &c., will oblige—WM. JOHN GREY.

[33275.]—**Dispersion of Sound.**—It is known that sound can be refracted; has anything like dispersion been observed?—WM. JOHN GREY.

[33276.]—**Organ Stops.**—I have made one very small organ and intend making another, but I only know the way to make Stopt Diapason and Clarabella pipes. Would one of your readers kindly tell me how to make a wood Lieblich Gedact or Gamba pipe?—A YOUNG BEGINNER.

[33277.]—**Blast Furnace Slag.**—Would Hugh Clements or Alfred Allen inform me how to judge the comparative fusibility of a slag by its analysis? I understand that the oxygen of the silica and oxygen of the bases have to be compared, and should be glad if they would give some example of such a comparison and explain how the fusibility is deduced therefrom; also how to decide whether alumina is a base or an acid in a slag where the silica, alumina, and lime are all largely present (34, 37, 22 respectively). I would also esteem information as to whether there is any rapid rough way of getting at the composition of a slag or an ore sufficiently correct to enable one to steer clear of too infusible mixtures, yet not so accurate as to necessitate delicate and tedious manipulations, impracticable outside a laboratory. —F. W. S.

[33278.]—**Plating.**—Will some of "ours" be good enough to put me in the way of silver plating lead, tin, or Britannia metal? I always fail when attempting these metals, although I can do all hard metals. I treat them as I would brass, &c., but the silver always comes off.—ARMOURER.

[33279.]—**Composition.**—I crave information as to how the composition is made which carvers and gilders use for picture frame corners, &c., or a composition which will have the same properties—viz., a soft elasticity while in preparation for casting or moulding, and a durability —*i.e.*, extreme hardness—when dry. The composition softens when exposed to influence of steam. I am doing a little modelling, and if I could but secure an article as above described, it would greatly aid me in certain cases. —NEMO.

[33280.]—**Straightening Horns.**—Can any readers of the MECHANIC inform me how to soften horns so as to straighten them? I want to make drinking horns of them, such as cows' horns.—AN OLD ENGINEMAN.

[33281.]—**Lathe Castings.**—I am about fitting up a small foot lathe, but cannot procure a set of castings nearer than England or U. States. The cost of importing and duty would amount almost to three times the value of castings. I propose getting a set cast here. I can make my own patterns if some kind reader of ENGLISH MECHANIC would give me the proportions and measurements for a set of castings for a 3in. or 4in. foot lathe. Would like a hollow mandrel, and back geared. Intend to use it for screwing and surfacing.—CANADA.

[33282.]—**Organ Pipes (Wood).**—Will any one kindly tell me what causes, and how to cure, the woolliness of tone? The stoppers seem to fit well, and I can detect no cracks. I cannot persuade the 8ft. stopped to speak their true notes, though I have tried varying the supply of wind by plugging the feet.—G. P. T.

[33283.]—**Scratch-brushing Gilt Articles.**—Will some one please tell me what liquid to use with the scratch-brush in scratch-brushing articles after they are gilt?—J. H. T.

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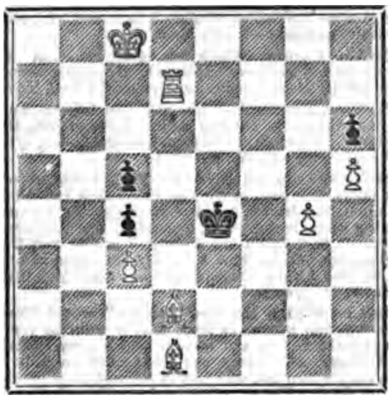
CHESS.

ALL Communications intended for this department must be addressed to J. PIERCE, Copthill House, Bedford.

PROBLEM CCCCXXXI.—BY DR. GOLD.

Black.



White.

White to play and mate in four moves.

SOLUTION TO 428.

White.	*Black.*
1. Kt to Q B 2.	1. Anything.
2. Kt to K Kt 7.	2. Anything.
3. Q mates.	

In 429 there should have been a Black Bishop at Black King's Rook's third. The solution is deferred.

CORRECT SOLUTIONS to 427 by J. J. Amery, Arcanum, and W. J. Jubb; to 428 by J. Dale.

T. DALE AND W. W. C.—See notice above respecting 429.

ARCANUM.—You are quite right about 424.

R. H. MICHELL.—In 424 if 1. $\overline{\text{R} \times \text{Q}}$. 2. P Queen's mating. In 423 if 1. $\overline{\text{Kt to K B 3}}$. 2. Kt mates. Your solution of 427 is incorrect, as if 1. $\overline{\text{P to Q B 5}}$ there is no mate.

WE deeply regret to have to announce the death of Mr. S. Tyrell, the celebrated problem composer of South Australia. Five of his best compositions, selected by himself, appear in "English Chess Problems." These make us wish to see a general collection of his problems published.

Novelty in Yarn.—Mr. Louis Cordonnier has hit upon a singular method of producing a novelty in yarn; this is not surprising when we consider the immense number of varieties of cloth which our neighbours designate as *nouveautés*, and what we term "fancy cloths." After having tried every imaginable way of weaving to produce different effects, there hardly remains anything new but to return to the spinning. Mr. Cordonnier takes a mule, and places upon this another row of rollers, through which, at a different speed, he passes a coloured or plain thread, but twisted in the reverse way of the direction of the yarn to be operated upon. In this way, when the spindles revolve, the two threads are twisted, but the additional yarn is at the same time untwisted; he then takes this doubled yarn, and twists it again with the same or any other yarn, but running it again in the opposite direction, which untwists the first thread, and produces a very singular effect, and one which in the loom will, no doubt, produce a novelty.—*Textile Manufacturer.*

Death of Mr. E. H. Jones.—Every reader of the ENGLISH MECHANIC will regret to learn that the body of Mr. E. H. Jones, of Monmouth, was washed ashore last week at Portakewett, near Bristol. It appears that the deceased started in his canoe from Monmouth on Saturday, 8th inst., about six p.m., for the purpose of visiting some relatives at Bristol. Proceeding down the river Wye, he was observed passing the village of Tintern between eight and nine p.m. From the meagre information at present to hand it would seem that nothing further was seen of him until the discovery of his body at the place above mentioned. The empty canoe was found at Oldbury, near Chepstow, and close to the junction of the Severn and the Wye. Mr. Jones was a member of the Canoe Club, and had previously made successful trips across the channel. He was a much-respected inhabitant of Monmouth, and the news of his melancholy end has cast a deep gloom over the town and neighbourhood. His recent valuable contributions on "Canoes and Canoeing" will be fresh in the mind of every reader. He was at all times ready to give information in connection with his favourite recreation, in the pursuit of which he has met with an untimely death.

ANSWERS TO CORRESPONDE

HINTS TO CORRESPONDENTS.

1. Write on one side of the paper only, and p
ings for illustrations on separate pieces of paper.
titles to queries, and when answering queries
numbers as well as the titles of the queries to w
replies refer. 3. No charge is made for insertin
queries, or replies. 4. Commercial letters, or qu
replies are not inserted. 5. No question asking f
tion or scientific information is answered thr
post. 6. Letters sent to correspondents, under
the Editor, are not forwarded; and the names
spondents are not given to inquirers.

The following are the initials, &c., of letters to
to Tuesday evening, June 18, and unacknowled
where:—
JOHN PARNELL.—M. W. Stevens.—J. H. Love
Browning.—T. Bolton.—H D. G.—W. C. Loc
W. J. Lancaster.—H.—Ne Sutor.—W. Mo
Nimrod.—Hawks.—Lawrence Briant.—Pro Re
F. C. Dennett.—George Bourn.—W. Wilton.-
J. B. Parsons.—G. T. S.—Medical Galvanist.-
triss.—Tha Sha.—H. F.—Underground.—Pere
Mike.—T. Clarke.—Omicron.—R. P. G.—Spee
—F. J. Jackson.—Harold.—Aquarius.—H. G
man.—Amos Newberry.—J. H. C.—Young Sc
—W. Jones.—E. Walker—Read and Mark.—
J. W. S.—A. Frazer.—Gallium.—J. Y.—D'
Senex.—C. A. L.—A Tinman.—A. Coates.—T
Vorticella.—Auditor.—A Reader.—Ignoram
Walker.—W. G. H. A.—H. E. H.—A Tyro in
—Alanda Dignus.—L. L.—Wallasey.—R. P
Dublin.—W. J. C.—T. Mitcheson.—Cl. Sy.—
—Bernard McGuire.—Marx.—W. H.—B. Snoo
AN INVALID. (Directions for making flexible st
given on pp. 265, 294, 345, and 417, Vol.
AMATEUR. (They are not patented, we beli
could probably buy them of any advertiser in
Have you tried Mottershead and Co.?)—J. W.
battery is self-contained in Lancaster's mi
The rest of your queries are probably answe
details given in our last number; if not write
L. L. (We should be glad to publish the photo.
—F. E. SPILLER. (The idea is already fa
medical men, but cannot be employed on quit
extensive scale as you seem to think possible.
(Persevere with your doctor's treatment.
overcome the malady unless the conditions un
you live prevent it. If, for instance, your
damp and draughty, or your work compels ex
wet and rain, your medical man has very unf
circumstances to contend with.)—IRISH SU
(Impossible.)—JASON. (Tests for arsenic in w
were given on pp. 44 and 71 of Vol. XXV.
p. 218 of same vol.)—H. L. (A description of
used in the Westinghouse brake was given o
the present volume.)—DESTRUCTIVE DIST
(Your letter is but a rejoinder, and, as you wi
the controversy, would serve no useful obj
serted.)—R. P. T. (Murray or Baedeker
publish handbooks of the district; inquire th
bookseller.)—C. H. DOMAILLE. (The auth
tainly a quack, and probably a swindler into th
Place proper confidence in your own adviser,
account trust yourself in the hands of unqua
unprincipled people, or you will be sure to
The habit you refer to is only dangerous in
subjects, but should always be avoided if p
ANGLAIS. (Get "Bradshaw's Guide," pub
Adams and Francis, London. Order thr
bookseller.)—COTSWOLD. (Not of the sligh
—PATIENT. (If you are disinclined to consult
man we are equally averse to prescribing, o
others to prescribe who cannot really know
you are suffering. Your best plan would
advice at some good hospital for chest d
E. G. D. (Professor J. W. Draper, New Yo
sity, New York, U.S.A.)—P. S. L. WHETST
question does not seem to us at all so foolish as
superior wisdom seem to think. The reply
practical man on p. 323 may induce you to ch
opinion.)—FREE LIBRARY. (See p. 317,
No. 300, for an illustration and description
Hughes's type-printing telegraph instrument.
(The idea has been before propounded, an
illustrated one or two proposed methods—n
idea that they might be adopted, but th
bicyclists might discuss the feasibility of suc
aid. The general opinion was adverse, and
was warranted.)—ÆGER. (Your medical
undoubtedly correct, but their treatment is
be beneficial unless aided by efforts of yo
counteract the "strain and worry" of your
occupation. Take up some active pursui
leisure hours, and with temperate living yo
cease to search for symptoms with which
yourself and your friends. Much useful i
on the prevention and cure of indigestion is
in our back vols.)—STEPHEN B. ESSEXTON.
it is all quackery.)—J. L. (No varnish is ap
face of the pictures—the glazed surface is o
rolling; ordinary varnish can be obtained of
in photographic materials. We do not see h
to do what you propose, but you are not ve
If you will say plainly what you want to do,
to assist you or insert your query.)—R. SPE
Yes. 2. We believe the phonograph is
country, but we do not know by whom.)—
(A dentist is the proper person to apply to.)—
(It is impossible to prescribe for headac
seeing and knowing more about the patient t
sider can do. See pp. 235 and 290, Vol. XI
Vol. XVIII.; p. 585, Vol. XVII.; p. 427,
and indices to previous vols.)—J. G. (
inks used for ticket writing will be found
and 481, Vol. XVII.)—FRED. MOORE. (Di
bending amber mouthpieces are given on
XXII.)
ONE COPY, Goldsmith, Glaucis, A Subscriber.—
to back vols.
R. S. S., H. W., A Civil Engineer, David,
queries are advts.
THOS. GEAR, Six and Eightpence, and others h
to queries already similarly answered.

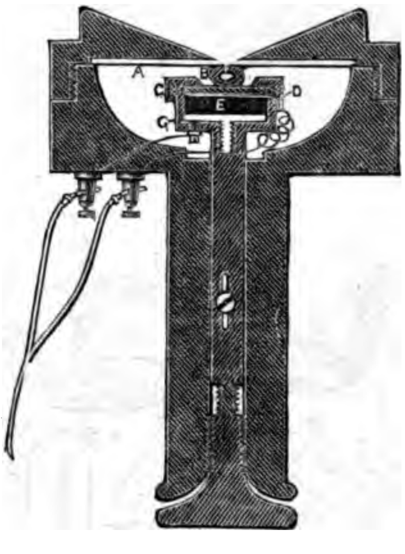
The English Mechanic
AND
WORLD OF SCIENCE AND ART.

FRIDAY, JUNE 28, 1878.

ARTICLES.

WHO INVENTED THE MICROPHONE?

THE question which heads this article is just now engaging the attention of the scientific world, and, if the answer is given with some warmth, we are afraid that Mr. Edison will have only himself to blame. In letters to the New York papers he has not only claimed the discovery of the principle of the microphone, but has supplemented his claim by making a charge of breach of confidence against Mr. W. H. Preece, "the coadjutor of Prof. Hughes in this pretended 'invention.'" We announced some time back—and it was well known in this country—that Mr. Edison had discovered a remarkably rapid change of electrical resistance in plumbago when subjected to pressure. That discovery led to the invention of the carbon telephone, which is shown in the annexed longitudinal section. Instead of a magnet telephone like the Bell, we have here a piece of carbon placed in a galvanic circuit, the vibrations of the diaphragm causing, by pressure, variations in the electrical resistance of the carbon, which result in the production of an undulatory current capable of reproducing in the receiving instrument sonorous vibrations similar to those which were made at the transmitting end of the line. In the engraving we have a holder resembling the ordinary form of Bell's telephone. We have the mouthpiece and the usual "ferrotype" plate or diaphragm of thin iron, A; B is a piece of rubber, resting on an ivory disc, C, beneath which is a plate of platinum, D. The block of compressed or gas carbon is represented by E, and beneath that is a plate of platinum, G, with a screw to attach it to the stem. The latter, it will be seen, can be withdrawn or advanced by means of the screwed endpiece, so as to bring the ivory disc, and consequently the carbon, with more or less force against the diaphragm. We believe this was the original form of the carbon telephone as first described for public information; but we need scarcely say that Mr. Edison made many changes and modifications, and ultimately he dispensed with the rubber and the other materials he had tried, and used a diaphragm so thick that its vibrations were inappreciable. With the recent form of his carbon telephone he has obtained "perfect articulation," and has transmitted with distinctness a whispered conversation. The discovery made by Mr. Edison was, therefore, that carbon under the influence of pressure varied in its electrical resistance. In a letter dated June 6, and presumably after he had read Prof. Hughes's paper, Mr. Edison makes some observations upon an editorial article which appeared in the *New York Tribune*, and disputes the claims advanced by Prof. Hughes to the "invention of the leading features of my carbon telephone, and of my microtasimeter or instrument for the measurement of minute degrees of heat." The phrases used lead to the conclusion that Mr. Edison must have been misled by a carelessly-drawn abstract of Prof. Hughes's paper, for, so far from the latter having laid claim to the discovery of the leading features of the carbon telephone, he went very much further and beyond, by discovering that all conducting substances may be employed with equal success, but that carbon was probably the best, because it is unoxidisable, and is cheap. In his paper (see p. 235) Prof. Hughes expressly states, after enumerating some of the substances with which he had experimented, that the best form and materials for the microphone were unknown, and subsequent investigation has disclosed the fact that many substances at one time considered unsuitable make excellent microphones. The statement that Prof. Hughes claimed the invention of Edison's microtasimeter is not based on anything found in the paper, and we believe the statement that the microphone or a modification could be employed as a very sensitive thermopile was made by one of the audience. Mr. Edison says that the subdivision of the carbon, and its metallisation by plunging it into mercury, were well known to him; and in the memoranda he furnished to Mr. G. B. Prescott—which were printed in the *Journal of the Telegraph* of April 16 last—the expression, "finely-divided metals," occurs, although mercury is not mentioned. In Prof. Hughes's paper he explained what had been done by Edison in the carbon telephone, and then went on to say: "It will be seen, however, that in the experiments made by myself the diaphragm has been altogether discarded, resting as it does upon the changes produced by molecular action, and that the variations in the strengths of the currents flowing are produced simply and solely by the direct effect of the sonorous vibrations." Mr. Edison says that the discarding of the diaphragm is his own invention, and he gives the following extract from a public announcement as proof of the truth of his statement:—"In the latest form of transmitter which Mr. Edison has introduced the vibrating diaphragm is done away with altogether, it having been found that much better results are obtained when a rigid plate of metal is substituted in its place. With the old vibrating diaphragm the articulation produced in the receiver is more or less muffled, owing to slight changes which the vibrating disc occasions in the pressure, and which probably results from tardy dampening of the vibrations after having been once started. In the new arrangement, however, the articulation is so clear and exceedingly well rendered that a whisper even may readily be transmitted and understood. The inflexible plate, of course, merely serves, in consequence of its comparatively large area, to concentrate a considerable portion of the sonorous waves upon the small carbon disc or button. A much greater degree of pressure for any given effort on the part of the speaker is thus brought to bear on the disc than could be obtained if only its small surface alone were used." Let it be remembered that in the microphone there is really no diaphragm at all; and it is clear that Mr. Edison has written under a misapprehension, for his "inflexible plate" is, to all intents and purposes, a diaphragm. Prof. Bell, so long ago as last December, stated that he had obtained distinct articulation with diaphragms as thick as ⅜in., and Lord Rayleigh has shown that metallic diaphragms, even when thick, do vibrate under the influence of sound, although the amplitude of their vibrations may be so minute that they are immeasurable. It is this very vibration of the diaphragm, or thick plate—whichever it is called—that enables Mr. Edison to bring the required variations of pressure on his carbon block; but, as is now well known to our readers, neither diaphragm nor plate is required in the Hughes microphone, but simply a conducting substance not liable to become rapidly oxidised. It is a matter for regret that Mr. Edison should have hastily penned the letters that have appeared, and it is still more regrettable that he should exhibit so great a desire to charge others with a breach of confidence. Mr. Preece was the representative of this country when Mr. Edison showed him the experiments he was then making, and explained to him the construction of the instruments he had already made; and as such, therefore, some answer must be expected from him. Mr. Edison says:—"The claim of Professor Hughes to the discovery that a modification of his microphone can be used as a measure of minute degrees of heat is still more preposterous than the preceding. This is a discovery of mine, which was first announced in the *Washington Star* of the 19th of April last. A copy of that paper was sent by me to Mr. W. H. Preece, the coadjutor of Professor Hughes in this pretended 'invention,' and I have positive evidence that it reached him before the presentation of the so-called 'microphone' to the Royal Society, inasmuch as he has made an extract from it in his address of May before the London Society of Arts." It does not appear to have occurred to Prof. Edison that any public scientific man in this country would hesitate before he laid himself open to such a charge as that, nor that it was possible a distinguished investigator like Prof. Hughes could have made important discoveries in the same branch of science as Mr. Edison pursues with so much energy and a success so brilliant; but, if it is true that the microphone of Prof. Hughes represents a discovery the limits of which are not defined by the carbon telephone—if, moreover, the microphone differs essentially from the carbon telephone—it is probable that any modification of it which can be employed to measure minute degrees of heat will differ entirely from the microtasimeter. So far as we know no trustworthy account of that instrument has been published; but it is said to be capable of measuring the 50,000th part of a degree of heat, and will be employed by Prof. Young in his observations of the solar eclipse next month. The form of microphone best adapted to act as a thermopile has, we believe, yet to be invented; and we venture to think that the dispute, so far as it has gone, arises simply from a mistake. It seems clear that Mr. Edison, while intent on perfecting his carbon telephone, confined himself too rigidly to its details, and so missed that wider and more comprehensive discovery which we believe Prof. Hughes would be the last to claim if he did not honestly believe it to be his own.—Since writing the above we have received the letter from Mr. Preece, which appears on p. 393.



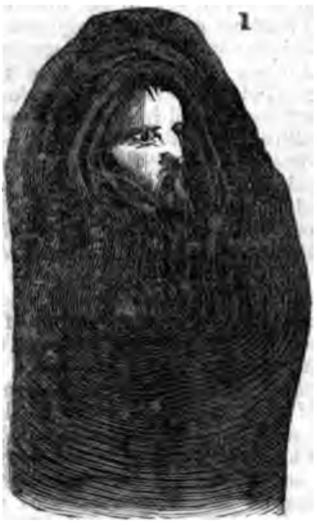
ON SOME CURIOSITIES OF MINERALOGY.

By J. H. Collins, F.G.S.

Honorary Secretary of the Mineralogical Society of Great Britain and Ireland.

An eloquent author has written * "There are no natural objects out of which more can be learned than out of stones. They seem to have been created especially to reward a patient observer. . . . . Trees, clouds, and rivers are enjoyable even by the careless; but the stone under his foot has for carelessness nothing but stumbling . . . . and yet do but give it some reverence and watchfulness, and there is bread of thought in it more than in any other lowly feature of the landscape."

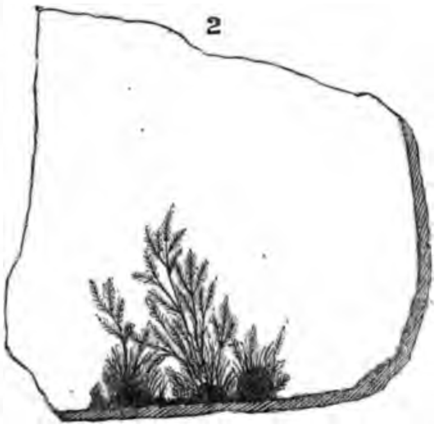
How true this passage is none but a mineralogist can know, but its truth is known to all who *are* mineralogists. An interest in minerals is, however, by no means confined to mineralogists. All who are interested in mining or metallurgy, all workers in metal, quarrymen, stonemasons, jewellers, and jewel-wearers, nay, every one who has a coin in his pocket, or who wishes to get one will find that the subject, properly brought forward, has interest for him. Scarce anything in nature is so perfect in colour as the ruby, the emerald, the sapphire, or the topaz; nothing so brilliant as the diamond or the rock crystal—except the stars—the very names of gems, skilfully used, suggest poetical ideas to the meanest as well as the greatest poets.

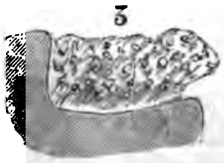


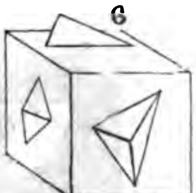
Minerals have their own peculiar characters and habits, keep with their own associates, and carry with them their histories written in unknown hieroglyphics, which it is the object of the mineralogist to decipher. Like Proteus they change their form under different conditions—like the chameleon, they change their colours under different aspects. Some glow with increased lustre by exposure to light or heat—others lose all their transparency under the influence of the very same agents, and can only be kept without injury if carefully secluded in dark cases. We will now describe a few of the more striking "freaks of nature" occurring in this department of nature, but which are very little known, except to the systematic student of mineralogy.

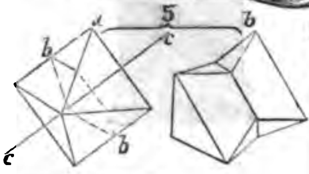
1. *Curious simulations.* One of the most striking examples of what may be called "inorganic mimicry," occurs in the well-known "Chaucer's Head," in the British Museum (Fig. 1). This is a fractured specimen of Egyptian jasper, the broken surface of which exhibits a likeness of the poet Chaucer, the right eye, the nose, and the forehead being remarkably well defined. Many similar accidental resemblances have been recorded by mineralogical writers, and few first-class collections are without one or more such examples.

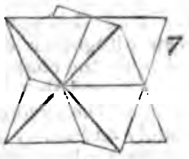
Far more common are the simulations of vegetable growth, known as "moss-agates," "dendrites," and the like. Fig. 2 is a facsimile of a dendritic crystallisation of oxide of manganese from an almost invisible fissure in a piece of lithographic limestone

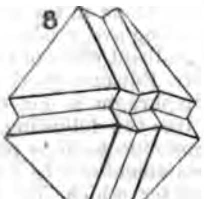


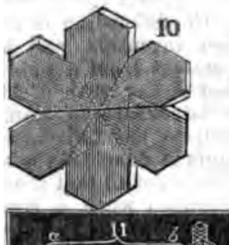








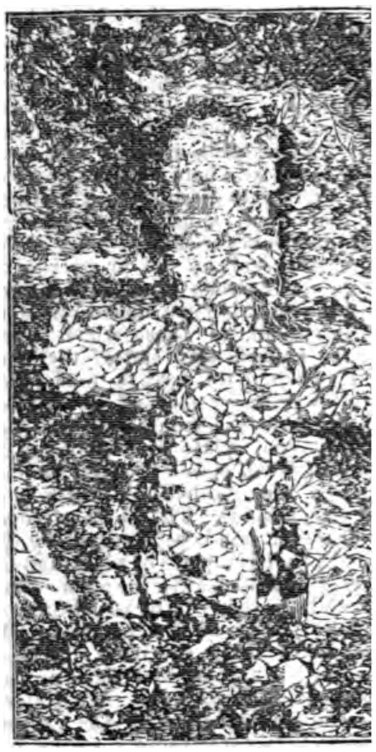




from Sölenhofen, now in the writer's possession. Its close resemblance to the frost crystallisations on a window-pane will strike every observer, and as in those the angles formed by the several branches are found to be absolutely the same in every part of the "tree."

So exactly do these dendritic forms simulate vegetable growths that they are fre-
quently mistaken for fossils, even by
rienced collectors. They are imme
due to that modification of force
seems to be especially active at the su
of bodies, and which has been
capillarity. The finest dendrites seen
formed in the narrowest fissures, an
is quite in accordance with the l
capillarity.

The peculiar formations observed
Lizard Serpentine by Messrs. Kin
Rowney are equally remarkable for th
semblance to organic forms.* One of
is sketched in Fig. 3. It very clos
sembles the fossil known as *Stenopo*
the condition of the serpentine of the
peninsula shows that the structure m
inorganic. It consists of a mass of *tr*
crystals imbedded in *Saponite*. Man
examples of what are called "str
simulations" are given in the sam
by Messrs. King and Rowney, an
even contend that the fossil known as
Canadense, which occurs in the oldest
rocks—the *Laurentians* of Canada—a
structural simulations.



If there are in inorganic nature
tural simulations" of the works of
simulations of works of art are
equally common. A great many n
occur in forms bounded by cu
curved surfaces. In the lower ch
instance, thousands of nodules
pyrites occur—called "thunderbol
the unlearned—perfectly globul
varying in size from a Spanish nut
64lb. cannon-ball, and these have ev
brought to the writer as "fossil
balls." The pale-green mineral, *Prel*
frquently met with in ancient volcani
is also frequently globular, the s
spheres, however, being not quite d
from each other or from the as
rock. The same globular tendency
itself in the "reniform" masses
pyrites, the "botryoidal" groups of
copper ore, and the "mammillary
(Fig. 4) so characteristic of the wel
green mineral, *Malachite*.

Most collections contain exampl
snow-white branching coralloidal *f*
from Styria. *Wire* has its na

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* Ruskin, Modern Painters. Vol. IV.

* See Ph. Mag., 1876, April.

ng representative in "native silver," ood, and *leather* in the peculiar fibrous · masses of hornblendic material as "rock-cork," "rock-wood," and tain leather;" needles in the so-called e ore" (*Aikinite*), and *thread* in the groups of "bismuthinite," "Miller- d especially in the beautiful silky of "Amianthus," which have fre- r been woven into an indestructible

y other striking simulations arise eculiarities of crystal growth, which s to be due to an "orderly disorder" action of the crystallising force. The najority of mineral substances occur, favourable conditions, as "crystals," d by plane surfaces geometrically to each other. Some crystals are d by planes, few in number, and of d only, generally, however, two or kinds of planes exist in what are "combinations." Some are exceed- omplex, the planes being numbered dreds.

es, Twin-crystals, or Hemitropes.— re groups of two or more crystals appear as if mutually intersecting ther, or, sometimes, as if a single had been cut in two in a certain n, one part turned round a certain r of degrees, and then reunited. The ound which the portions may be sup- o have moved is called the "twin- nd the plane of movement the "twin-

As to the causes of macle formation, eed of crystallisation generally, very known; but each substance seems to ect to laws from which it rarely or eviates; and this is especially evident e groups.

acles of juxtaposition.—These may s very simply illustrated. Fig. 5A nts a regular octahedron. Suppose he cut in two in the direction of the line or "twin-plane," *b b*, one-half on the axis, *c c*, through 90°, and o again united, a macle or "twin- " like Fig. 5B will result—a form s frequently met with in *spinel, alum*, any other minerals. Of course no vision and reunion has really taken he whole crystal has probably taken rm from its origin; but in all such the amount of calculated rotation— e amount of rotation necessary to he portions into such a position as l up a perfect form—is fixed within arrow limits. It will generally be , 90°, 120, or 180°.

terpenetration Macles.—These admit lly simple illustration. Fig. 6 is a n example of this kind of macle, in wo cubes apparently intersect and te each other—it is often found in rites and in fluor. In this example rfaces or planes of one cube are l to planes which would truncate the gles of the other. The "axes" of pective cubes (imaginary lines join- centres of each pair of faces) will be ly inclined 45° to each other.

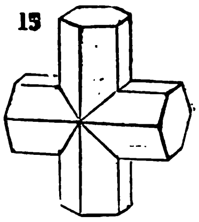
7 is an interpenetration macle of composed of two tetrahedrons. Here le of inclination of the twin axes to her is 90°.

8 is a somewhat different kind of Here four interpenetrating octa- s occur, the axes of which are not d, but parallel to each other—merely g apart a little distance. This cy to parallel macling is well seen . 9, which is a form not un- tly met with in Aragonite. Some- he successive members of the group thin as to appear on the compound , *a a' a"*, merely as a striation. Simi- cles are met with in Albite and lase, and are often of much use in dis- hing these felspars from Orthoclase. ng the peculiar geometric results of the laws of macle growth the most common are stars and crosses. Fig. 10 is a stellate macle of chrysoberyl, and Fig. 11 *a b* shows two forms of snow crystal—the first a simple, and the second a very complex example of stellate grouping. Of the same nature is the crystal of Cerussite sketched in Fig. 12, which consists of six buttress-like plates, meeting at a common centre, and supporting each other.

Crosses are even more frequent than stars among natural crystals, stars being more frequent in artificially formed crystals. The Latin cross, Fig. 13, is drawn from a photograph of a specimen of Cornish granite now in the possession of a friend of the writer. It represents an interpenetration twin of orthoclase, a mineral which seems to have a special tendency to form such combinations.

Thus the porphyritic phonolite of the "Wolf" rock is completely filled with almost microscopic crosses of various forms, so that it is almost impossible to find a piece as big as a sixpence without one or more tolerably well-formed examples. Fig. 14 represents two of these cross forms at *a* and *b*, sketched from a microscopic section in the possession of the writer, and magnified some 50 diameters.

15



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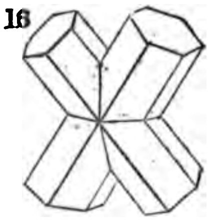

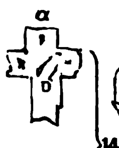

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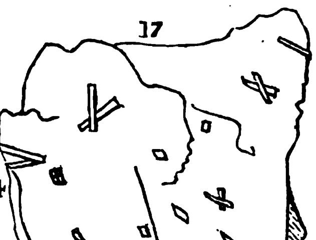

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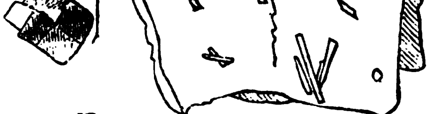


Fig. 15 is a Greek cross often met with in the mineral staurolite; the same mineral often presents the St. Andrew's Cross, Fig. 16. The mineral chiastolite also occurs in very similar forms. Fig. 17 is a copy of a piece of chiastolite slate from Skiddaw, showing many irregularly-crossing pairs of crystals. The mineral Andalusite, which is very nearly related to chiastolite, has a very remarkable habit, which is well exhibited in Fig. 18. Fig. 18*a* is a crystal dissected by Mr. B. Horsford, of Springfield, Mass.; Fig. 18*b* represents one of the four associated white portions; Fig. 18*c* the central black portion of dark slaty substance.

These few examples of macle formation will suffice to illustrate the strange effects resulting from the operations of laws, which up to this time are almost altogether unknown. In both kinds of macles it is worthy of remark that the twin axes are either parallel, or else inclined, so as to form certain definite angles, the most usual being 30°, 45°, 60°, 90°, 120°, and 180°. Generally macled crystals may be at once known by their re-entering angles, but occasionally macles occur which exhibit only salient angles—as when six rhombic prisms of barytes or aragonite combine to form one apparently hexagonal prism.

In a future paper I propose to discuss the connection existing between chemical composition and crystalline form—a question which is by no means so simple as it looks. Probably it is only one of many causes affecting crystalline form. It is worthy of remark, however, that some minerals, as oxide of tin (Cassiterite), are almost constantly macled, while others, as *garnet*, are very rarely macled. Again, the temperature and pressure existing at the time when the mineral was in process of formation may have affected the results, so also the electrical or magnetic condition of the surroundings, the concentration or dilution of the mineral solutions from which most of the examples referred to have been formed; the comparative abundance or rarity of the material present; all these have, no doubt, had their share in producing the results of to-day, but as they all belong to the general subject of *Crystallogeny*, which is beyond the scope of this paper, no more need be said at present.

THE NEW PHOTO-ENGRAVING PROCESS.

A few particulars of M. Michaud's new process of photo-engraving metallic plates, specimens of which are exhibited at the Paris Exhibition, have been made known, and we are in a position to appreciate the value of the method employed. A negative of the subject to be reproduced having been obtained a print is taken on a film of bichromated gelatine supported by a metal plate. The print is developed by the usual means, and after being dried in the open air is placed in a box containing a hygroscopic material, the dampness of which causes the gelatine to swell slightly, and so increases the amount of relief. The secret of M. Michaud's process consists in pressing this gelatine film into the plastic face of a fusible metal, which is contained in suitable trays or dishes. The "forme," as it is called, is treated in much the same way as the mould and block in the process of electrotyping, being placed under a screw press, and allowed to remain until the metal becomes solid. The fusible metal employed by M. Michaud is Darcet's alloy, with the addition of about 11 per cent. of mercury. The alloy of Darcet or Rose is usually compounded of bismuth 50, tin 30, and lead 20, and is fusible at 212° Fahr.; but other proportions of these metals, for there are many alloys of Darcet, produce differences in the metal which may be found of especial value in the new process. Thus an alloy of bismuth 80, lead 70, tin 10, becomes soft in boiling water, but does not melt; while one made up of bismuth 80, lead 40, tin 40, becomes very liquid at 212°. If the quantity of lead in the last is reduced to 30 parts, the alloy becomes liquid, but not very fluid, at 212°. The addition of mercury to any of these alloys reduces the fusing point below the temperature of boiling water, and it is possible that, by adding 11 per cent., M. Michaud may have obtained the metal best adapted to his wants—sufficiently hard when cool, and sufficiently fusible to be capable of taking the impression of the gelatine without injuring the fine lines. At any rate the proportion of mercury added will affect the degree of hardness within certain limits. The plate produced by impressing the gelatine on the semi-fluid face of the alloy can be employed for the production of other plates; but for the purposes of typography it will be seen that several operations must still be carried out in order to obtain a raised plate in hard metal from a sunk plate in a fusible alloy. When the picture required contains half-tones, it is necessary to obtain a grained surface. This is accomplished by means of a special film of coloured bichromated gelatine, which is exposed under a plate dusted with a rather coarse opaque powder. The film thus produced is attached to the negative by means of a solution of gum-arabic, containing a little bichromate of potash, the operation being performed under water. The parts not affected by light are then removed in the usual manner, and a negative is obtained with a grained surface from which the print is taken with which the impression is made. We do not know whether the process is protected in this country; but at all events it appears to be very successful, and will no doubt be soon developed by other manipulators.

A SIMPLE WATER MOTOR.

THE useful little water-wheel motor illustrated in the annexed engravings has been patented by Mr. O. J. Backus, of Newark, N. J. Fig. 1 is a sectional view of one plate of the wheel case, showing the wheel partly in section; Fig. 2 is a vertical section through the wheel and case; and Fig. 3 shows one method of putting the motor to work. The invention consists of a wheel carrying buckets suitably shaped and disposed around its periphery in such a manner that when water is forced against them the wheel is caused to revolve with considerable power, sufficient, even when of small size (about 7in. diameter), to drive a sewing machine. The water wheel chamber is made up of two casing plates bolted together. Each plate has an annular rib to receive the bucket-carrying portion of the wheel, and also a central annular depression surrounding the bearing of the shaft. The lower portion of the casting or casing is provided with an upwardly flaring pocket, A, of less width than the casing itself, taken through the annular space, but of a length nearly equal to one-third of the circumference of the casing; the bottom of this pocket converges to a discharging nozzle, which connects to the waste pipe, P. The ingress pipe forms part of the upper edge of the pocket, having a finely perforated nozzle to which the water inlet pipe, W, is secured. In Fig 2, the casing is shown with a bracket to secure the motor to the top of a sewing machine or other table, so formed that while it serves to hold the motor to the table top, it also forms a part of one of the long bearings for the wheel shaft. This bracket extends sufficiently below the point at which it forms one of the bearings of the shaft, to elevate the same above the table when the motor is in position, thereby enabling a direct connection to be made between the shaft of the motor and the driving shaft of the machine to be operated. The pocket A, nozzles, and bracket are all cast with, and form a part of, the plate forming the one-half of the casing. The other plate has neither a bracket nor a pocket formed in it. The two plates, when bolted together, form the bucket chamber of the wheel, and an annular laterally extended chamber, *m*, to receive the "eyebrows" or water sheds, *d*. This chamber surrounds the shaft and bearing, and owing to its concavity the water, flowing down the inner face of plate over the eyebrows, *d*, will be conveyed past and below the shaft without escaping from the wheel case between the bearing and the shaft. By the peculiar form of chamber, *m*, that part of the wheel case can be contracted laterally, as shown at Fig. 2; and besides this the bearings can be made long enough to support the wheel shaft without occupying more room laterally than the width of the wheel case. The buckets of the wheel are struck by a minute stream of water from the nozzle, directed downward and inward on a line tangent to a circle within the circumference of the wheel, thereby receiving all the force of the stream to operate the wheel. To prevent the reaction of the water upon the buckets the pocket, A, commences directly below the injecting nozzle, and conducts all the water down to the discharge pipe.

To obtain a very light wheel, wire spokes may be used to connect the buckets to the hub of the wheel secured to the shaft, C, yet this part of the invention is not confined to the above, as any suitable construction of wheels may be used. For the purpose of starting and stopping the machine a single-way cock is employed, through which the water passes on its way from the service pipe to the wheel case; this cock is mounted upon standards fixed in a drip pan. The plug of the cock extends so as to form a support for a pedal or foot lever by means of which an operator regulates the flow of water at will. Between the cock and the supply nozzle is applied a vessel made in two detachable parts, and provided with a perforated diaphragm to prevent any foreign matter in the water from collecting in and closing up the nozzle. This vessel, being in two parts, may be removed for cleaning without stopping the flow of water to the cock, L.

The peculiar advantages of the arrangement depicted by Fig. 3 are that the motor or wheel is set upon an adjustable swinging bracket to operate a sewing machine or lathe at different angles and locations without crossing the belting, and without disconnecting the water pipe. Fig. 3 is, then, a side elevation of reversible water motor provided with projecting lugs, G and G^1 fashioned to fit into a dovetail slot of the swinging section of a bracket; this bracket is secured to the wall or wainscoting, and the swinging section is secured to the horizontal projecting portion of the bracket by means of a thumbscrew or pin, which forms the pivot or hinge upon which the motor is swung either to the right or left. The dovetail projections, G, are cast upon, and form an integral part of the case, A, by which means the motor is reversed without crossing the driving belting to operate sewing machines in any part of the room.

FIG. 1

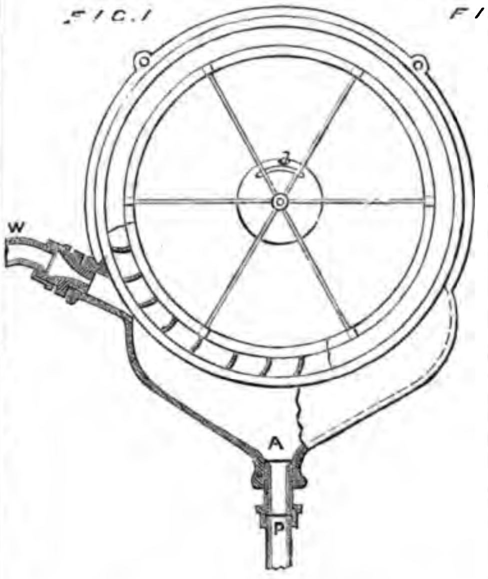


FIG. 2

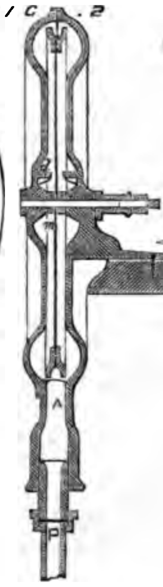
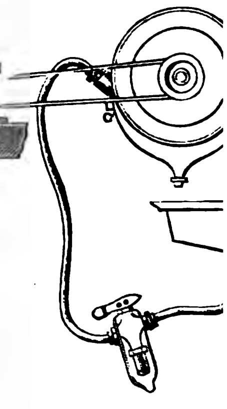
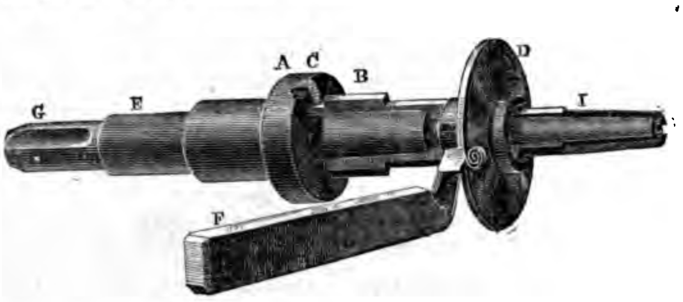


FIG. 3



A NEW EXPANDING MANDREL.

IN the annexed engraving we illustrate a new expanding mandrel, patented by Mr. Le Count, and which can be seen at Messrs. Churchill's, Wilson-street, Finsbury. The figure is so self-explanatory, that a mere description of the parts will be sufficient. E is the body of the mandrel, and G is the end where the dog is attached. A is a sleeve which draws the three keys, B, up an incline in the body, E. These keys are gibbed on the under side, and fit in the grooves, I, which are made to match. C shows the head of the key, B, held in an annular recess turned in the sleeve, A. D is the work, and F the tool. To tighten the work it is only necessary to drive, with a copper hammer or a piece of soft iron or brass, on the end G, while a few taps on the other end will loosen it. The amateur's size takes anything from ⅛in. to 1 inch.



HEATING A TOWN BY STEA

THE following particulars of the method
on steam to private houses for heating p
are given by Mr. G. Maw, F.G S., who has p
inspected the arrangement at Lockport, New
The experimental works in Lockport we
menced last year, and during the last wint
200 houses in the city were heated from the
supply, through about three miles of pipi
ating from the boiler-house, containing tw
16ft. by 5ft., and one boiler 8ft. by 8ft.
boilers were during the winter fired to a pre
35lb. to the inch, with a consumption of fou
anthracite, costing 4½ dollars a ton; dur
summer but one boiler is fired, consuming a
a half of anthracite in 24 hours, and a pre
25lb. per inch maintained.

The boiler pressure of 35lb. in winter and
summer is maintained through the entire le
the three miles of piping up to the points
sumption, where there is a cut-off under the
of the consumers. The first 600ft. of mai
the boilers are but 4in. in diameter. Th
1,400ft. of 3in. pipes, 1,500ft. of 2½in. pi
2,000ft. of 2in. pipes. The supply pipes fro
mains to the houses are 1½in. in diameter, an
each house ¾in. pipes are used. In additio
cut-off tap from the main under the contro
consumer there is a pressure valve regula
5lb. pressure under the control of the compa
beyond this is an ingeniously constructed
which not only indicates the total consum
cubic feet of steam, but also the quantity o
used in each apartment. At each 100ft. of
expansion valve, like an ordinary piston and
is inserted, allowing an expansion in each se
100ft. of 1¾in. for the heat at 35lb. pressu
condensation whatever occurs in the mains.
are covered with a thin layer of asbestos pap
the iron, then a wrapping of "Russia fel
finally wrapped round with "Manilla pape
smooth light brown paper, over all, and th
encased in timber bored out three-quarters of
larger than the felt-covered pipes, and laid a
streets like gas-pipes.

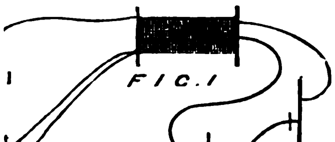
The distribution of heat in the apartme
means of radiators, consisting of inch pi
long placed vertically either in a circle or as
row, and connected together top and botto
an outlet pipe for the condensed water, which
at a temperature at a little below boiling
sufficient for all the domestic purposes of th
or is used as accessory heating power fo

and other purposes. The steam has also ied at a distance of over half a mile from s for motive power, and two steam engines se and 14-horse power are worked from the t a distance of half a mile, with but a icreased consumption of fuel. The laid-on being also used for cooking purposes, for nd even baking, and I witnessed in a house rters of a mile from the boilers a bucket of r raised to boiling heat in three minutes, ssage of the steam through a perforated inged into the bucket As in the case of ly, the Steam Supply Company lay their o the houses, the consumer paying for all pipes, fittings, and radiators. In a y-sized eight-roomed house the expenses of ounted to 150dols., or a trifle over £30, and houses, with more expensive fittings, to or £106 or £107.

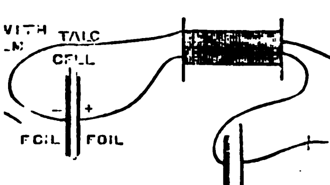
erations of the Heating Company have been present time of an experimental character, the 200 houses already supplind with the onnection, the actual cost of the coal that ve been used for heating has been pro- received in payment, and the amount has ide margin over the working expenses, ne company's operations at present cover ll portion of the area for which they have plant. The working expenses consist of more than the coal and the wages of two and the central plant appears very small, al and bulk, for the results obtained. The f the company consists of 50,000dols., in ls. shares, which has covered the cost of l plant, and the three miles of steam-pipes gh the city. The scheme on all hands is dged as a great success, and from inquiries who have the steam heating in use, I am that the system of a central steam supply d to become the future means of heating

DIA-ELECTRIC.*

NG the early part of last summer, like ny others, I put the telephone through a experiments; in this instance with a view at something definite as to the precise cir-es under which sound was reproduced at



F I C. 1



F I C. 2

ving end of a telephonic circuit. Why? : had observed that, although a disc of the steel with a slice off the end of an iron bar tre afforded the best results for sending, it attered little what the receiving diagram provided the sound was received from the by a material conductor and not by the d for receiving thick discs and thin bladder with iron in its centre, bladder sprinkled dust, and the flat end of a crowbar. There ght improvement with some over others in or in sensitiveness, but in no case did mass ceiving end appear greatly to affect the

then, was this sound produced? Authori-ainly differed, and still differ, upon the me thought it was the actual vibration of ragm consequent upon magnetic attraction lsion. Prof. Bell considered the effect as r, others thought it due to both, and, as I it due to neither, I set to work in my own ttle it.

st other experiments was one to ascertain onic effect of magnetic surface, and the magnet used had a flat iron disc at its l in size to the thin iron diaphragm near it, atter was fixed at its centre to admit vibra-its circumference. It happened that the le contact with the magnet, and the two e secondary coil of the indicator, used to he effects, getting accidentally in contact, ith the helix, the other with the diaphragm, ition of sound I had long vainly striven to s emitted loud and clear

as mystery, and mystery, that being followed up, led me far from the telephone. In fact, I had now two sound phenomena upon my hands instead of one. To what could this latter be due?

It was found that the nearer the discs approached each other the more intense became the sound, until touching, the insulation between them was destroyed, and the sound ceased. It could not be a magnetic effect, for discs of any conducting material would act the same. And, moreover, upon placing two discs—one each side a third—that the respective effects might be neutralised, it turned out that the sound was nearly doubled in loudness rather than diminished (Fig. 1, in which B is the battery, I the inductophone, and T transmitter). It appears evident that the sound effect was due to electrostatic induction, and to the arrangement was, consequently, applied the term inductophone. Thus, if two sheets of tinfoil were respectively connected to the ends of the secondary coil, and a tune played upon a telephonic transmitter in the primary circuit; that tune would be reproduced upon foils loud and distinctly. The foils, however, require to be insulated from one another by a sheet of paper or other dia-electric, and pressed gently together. Sheets of damp paper insulated by guttapercha have the same effect, provided the damp paper does not actually adhere to the insulating material; and, with great care and perseverance, sound may be—it has been—obtained from two opposing films of soap-water.

Months were spent in cogitation and experiment, during which it further transpired that, if any two electrified surfaces were brought near one another, with a film of air between them, sound could always be reproduced; but that, directly the air was excluded, no sound whatever could be obtained. Here was a hint, which, being acted upon, conclusively proved that these inductophonic sounds were the results of the electrification and consequent vibration of the air film. Thus, if two leaves of fold, insulated by percha, were placed under a press, clear sounds could be obtained until the press was forced home to the exclusion of the air. So, too, if upon the exterior sides of a thin flat cell lie pasted tinfoils respectively connected with the inductor, so long as the cell containing air, sound is emitted, but directly the cell is filled with water sound ceases. If, however, two pieces of talc secured at their edges, so that they contain between their flat sides a film of air, be plunged into the cell of water, sound is again heard, but fails upon the withdrawal of the talcs. (Fig. 2.)

But more than this, if air is electrified by two opposed surfaces, why not by one? The experiment was tried, and it was found that the air is apparently more or less negative to one pole of the secondary coil; for, upon attaching that end of the coil to a metallic plate, to damp paper or wood; or by dipping the end of the wire into an insulated glass of water, the ear placed near one of these charged surfaces easily detected the faint reproduction of sound emitted from it. Recently a Hughes's transmitter or microphone has been placed upon a metallic body in connection with this particular end of the secondary coil, and the sound again produced upon a telephone. In this case the vibrations given to the microphone by the charged body are first developed in that body by the air undulations beating against it. If, however, the charged body be carefully excluded from the air by being covered with some insulating material, no sound will be transmitted by the microphone.

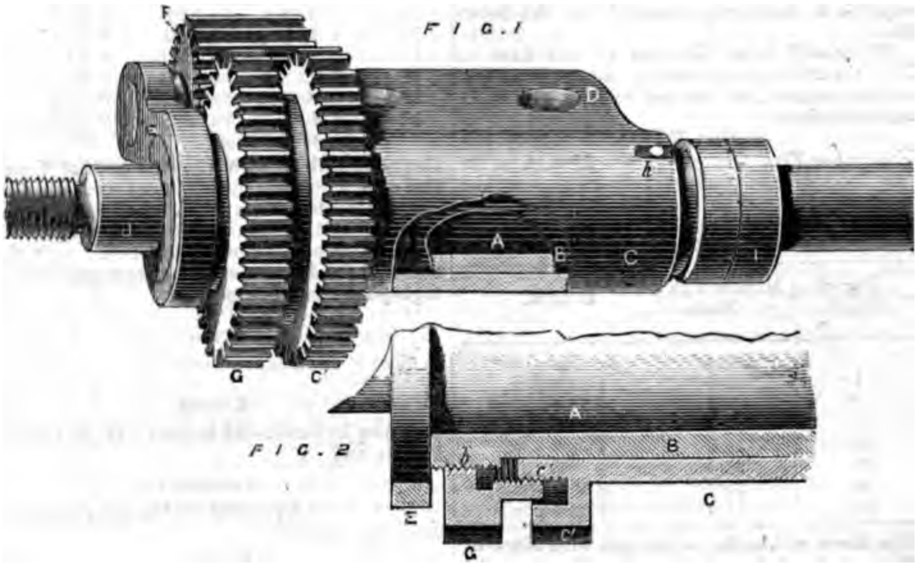
Now, what may we deduce from these experiments? I think this—that we have here another addition to the already long list of electrical phenomena—atmospheric dia-electricism. Perhaps, too, many substances are subject to a similar peculiarity, whether the dia-electrical effect produced consists of a like or of but an unlike kind is uncertain.

Aided by the experience gained with my inductophone, the old telephonic experiments were re-examined and new ones tried, and furnishing evidence to my own mind that just as inductophonic sound undulations are due to the dia-electric, so the true telephonic sounds are based upon Faraday's dia-magnetism. Upon the latter theory, however, there are experiments still under attention, and their results for or against it I hope to give in another paper.

METHOD OF CORRECTING A LEADING SCREW.*

By Joshua Rose, M.E.

It was recently required, when cutting a new screw at the Pratt and Whitney Company's works, to correct the error in the lead screw of the lathe in which the new one was to be cut. This was accomplished by employing the device shown in our engravings, and which was designed by Mr. A. Swasey. It was first ascertained by testing the lathe that its lead screw was too short by 7·100 of a revolution in a length of 2ft., the pitch of its thread being 6 to an inch. Now in 2ft. of the screw there would be 144 threads, and since 7·100 (the part of a revolution the thread was too short) × 1·6 (the pitch of the thread) = 7·600 (which was called 1·85), the error amounted to 1·85in. in 144 turns of the screw. The construction of the device employed to correct this error is as follows:—In Figs. 1 and 2, A represents the bearing of the feed screw of the lathe, and B *b* a sleeve, a sliding fit upon A, prevented from revolving by the pin, *h*, while still having liberty to move endways. C represents a casing affording journal bearing to B *b*, having a fixed gear wheel at its end, *c′*, and an external thread upon a hub at that end. D is the flange of C to fasten the device to the shears of the latter, being held by screws. E represents an arm fast upon the collar of the feed screw, and carrying the pinion, F, the latter being in gear with the pinion, C′, and also with G, which is a pinion containing two internal threads, one fitting to B at *b*, Fig. 2, and the other fitting to C at *c′*, Fig. 2, the former having a pitch of 27 threads to an inch, the latter a pitch of 25 to an inch.



F I G. 1

F I C. 2

The operation is as follows:—The ordinary change wheels are connected to the feed screw, or lead screw, as it is sometimes termed, at J in the usual manner. The arm, E, being fast to the feed screw will revolve with it, and cause the pinion, F, to revolve around the stationary gear wheel, C′. F also gears with G. Now F is of 12 diametrical pitch and contains 26 teeth, C′ is of 12 diametrical pitch and contains 37 teeth, and G is of 12 diametrical pitch and contains 36 teeth. It follows that the pinion, F, while moving around the fixed gear, C′, will revolve the pinion, G (which acts as a nut), to an amount depending upon the difference in the number of its teeth and those of fixed gear, C′ (in this case as 36 is to 37), and upon the differance in the pitches of the two threads, so that at each revolution G will move the feed screw ahead of the speed imparted by the change gears, the end of the sleeve, B, abutting against the collar, I, of the feed screw to move it forward.

In this case there are 36 turns of the feed screw, A, for one turn of the nut pinion, G, the thread on sleeve, B, being 27, and that on the hub of C being 25 to the inch; hence, 36 turns of the feed screw gives an end motion to the sleeve, B, of 1-25 minus 1-27 = 2-675, and 1-36 of that = 1-12150 of an inch = the amount of sliding motion of the sleeve, *b*, for each revolution of the lathe feed screw. By varying the proportions between the number of teeth in C′ and G and the pitches of the two threads in a proper and suitable ratio, the device enables the cutting of a true thread from any untrue one in which the variation is regular.

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* L. J. G. Adams, A.S.T.E., from the *Electrician*.

* From the Scientific American.

ASTRONOMICAL NOTES FOR JULY.

The Sun.

Day of Month.	Souths.	At Greenwich Mean Noon.		
		Right Ascension.	Declination North.	Sidereal Time.
	h. m. s.	h. m. s.	° ′ ″	h. m. s.
1	0 3 32·35 p.m.	6 41 10	23 7 10	6 37 37·39
6	0 4 27·03 „	7 1 47	22 41 48	6 57 20·18
11	0 5 12·34 „	7 22 15	22 6 37	7 17 2·97
16	0 5 46·37 „	7 42 32	21 21 57	7 36 45·76
21	0 6 7·74 „	8 2 36	20 28 14	7 56 28·55
26	0 6 15·51 „	8 22 27	19 25 53	8 16 11·33
31	0 6 8·77 „	8 42 3	18 15 27	8 35 54·12

At 9 a.m., on July 2nd, the Sun will be in apogee; or, in other words, we shall then be at our greatest distance from him. At this instant—if we assume the Solar Parallax to be (according to the recent determination by Capt. Jupman) 8·813″—we shall be removed from him by an interval of 94,204,900 miles. There will be no real night until July 21st, as it is not until that date that the Sun will descend 18° below the northern horizon at midnight. Indications of returning activity are beginning to be perceptible at infrequent intervals on the Solar disc.

There will be an ECLIPSE OF THE SUN on July the 29th; as it, however, will be invisible in this country, no further reference to it is necessary here.

The Moon

Enters her First Quarter at 8h. 20m. a.m. on the 7th; and is Full at 10h. 54·7m. in the morning of the 14th; she will enter her Last Quarter 15·9 minutes after Noon on the 22nd, and be New at 9h. 40·3m. p.m. on the 29th.

Day of Month.	Moon's Age at Noon.	Souths.
	Days.	h. m.
1	1·0	1 1·3 p.m.
6	6·0	5 17·7 „
11	11·0	9 48·9 „
16	16·0	1 23·2 a.m.
21	21·0	4 48·5 „
26	26·0	8 49·3 „
31	1·6	1 32·7 p.m.

The Moon will be in conjunction with Mars at Noon on the 2nd; with Jupiter at 9 a.m. on the 15th; with Saturn at Noon on the 20th; with Venus at 9 a.m. on the 27th; with Mars again at 4 a.m. on the 31st; and lastly with Mercury at 5 o'clock on the same afternoon.

Occultations of (and a Near Approach to) Fixed Stars by the Moon.

Day of Month.	Name of Star.	Mag.	Disappearance.	Moon's Limb.	Angle from N. Point.	Angle from Vertex.	Reappearance.	Moon's Limb.	Angle from N. Point.	Angle from Vertex.
			h. m.		°	°	h. m.		°	°
6	B.A.C. 4201	6	8 24 p.m.	Dark	65	93	9 29 p.m.	Bright	236	270
13	B.A.C. 6562	6½	8 43 „	Dark	87	61	9 58 „	Bright	292	276
15	4 Capricorni	6	3 4 a.m.	Bright	67	90	3 48 a.m.	Dark	347	15
16	θ Capricorni	4	†2 28 „	NW by N	211	222				

† A near approach.

Mercury

Comes into superior conjunction with the Sun at 1 p.m. on the 4th: after which he will, of course, become an evening star, and, after the middle of July, be fairly well placed for the observer.

Day of month.	Right Ascension.	Declination North.	Souths.
	h. m.	° ′	h. m.
1	6 25·1	24 18·5	11 47·5 a.m.
6	7 12·8	23 57·7	0 15·4 p.m.
11	7 58·2	22 31·8	0 41·0 „
16	8 39·4	20 15·9	1 2·5 „
21	9 16·0	17 27·2	1 19·3 „
26	9 48·3	14 20·1	1 31·9 „
31	10 16·7	11 5·6	1 40·5 „

During the month of July, Mercury will thus travel through a considerable part of Gemini, across the whole width of Cancer, and so into Leo. He will be about 1¼° N. of δ Geminorum on the 6th; some 24′ N. of η Cancri on the evening of the 14th; and nearer still to 83 Cancri on that of the 20th. He will be in the same telescopic field of view as Regulus on the 28th; and he will further be in conjunction with Mars at 5 a.m. on the 23rd, but will not then have risen.

Venus

Is a morning Star during the whole of July; and, in one sense, is well placed for the observer. Her angular diameter, however, continues steadily to decrease, and her gibbosity to increase, so that her interest as a telescopic object may be held to diminish daily.

Day of Month.	Right Ascension.	Declination. North.	Souths.
	h. m.	° ′	h. m. a.m.
1	3 56·7	18 19·3	9 19·5 „
6	4 20·7	19 32·9	9 23·7 „
11	4 45·1	20 35·2	9 28·4 „
16	5 9·9	21 24·9	9 33·5 „
21	5 35·1	22 0·9	9 39·0 „
26	6 0·6	22 22·4	9 44·8 „
31	6 20·4	22 28·5	9 50·8 „

Hence it will be seen that the path of Venus this month lies through Taurus and Gemini. She will be less than 1° N. of ι Tauri on the morning of the 6th; and in conjunction with μ Geminorum at 9 a.m. on the 29th; both the Star and the Planet being visible together in a high-power field of view.

Mars

Is close to the Sun, and invisible.

Uranus

May now be considered to have left us for the Season, and

Neptune

Will not be in a position for the observer again until the autumn.

Jupiter

Rises about 9h. 30m. p.m. at the beginning of July; and some 2 hours sooner at the end of it. As far as his meridian passage is concerned, he is a morning Star up to the 25th; at 9 a.m. on which day he comes into opposition with the Sun. This, then, would be a favourable time for the observer, but for the fact of the Planet's great South Declination, which must prevent the scrutiny of anything like delicate detail on his surface.

Day of Month.	Right Ascension.	Declination South.	Souths.
	h. m.	° ′	h. m.
1	20 30·7	19 32·7	1 54·7 a.m.
6	20 28·5	19 41·4	1 32·9 „
11	20 26·1	19 50·6	1 10·8 „
16	20 23·1	20 1·9	12 44·3 p.m.
21	20 20·5	20 11·5	12 22·0 „
26	20 17·8	20 20·9	11 59·7 „
31	20 15·1	20 30·1	11 37·3 „

The short retrograde path indicated in the above ephemeris lies wholly in Capricornus. Jupiter will be about 2° S. of the pretty double Star ρ in that constellation on the night of the 20th; S. of, and a little nearer to, π on that of the 21st; and approaching to σ on the 31st.

Jupiter's Satellites.

Day of Month	Satellite.	Phenomenon.	—
			h. m. s.
2	I	Ec D	1 13 38 a.m.
2	*I*	*Sh I*	10 24 0 p.m.
2	I	Tr I	10 57 0 „
2	II	Sh I	12 19 0 „
2	I	Sh E	12 44 0 „
3	I	Tr E	1 17 0 a.m.
3	II	Tr I	1 23 0 „
3	*II*	*Sh E*	3 15 0 „
3	*I*	*Oc R*	10 32 0 p.m.
4	II	Oc R	10 44 0 „
4	III	Sh I	11 13 0 „
5	III	Tr I	1 12 0 a.m.
5	*III*	*Sh E*	2 46 0 „
9	*I*	*Ec D*	3 8 6 „
9	I	Sh I	12 18 0 p.m.
9	I	Tr I	12 41 0 „
10	I	Sh E	2 38 0 a.m.
10	*II*	*Sh I*	2 56 0 „
10	*I*	*Tr E*	3 1 0 „
10	*II*	*Tr I*	3 41 0 „
10	*I*	*Ec D*	9 36 47 p.m.
10	I	Oc R	12 16 0 „
11	*I*	*Sh E*	9 6 0 „
11	*II*	*Ec D*	9 25 11 „
11	*I*	*Tr E*	9 27 0 „
11	II	Oc R	12 58 0 „
12	*III*	*Sh I*	3 12 0 a.m.
13	IV	Oc R	11 47 0 p.m.
15	III	Oc R	9 46 0 „
17	I	Sh I	2 12 0 a.m.
17	I	Tr I	2 24 0 „
17	I	Ec D	11 31 23 p.m.
18	I	Oc R	2 0 0 a.m.
18	*I*	*Sh I*	8 40 0 p.m.
18	*I*	*Tr I*	8 50 0 „
18	I	Sh E	11 0 0 „
18	I	Tr E	11 10 0 „
18	II	Ec D	11 59 43 „
19	*II*	*Oc R*	3 12 0 a.m.
19	*I*	*Oc R*	8 26 0 „
20	II	Sh E	9 48 0 p.m.
20	II	Tr E	10 2 0 p.m.
22	IV	Sh I	2 29 0 a.m.
22	*IV*	*Tr I*	3 9 0 „
22	*III*	*Ec D*	9 15 58 p.m.
23	III	Oc R	1 3 0 a.m.
24	*I*	*Sh I*	4 6 0 „
24	*I*	*Tr I*	4 8 0 „
25	I	Oc D	1 24 0 „
25	*I*	*Oc R*	3 44 0 „
25	I	Tr I	10 34 0 p.m.
25	I	Sh I	10 35 0 „
25	I	Tr E	12 54 0 „
25	I	Sh E	12 54 0 „
26	II	Oc D	2 29 0 a.m.
26	I	Ec R	10 10 30 p.m.
27	II	Tr I	9 21 0 „
27	II	Sh I	9 29 0 „
27	II	Tr E	12 18 0 „
27	II	Sh E	12 25 0 „
29	III	Oc D	12 41 0 „

Ec. Eclipse; Oc. Occultation; Tr. Transit of Satellite; Sh. Transit of Shadow; D. Disappearance; R. Reappearance; I. Ingress; E. Egress. The printing of a phenomenon in *italics* indicates that its visibility is rendered doubtful, either by the brightness of the twilight or by Jupiter's proximity to the horizon.

ly as Jupiter is now situated, the observer . watch the transit of Satellite III. on the norning of the 5th, in the hope of seeing ıarkable change from a bright spot to a ne as it crosses the planet's disc.

Saturn

orning Star, but rises about 11h. 30m. t the beginning of the month, and a little 9h. 30m. p.m. at the end of it. He is in a ately good position for observation, being cally on the Equator. The ring, as we ked last month, now presents a distinctly rm shape; and we are once more looking southern side.

Right Ascension	Declination South.	Souths.
h. m.	° ′	h. m.
0 13·7	0 59·5	5 37·1 a.m.
0 14·1	0 58·6	5 17·9 „
0 14·3	0 58·7	4 58·4 „
0 14·4	0 59·8	4 38·8 „
0 14·3	1 1·8	4 19·1 „
0 14·1	1 4·8	3 59·2 „
0 13·7	1 8·8	3 39·1 „

ı thus remains sensibly stationary in that lingly barren region in Pisces, to the and South of the First Point of Aries, we left him last month.

Shooting Stars

e looked for on the nights of the 17th, th, and the 29th of July.

wich Mean Time of Southing of of the Principal Fixed Stars, on the ıt of July 1st, 1878.

ır.	Souths. h. m. s.
næ Borealis	8 50 29·91 p.m.
entis	8 59 12·79 „
es	9 42 46·50 „
culis	10 29 47·59 „
iuchi	10 49 55·49 „
onis	11 14 21·42 „
ttarri	11 27 1·84 „
... ...	11 53 17·10 „
lso	12 20 12·43 „

method of determining the Local Mean of Southing of either of the Stars in the list will be found on p. 60 of Vol. XXIII.; at of finding the instant of its Meridian ;e for any other night in July on p. 393 . XXII.

ORGAN: A COMPREHENSIVE EATISE ON ITS MANUFACTURE, CURAL, AND LODGMENT.*

By John Watson Wedman,

ssociate of the College of Organists, London.

I.—GENERAL TREATMENT IN MANUFACTURE.

N example of the method last described occurs at the church of Notre Dame, er-square, London, by Gern, London.

Gas Engine.

ONSTRUCTION. This is a recent invention, stined, if I mistake not, to become very ıle. The principle is simply the ad- ıg to a Cylinder containing a Piston r to the usual Steam-engine type, a mix- f hydrogen Gas and common atmospheric proportioned to the required condition, xploding, either by naked flame or elec- park; the result, of course, being the tion of the Piston, and a succession of ex- ns, producing the desired continuous n. It may be here mentioned that gas ed by the evaporation of Mineral oils— s Petroleum, &c.—has been used instead l-gas; see *Fogarty* a little farther on. so Improved Air-gas Company, Limited; ll and Co., 280, Oxford-street, London.

The first practicable Gas Engine was, I e, made by Lenoir; his arrangement, er, was elaborate, and, to some extent, sous, as it included the use of a Battery, either galvanic or electric. The first practically *useful* gas-motor seems to have been constructed by Hugon: the principle he adopted was simply that of the Steam-engine—a water-jacket round the cylinder guarding against excessive heating; improvements in the valves of this engine have been made by Ford, and it certainly is now a quiet and useful motor. The Gas engine has also been taken in hand by American inventors, among others by Brayton (see English Mechanic, 1877, January, page 484): also notably by Fogarty, of Warren, Massachusetts (see English Mechanic, 1874, August, page 529), who interposes a column of water between the explosion and the piston; the object, doubtless, being to keep the cylinder clean: but the bulk of the engine is increased, and the power of the explosion possibly diminished. Fogarty also uses Gas obtained from Petroleum.

I would not at present be understood to *advocate* the use of Gas made from Petroleum, &c., as its explosive qualities might be subject to much variation, and therefore require a constant regulation of the due proportion of atmospheric air; at same time this explosive *may*, for aught I know, be as reliable as coal-gas.

[17, a.] Up to the present time (1877) the chief improvements in the Gas engine seem perhaps, to have been made by Messrs. Otto Langen and Crossley, of Manchester. These Inventors were apparently the first to realise that such an impulse as that furnished by an explosion of gas is of an intensely *powerful*, but at the same time of a distinctly *transient* nature, and that to drive a piston suited to the continuous impulse of steam or water by such a method, was simply bottling up a Giant that might, in his terrific struggles for liberty, ultimately shake his prison to pieces. Consequently, in the "Otto and Langen," gas is not applied *at all* as the actual motive power; the explosion being merely employed to throw a piston up to the top of a long cylinder, a vacuum, of course, instantly resulting after the explosion has taken place; consequently, the pressure of the atmosphere sends the piston down again; and the requisite catches, pawls, &c., being provided to throw the piston-rod or rack (or its wheel) into gear as soon as it has reached its highest point, a continuous motion of the Engine is the result.

b. The Otto and Langen is certainly, at the present moment, a rather noisy fellow; but it makes, after all, little more than a clatter; of the heavy *throbbing* shake inevitable in the Hugon there is here next to nothing, and for obvious reasons. The Cylinder is water-jacketted in the usual way. The inventors hope, by still further improvements, soon to render the Otto and Langen practically silent; it may be added there is no unpleasant smell whatever that the present writer could detect. It will be seen that the "Otto" is not really a Gas-engine at all, Gas not being employed as the Motor. The term "Atmospheric Gas Engine," adopted by the inventor, is sufficiently descriptive and accurate for all practical purposes. The force is, of course, limited to atmospheric pressure, and this will, probably, prevent its displacing steam where high powers are required; but for an enormous number of occasions—where a moderate, handy, safe, economical, and intermittent power is required, among which the *Blowing of Organs* occupies a conspicuous place—the Otto and Langen is, so far as I can see, destined to work a complete alteration.

c. Since the foregoing was first written the Silent Engine just referred to has actually appeared. In it the force of the explosion is transmitted directly to the Crank-shaft; the rate of the Engine is, consequently, uniform, and the economy arising from the decrease in number of explosions as the load is lightened is of course sacrificed. On the other hand the advantage of silence is gained, and the explosion is so controlled as to take place, as it were, gradually, thus avoiding the great shock felt in the *Hugon*. The price of working is about same as in first kind; the prime cost is a little higher in the 1 h.p., but a trifle lower in the larger sizes; the first kind may, for distinction, be termed the *Intermittent*. For full description of the Gas engine and the various Patents in connection with it, see the English Mechanic, p. 554, Vol. 26, and continued March 29, 1878, &c.

d. Attachment. The Gas engine demands, in all cases, the employment of a Crank-shaft to transmit its action to the Feeders. The *intermittent* nature of the Power (supposing the Intermittent form used) would render this necessary under all circumstances; but the comparatively rapid motion of the Engine shaft makes it still more so: the crank shaft, however, is a simple affair. The Bellows can (and, in fact, had better in all cases where area is limited; *see* loss if Feeder cut, 6, d.), with this Motor, have but two Feeders of exactly equal size and drop; the Cranks on the shaft, always opposite each other, of a radius corresponding to a trifle more than half the Feeder-drop (to allow for the Lug), and placed exactly opposite the centre of each Feeder. Eccentrics are to be preferred to Cranks, but are rather more expensive; a Rod will, of course, run direct from the Eccentric or Crank to the Lug on the Feeder (for this *see* Bellows, 7, e.). On the Engine shaft will be the flat-rimmed wheel, known technically as the Pulley; on the Crank or Eccentric shaft will be a similar one, but of larger diameter, the two connected by the usual driving Belt or Band: on the amount of difference between the two "Pulleys" obviously depends the amount of speed and power at which the Engine actuates the Blowing-shaft—that is, that which carries the Cranks or Eccentrics. Three Feeders will generally be preferable to two when the small additional room and cost can be borne.

e. We now come to the question of the exact method of *Governance*. The chief defect for Organ purposes (although in truth it can hardly be called such, as will be presently seen) in the Gas engine is that its action cannot be automatically controlled by the motion of the Bellows. A regulating valve is, of course, employed for the gas inlet, so that when it is known that certain power only will be required, the admission of the charge can easily be regulated accordingly. It will, however, be obvious that, in the case of the Organ-bellows, this method is quite out of question, the demand on the wind being so very variable, and, so to speak, capricious.

f. As regards the Hugon, or the Silent Otto, or any Engine in which the piston is connected directly with the Engine-shaft in the usual way, some automatic contrivance for "slowing" the Blowing when the Bellows is full, becomes (except as to be presently noticed) virtually necessary; for otherwise the Feeders must *always* be kept acting sufficiently rapidly to supply the "Full Organ;" and this is obviously inconvenient, even when they (as generally recommended for Machine-blowing) discharge into each other. The best method, therefore, becomes to use a Fast and loose pulley, as it is termed—that is, to have on the Bellows shaft a free wheel close to, and of the same diameter and size as, the wheel or pulley receiving the band. Thus, when the Receiver has risen a certain height, it raises the end of a Lever, which, in its turn, drives a Fork, between the prongs of which the band runs; and thus the latter is forced sidewise, and on to the "free" pulley, so, of course, simply revolving with the Engine (the Bellows shaft itself at a standstill), until, by the descent of the Bellows, the Band is again brought on to the driving pulley.

g. The foregoing method is (provided the Bellows be large enough, *see* i., next) thoroughly satisfactory; but it is now to be observed that with an Intermittent (Otto) Gas Engine it may be dispensed with, provided the Escape-valve be so that Feeders "blow off" into each other; for it will be obvious that the load will be so reduced at this moment—the dead-weight of the Feeders (and they balancing each other) being all to be moved—that the *number of explosions* will be lowered and the economical regulation thus obtained. Of course, it will be understood that no regulation as regards stopping or slowing the Feeders will be got this way; for as soon as they slacken a fresh explosion will take place, and—there being no loose pulley in operation—again be impelled; but the saving in Gas will remain, and the oscillation of the Feeders is not a thing of practical import as regards disturbing the wind: of course, friction goes on, though lessened. Even when Fast and loose pulley is employed it may well be in conjunction with the aforesaid form of Escape-valve, thus combining the methods. This assumes that the middle-board can be got at in case of derangement; if it cannot, better have the usual *exterior* Escape-valve. It will, of course, also be obvious that this method of dispensing with Fast-and-loose Pulley might be adopted with the Silent Otto or similar Engine; but as no gas is saved in such case, it is worth while to go to the expense of the Fast-and-loose, and so save the friction and vibration of the Blowing-action and Feeders, besides ensuring the Escape-valve accessible.

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h. We must now notice the exception spoken of. Hitherto it has been assumed that the Bellows to which the machine is attached will be those actually supplying direct into the Pipes; but, as stated in Reservoirs, this does not necessarily follow. The question and necessity of Reservoirs and Intermediaries have been already gone into (15, e.); it will be sufficient here to observe that the presence of the Reservoir makes no difference, the Supply-Receiver must either have Waste-valves for Feeders to blow off into each other *or* the Fast-and-loose Pulley must be employed.

i. The former can, of course, be used with any size Bellows, but the latter is under different conditions; it is evident that the *resistance* which the throwing off of Pulley offers to rise of Receiver is more than with a properly constructed Cock; the said resistance, in fact, cannot be set under 7lb., although it may easily be a little more; now, it is evident that 7lb. placed in the Receiver of a small Bellows will give a palpable increase of its wind pressure, and so it will be easy to understand how that when an Organ is under certain size, and Automatic regulation of its blowing be by Fast-and-loose Pulley, a *second* Bellows becomes necessary—*this* feeding into a Reservoir that supplies the whole Organ. Thus the increase of pressure caused by the throwing off and on of Band will be cut off from the Reservoir, and, consequently, from the entire Organ.

The smallest Receiver that will remain practically unaffected by an increase of 7lb. has been already given (16, l.).

j. Where the Bellows are below this minimum size, and a Reservoir is yet not desired, the Counter (Interior) Waste valve furnishes the best plan with a Gas-engine; but the better way in such case will be have a *Hydraulic*, as more suitable to so small a power; the regulating valve of this can be made as delicate as desired.

k. It is only necessary to add that when the Bellows-shaft is allowed to revolve only in *one* direction (this should always be *insisted* on with Machine blowing), the posit of the Shaft should be such that the deflection of the Rod or Tug is, during its actual blowing stroke, divided across the *semi*-diameter of the Crank or Eccentric; the said deflection will, of course, then be greater during the *return* of the Feeder, but this is of no moment. Also, if possible, the *direction* of revolution should correspond with that of Feeder—that is to say, the centre of the Crank should be vertically over a point between Feeder-hinge and Tugs; this will generally necessitate lengthening of Lug, but no more space total occupied. Remember that this posit of Shaft will, perhaps, give rather less steadiness than when the tug deflection is shared across the *entire* diameter of Eccentric; but it will economise power and diminish strain.

l. Examples of the use of the Hugon Engine are furnished by the Screen Organ in York Minster—4 Man., 69 Sound. Stops, including 3 of 32ft.: and in the Instrument of 49 Sounding Stops, built for Mr. Thomas Spratt, Vassall-road, London. The latter has an engine of ½ h.p., which is not, however, fully adequate to so large an Organ (see next, and 16, j.).

m. Of the use of the Intermittent Otto, an example is furnished by the Royal Normal College for the Blind, Upper Norwood, London, S.E.: an engine of 1 h.p. drives Bellows for 3 different Organs. The Hugon of Mr. Spratt's *Instrument* just mentioned has since been transferred to the Chapel Royal of the Savoy, London, and replaced by a 1 h.p. Intermittent Otto.

n. The branch House in connection with the Otto and Langen is 116, Queen Victoria-street, London, E.C. Any inquirers will be certain to meet with the fullest and most courteous attention. The parent establishment is Great Marlborough-street, Oxford-street, Manchester.

(*To be continued.*)

EXPLOSIONS IN COAL-MINES.—V.

By T. Wills, F.C.S.

I PASS now to another source of danger in the use of safety lamps. If a lamp is exposed too long to an explosive atmosphere, the gauze will become red hot, and in this state may kindle the outer mixture, or the rapid oxidation of the gauze may impair it to such an extent as to increase the size of the apertures, so that the flame may pass through. A lamp introduced into a mixture of fire damp and air is at once filled with the mixture which burns within the gauze. When such a state of things occurs, means should at once be taken to extinguish the lamp, the wick should be drawn down, by means of the trimming wire, until the oil flame is out. If the amount of fire-damp in the air is not very large, the burning mixture within the gauze will go out at the same time, but it may, and sometimes does happen, that the combustion within the gauze still continues. This state of things is very critical, and prompt measures must be adopted to prevent the heating of the gauze to redness, which would speedily take place. The lamp in such a condition should be moved as little as possible, it may be smothered out either under a coat, or by burying it under loose coal or dust, or plunging it into water; cases have been known, indeed, even when this has been done, in which lamps buried under the dust of the roadway have been found still alight a considerable time afterwards. The special danger here alluded to depends considerably upon the character of the fire-damp mixture, and to some extent also upon the lamps. The Stephenson lamp is usually extinguished if there be but a small proportion of fire-damp present. When the oil flame is extinguished, the combustion within the gauze will be extinguished at the same time; if there be a very large proportion of fire-damp, more than 1 to 6 of air, then no danger will arise, as the flame will be extinguished, and no burning will take place within the lamp. A miner who finds that after the extinguishing of the oil flame there is still combustion within his lamp, should regard the matter as critical, and use all his presence of mind in making an attempt to smother his lamp out. Working should never be permitted at all in atmospheres containing large quantities of gas. The next two causes of failure of lamps are not so absolutely under control as the former. It has been known for a long period that lamps are not safe if exposed to an explosive current travelling at a rapid pace past the lamp; under these circumstances the flame is sometimes carried bodily through the gauze, and communicates combustion to the exterior atmosphere. The explanation of this fact is not difficult. The efficacy of the safety lamp depends upon the cooling effect of the wires of the gauze, this cooling effect lowering the temperature of the burning gases below that at which they can communicate combustion to the mixture outside; for this effect, however, to take place, the gases must be in contact with the cooling surfaces for a definite time; if this be not the case they may pass through at a temperature still high enough to inflame the explosive atmosphere; a rapid draught through a lamp tends to produce this result, and the important point to be determined is the precise rate at which the current must be travelling.

A committee was appointed by the North of England Mining Institute, in 1867, especially to investigate this subject, and its report is interesting and valuable. A large number of experiments were made, a few with fire-damp, the majority with ordinary coal gas. Some slight inaccuracy is to be expected from the use of coal gas, as the temperature required for its inflammation is lower than that required for actual fire damp. The general result of these experiments was to show that a current of explosive gas, travelling at the rate of from 7 to 9ft. per second, impinging upon a safety lamp, would cause the flame to pass through the gauze and ignite the outer mixture. Mr. W. Galloway, of Cardiff, has repeated some of the experiments with fire-damp, and has come to very much the same conclusion—*i.e.*, a velocity of from 7 to 8ft. per second. In the experiments of the committee above referred to, a record was kept of the length of time during which the experiment lasted as well as the velocity. The importance of this is readily seen, although no special stress is laid upon the matter in the report. The longer the experiment lasts the hotter will the gauze of the lamp become, and its cooling influence will to the same extent be impaired. When this is the case it is to be expected that a lower velocity the explosive current will suffice to pass the fla through the gauze than before; this is seen to borne out by the following figures taken from t record of some of the above experiments:—

		Velocity of Current at which passage of flame took place in feet per second.		Duratio of exper ments i second
Davy lamp	...	13·6	...	6
Do.	...	7	...	12
Clanny lamp	...	10	...	20
Do.	...	9 6	...	43
Do.	...	9 0	...	45
Do.	...	8·5	...	48
Stephenson	...	12·7	...	7
Do.	...	11·3	...	12
Do.	...	11·3	...	29
Do.	...	10·3	...	52

The mean results of these experiments show that any current, travelling at a rate of 7 feet p second or more, might be dangerous, and th usually the Davy lamp allowed the flame to pa the most readily, the Clanny next, and the Stephenson last. The Mueseler is about as safe as t Clanny.

Effects Produced by Alterations of Pressu and Temperature.

The effects produced by such changes upon th volume, motion, and accumulation of gaseous ma ter, are, in connection with the occurrence of fi damp in mines, very important.

The normal pressure of the atmosphere upon eve square inch of the earth's surface is 15lb., and this equivalent to a barometric reading of 30in.; a alteration, consequently, of an inch in the height the barometer indicates an alteration of ½lb. pressu upon each square inch of surface. According Boyle's and Marriott's law, the volume of a g varies inversely as the pressure. If the pressure doubled, the volume is reduced to one-half, and vi *versâ*. As the mobility of gases permits their rap change of volume, the effect of an alteration of pre sure becomes at once evident. An alteration temperature also affects the volume of a gas, an consequently, its density, a rise of temperatu causing an expansion. The amount of this alter tion is fixed and definite, being 1-490 increase decrease for each degree Fahrenheit up or dow These two results (pressure and temperature), eith singly or together, cannot fail to have an importa bearing upon the issue of fire-damp into a pit a upon the ventilation generally.

The rate at which the fire damp issues into a mi from fissures and cavities is dependent mainly up the difference in the pressure upon the gas confin in such spaces, and the pressure in the galleries the mine; the gas flows into the pit tending to establish an equilibrium of pressure; if the pressure withi the mine be decreased, the rate of flow will be i creased, and vice versâ. It does not follow that t whole effect of the alteration will be evident imm diately, as, if fissures extend over some considerab area and communicate with large reservoirs of ga it will take a larger or shorter interval before t rate of the flow of the gas into the pit once mo adjusts itself to the changed pressure. The iss of gas from the exposed coal face, and from t excavated coal, is influenced in the same way, b the effect in this case may be looked for mo speedily upon a change of pressure than in t other.

The natural ventilation of a mine depends upo the difference in density of the air within the min and that on the surface of the earth; the air belo the surface is warmer than that above, and consequently possesses a less density. A shaft bein opened into a mine, the lower air being light wi seek to ascend, while the upper air being heavi will tend to descend; if no means be taken t divide these two currents they will neutralise eac other, but if a second shaft be opened, or a singl shaft be divided into two separate channels, an an artificial draught be started upwards throug one of these, then a continuous current can b maintained up the one shaft and down the other dependent entirely upon the difference in the tw densities—the greater the difference in density th more rapid will be the current. Now, the greate difference in density will occur when there is th greatest difference in temperature, the most rapi current being produced when the temperature at th surface is lowest and the temperature below groun the highest; the temperature in a mine is tolerabl constant, so that the rise and fall of the temperatu above ground will be the variable element. T natural ventilation of coal mines is most successf in winter. It has already been shown that the safe or danger of a mine in which inflammable gas occu depends upon the rate at which the fire-damp issu into such a mine, and the rate at which such f damp is carried away by the ventilating curre hence it will be seen that the variations of pres and temperature must be expected to have a v important influence on explosions taking place mines. The subject has received considerable attention, and a mass of evidence has been placed on record; it is in reality by the accumulation of such evidence that some successful generalisations are to be expected, for it is only by observing a number of facts that the elements of uncertainty (arising from a number of special circumstances) can be eliminated.

The first important publication on the subject is a paper by T. Dobson, published in the report of the British Association for 1855, the title being, "On the Relation between Explosions in Coal Mines and Revolving Storms." The paper contains the records of a number of great storms or cyclones, together with the known explosions which took place at about the same time. The examination of these statements shows a general connection between the meteorological disturbance accompanying a storm, and the accidents from fire-damp occurring in a mine; one remarkable instance is mentioned. A great storm occurred in England on the 4th of October, 1846. During the previous four months no accidents from explosions are recorded, but within 11 days, near the above date, five fatal explosions took place—viz., on September 26th, 28th; October 1st, 3rd, and 6th—and after this no explosion in the English coal-pits is said to have taken place for six weeks. Mr. Dobson has taken all the recorded explosions happening up to 1854, which number 514, and has plotted them in the form of a curve, which is proved to have a certain correspondence with the curves representing the changes of the barometer and thermometer. Further, 491 of these explosions, being those for which the day of occurrence is known, are arranged in 73 periods of five days each, and from the result, Mr. Dobson concluded that explosions take place with a certain amount of periodicity, being more frequent during the autumn and winter months than at the other seasons of the year. Little information was added to this knowledge until Messrs. Scott (the Director of the Meteorological-office) and Galloway continued the investigation. Their first paper was published in 1872, in the "Proceedings of the Royal Society," Vol. XX., p. 292. In this paper the general influence of a depression of the barometer or a rise of temperature is maintained, but the supposed periodicity of Mr. Dobson is disproved, for Messrs. Scott and Galloway took the whole of the explosions occurring for 20 years, numbering 1,369—these were all represented by intervals of five days in two periods of 10 years—the result showed that there was little or no difference in different seasons of the year; the absolute maximum fell at the end of January, and the minimum at the middle of September. The meteorological observations used for comparison were made at Stonyhurst. A difficulty occurs in respect of any such curves owing to the important influence which the partial or total suspension of work in a mine on Sundays exerts. Explosions do not happen only at the commencement of a barometric depression, but frequently two or three days afterwards; the limit is placed in this paper at three days; the reason of this is obvious. The gas begins to be influenced at once by such a depression, but its effect upon the atmosphere of the mine is a gradual one, and it is pointed out that an oscillating barometer within comparatively narrow limits, may have eventually the same effect as a sudden and considerable depression. Spaces and cavities, and even the ventilating current, may be considerably fouled with fire-damp before any alteration of temperature or pressure takes place, and the effect of such changes may be to cause the issue of such an amount of gas as shall produce a dangerous result. A careful watch is advised to be kept upon the state of a mine, when either a fall of barometer or a rise of thermometer, or both together takes place. A second and a third paper by these gentlemen appeared in October, 1873, and October, 1874, continuing the observations and tabulating the results in a convenient form. The following exhibits the general results:—

Year.	Total number of explosions	Percentage due to		
		Barometr.	Thermometer.	Neither.
1868-70	550	49	22	29
1871	207	55	12	26
1872	233	58	17	25

On December 20th, 1871, a sudden storm occurred, with which five accidents are associated.

The following practical observations are made in these papers:—1st. If the barometric curve, after having remained about the same height for several days, descends half an inch, or an inch, during the next two or three days, fire-damp may be expected in greater quantity than usual in cavities in the roof, and in the higher parts of the working, both during the descent of the curve and for a day or two after it has reached its lower limit; under these circumstances fire-damp may also be expected to appear in some places in which it had not been seen before.

2nd. As the curve of temperature rises to 55° and upwards, the ventilating power should be increased at the same time; and the higher the temperature, the greater is the necessity for such increase in order to prevent a possible stagnation of the ventilating current.

3rd. If a sudden fall of the barometer takes place (an inch in twenty-four hours or so), or a further fall after it has been unusually low for a day or two, the utmost care will be necessary to guard against explosions, and more especially if this phenomenon be accompanied by a rise of temperature.

The average number of annual explosions involving the loss of more than 10 lives, has been for the last 20 years, three. The Mines Regulation Act requires that, "After dangerous gas has been found in any mine, a barometer and thermometer shall be placed in a conspicuous position near the entrance of the mine;" it is not, however, necessary that separate meteorological observations shall be made for each mine, one station at which such observations are made being sufficient for those mines within a distance of 100 miles. It was considered at one time that the direction of the wind exerted some influence, but these latter ivestigations have proved that such is not the case. Great complaint is made by Mr. Galloway of the very imperfect, and somewhat culpably faulty, reports, which are required by law to be made regarding the occurrence of fire-damp in mines. The firemen, upon whom the duty falls, ought to be steadily conscientious in this matter, and it should be the care of those in authority to see that, as far as possible, such is the case. Finally, it may be again stated that no naked light should be used in a mine in which fire-damp exists, or in unventilated spaces, especially on a fall of the barometer taking place.

THE PREPARATION OF ROCKS AND FOSSILS FOR MICROSCOPICAL EXAMINATION.*

BY R. FRITZ GAERTNER, PH.D.

It is often supposed by those who have never prepared sections of rocks or fossils that the process is associated with great difficulties and expenditure of time, but this in reality is not the case, A small amount of practice is needed for the beginner, and he may soon be able to manufacture sections which are fit for the microscope. The time spent in the mechanical operation of grinding rocks is not only remunerated by interesting and instructive preparations, but adds also to a complete knowledge of their physical structure, gained by a close observation of the various features they present during the process of preparation.

In cases where large numbers of sections are to be prepared it is not possible for the lithologist or palæontologist, for want of time, to perform all the work himself; he may be assisted by any person of ordinary ability in the preliminary part of preparation. Those who do not personally wish to prepare sections can be referred to Mr. Fues, of Berlin, or to Mr. A. A. Julien, School of Mines, New York city, who prepare and deal in sections, which, on account of their perfection, deserve commendation.

In the present article I wish to describe the process of preparing rocks or fossils for microscopical study. They are mainly intended for those who design to make sections themselves, and to whom a detailed description of a mechanical operation may be of some assistance in their first attempts.

Selection of Rock Material.—It is quite important, in order to make a complete microlithological analysis of rocks, to select material which is characteristic. Most rocks are in various states of alteration; it is therefore necessary to choose fragments both from the fresh and decomposed parts, as thin sections of the latter ones are just as important and instructive as those taken from parts in which no visible change has occurred. Usually such decomposed rocks are very fragile and crumbling, because their crystalline structure or their cementing medium has been destroyed by the process of decomposition. Before undertaking to grind them their firmness must be restored. The fragments of such decomposed rocks are at first well dried, and then placed in liquid Canada balsam, which is exposed on an iron plate to a gentle heat till it has filled and penetrated the pores and fissures of the rock. They are then separated from the Canada balsam and laid upon the warm iron plate till the balsam proves to be hard when cooled down, and are then capable of undergoing the process of slicing or grinding.

Apparatus.—It consists in its most simple form of some plates of iron and glass about eighteen inches square, to allow a full stroke with the arm during the grinding process. They have to be perfectly even and flat. Emery of various degrees of fineness is required to be used on the plates with an addition of water. Fragments of rocks are ground by hand and treated as will be described in the following lines.

In the New York State Museum of Natural History at Albany, where a large number of rocks and fossils have to be cut and prepared for thin sections for illustrating the palæontology of New York, the slow process of grinding by hand had to be abandoned, and a small boiler and steam engine of two and a half horse-power were purchased, for the purpose of using steam power for the grinding and slicing operations. The grinding apparatus is formed by two circular iron plates (A and B) of eighteen inches diameter and one-half inch thickness, which rotate horizontally with a velocity of about 300 revolutions a minute. The slicer, which is used to cut the rock in certain directions, or to separate from it small slices to be ground afterwards, is a thin copper or steel disc of twelve inches diameter, and turns also horizontally with the same velocity as the grinding plates. For rocks above hardness 5, another slicer of steel is used, which turns vertically, and which is fed with diamond powder moistened with oil.

The whole apparatus may be run at the same time, and is arranged in such a manner that no one operation interferes with another.

The grinding and slicing is performed by the aid of emery, which is constantly applied to the plates and slicer with a brush held in the left hand. The plates are kept wet by a small current of water. It is important to use emery of different but uniform degrees of fineness as the work progresses. A mistake usually made by beginners is to choose a too coarse emery, in order to hasten the work of grinding, but they soon discover that all their sections break and wear off long before being half finished. It is advisable to use for the coarse grinding on plate A an emery which can be bought in any drug store as Emery No 90 (A). Plate B is charged with flour of emery (B); it serves also to prepare one or two sorts of finer emery from it, by treating a certain quantity of the flour with water in a vessel which may be about three feet high and six inches in diameter. In stirring the water the emery becomes suspended in it; after a lapse of fifteen minutes the water with emery which has not settled down during this time is decanted in a similar vessel, and left there for twenty minutes more, when the water may be drained off. A sediment of fine emery will thus form in the latter vessel; and after having repeated the process for some time the emery sediment (emery C) is taken from the vessel, dried and bottled. Its degree of fineness is expressed by the number of minutes, which is in this case fifteen minutes.

Canada balsam serves as a cementing medium; it also is used to increase the transparency of various sections. It should be entirely clear and not of yellowish tint. Usually a solution of Canada balsam in turpentine is employed to mount such rocks as will not undergo any change in heating them gently over a warm plate of iron. For rocks which cannot be exposed to any heat a solution of pure Canada balsam in chloroform is used. Both solutions of Canada balsam should be well bottled to prevent evaporation.

Object-Glasses.—The slides of glass which are intended to bear the section should be entirely clear, free of any colour, air bubbles, or any other enclosures, as those which are used in other branches of microscopy. Their size should be uniform. Prof. Zirkel, of Leipzig, the distinguished lithologist, has proposed and introduced the following size, 45mm. by 25mm., which is preferable to the ordinary 3 by 1 inch, as a slide 45mm. by 25mm. can be rotated on the table of the microscope; besides they are less liable to break in dropping thom, and also take up less room.

In the New York State Museum of Natural History the slide measuring 45mm. by 25mm. is adopted. As it was found that this glass slide was too small for a number of sections of fossils, which exceed the usual size, two other standard sizes were introduced which are in proportion to the first. Size B is twice the size of first = 50mm. by 45mm. Size C is twice the size of second — 50mm. by 90mm. It would be of great advantage if a uniform size were introduced in the various collections of those who prepare sections. The slide 45mm. by 25mm. is generally adopted with lithologists and palæontologists both in America and Europe.

Process of Slicing and Grinding.—The fossil or rock is at first marked with a pencil, and afterwards with a file, in the direction in which it is designed to be cut. It is then held with the right hand without any further apparatus, in such a direction that the revolving slicer will cut the specimen according to the marked line. The slicer is constantly supplied during the operation with flour of emery and water. If there is plenty of material and no special direction needed, small slices can be separated from the rock with a heavy blow with a hammer. The rock fragments should, as a rule, not be beyond the size of a twenty-five cent piece; of course it is of great advantage to prepare sections which offer a large field for observation, and the rock specimens should not be chosen too small, as they lose in size during the grinding process.

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* From the *American Naturalist*.

The slice of rock which has been separated either by the slicer or by the heavy blow with a hammer, is gently pressed with the right hand against the turning plate, A, while the left hand supplies plate, A, with emery A and water. It is necessary to change constantly the position of the rock-slice in the right hand, in order to grind it to an even and plain surface. The slice is then well rinsed, and cleaned of any particle of emery, A, and then transferred to plate, B (emery B), where the grinding proceeds till its surface is free of any scratches. Being cleaned of the emery, B, it is brought upon glass plate, C (emery C), and ground till its surface is entirely smooth. The rock section is finally well rinsed and brushed to clean off all impurities, and allowed to dry.

Mounting Process.—A slab of iron two and a half feet long, four inches broad, and half an inch thick, is laid horizontally upon a tripod (of iron) and heated with a Bunsen burner. The glass slide on which the rock fragment is to be mounted is well cleaned, and laid upon a part of the slab, which is of a constant and moderate heat; after being warmed a few drops of Canada balsam are placed upon the glass, and left with it on the slab till the balsam, by evaporation, has assumed a tenacious condition, in which its films will not adhere much to the fingers, and yet be pliable enough to be bent readily without breaking. The warmed mineral slice is now laid upon the Canada balsam with its ground face down, and allowed to remain on the slab till all air bubbles have disappeared below the slide in the balsam. It is then gently pressed on the glass, and then taken off, and allowed to cool. It is of great importance to use Canada balsam in its above described condition, as the rock section during the process of grinding thin unavoidably breaks to pieces in case the balsam proves to be too soft; and if, on the contrary, it has been too long exposed on the slab it will become brittle, and the section will during the grinding be liable to break off. The loosened mineral slice must in such a case be laid into a dish with turpentine to dissolve the balsam, and after being well cleaned is mounted again as described. There is no considerable difference in the process of mounting with balsam in solution with chloroform or with turpentine. The balsam in chloroform is allowed to harden in a warm room; it usually needs one or two days, while the solution in turpentine by application of heat hardens in from five to ten minutes. In the latter case care should be taken not to heat the balsam too quickly, as it turns yellowish on account of a partial carbonising.

Grinding Operation.—After having used all necessary precaution in cementing the rock fragments to the glass, the grinding manipulation now begins on the reverse side of the section. It is ground at first on plate A (emery A), then on plate B (emery B), till the section commences to be translucent, or till it is so thin that it is not advisable to continue the process on the rotating wheel. It is, of course, only a matter of experience to know how long to use the various wheels, as much depends on the consistency of the rock material. It is advisable to discontinue the use of plate B before the slice is too much reduced in thickness, so as to allow a further treatment on glass plate C with the fine emery C. Due precaution should be employed, so as not to grind the section uneven. To avoid this the position of the section should frequently be changed in grinding. The section is ready as soon as it is thin enough to allow a complete study of its texture and its component parts, of which a preliminary examination under the microscope will be found the best test.

Process of Covering and Remounting.—The section is well rinsed and brushed to remove any emery which might have remained on the glass, or which may be accumulated in the pores or fissures of the slice. It is then laid in a vessel with turpentine, in order to dissolve the excess of Canada balsam around the slice. In a few minutes it will be softened enough so as to be easily removed by a gentle brushing with turpentine, after which it is well washed, and then dried with chamois leather. In order to protect the section and also to increase its pellucidity, it is usually imbedded in balsam and covered with a thin glass, the thickness of which should not exceed 0·25 mm., to allow the use of a high magnifying power.

Usually the glass slide on which the mineral slice has been cemented to grind it thin, becomes partly ground during the various operations. It may be replaced with a clean slice on which the mineral slide is mounted, as already described.

The separation of the section from the original glass is done by gently heating it till the Canada balsam becomes softened enough, so as to allow the removal of the section by a slow sliding to a vessel with turpentine. The heating should be done very gently, otherwise a crust of hard Canada balsam will form around the sections, the removal of which by aid of turpentine or any other dissolving medium will be most difficult.

Another method consists in laying the glass with its slice in a dish with turpentine, and to leave it there till the balsam is entirely dissolved, after which the slice of rock may be separated from its glass without any difficulty. The thin slice is transferred to another dish with turpentine, and left there till it proves to be entirely free of any foreign matter. It is then taken from the vessel with the point of a knife, rinsed with alcohol and dried, afterwards mounted on a glass which has been warmed, when the slice may be placed upon it with a few drops of Canada balsam.

The whole operation of transferring needs great care, as some mineral slices will prove to be very fragile on account of their thinness. Sections which are made of a rock material which needed a preliminary treatment of Canada balsam to make it firmer would break entirely to the smallest fragments in the attempt to remove them to another glass, and have therefore to remain on their original glass. Before covering them the greatest care should be taken to free them entirely from any Canada balsam around the borders of the mineral section, and also from emery, which sometimes can only be detected by aid of a magnifying glass. The remounted mineral slice, or the one which could not be removed, as stated above, is covered with a few drops of Canada balsam, and laid again upon the warm slab till the balsam has obtained the required tenacity. A thin cover glass, corresponding in size with the mineral slice, is cleaned with alcohol and warmed; it is then taken up with a pair of forceps and dropped slopingly on the slice, so as to exclude any air. The section is left on the warm slab till all air bubbles have disappeared which may have been inclosed between the section and cover-glass; the latter is gently pressed upon the section, and then allowed to cool. Care should be taken to place the mineral slice and cover glass in the centre of the glass slide, which will contribute to a nice appearance of the finished preparation. The surplus of Canada balsam around the cover-glass is cleared off by brushing it with turpentine, then it is well rinsed with water, and after being dried it should be labeled at once. The labels should be applied on both sides of the preparation, and inscribed with the name and locality and geological group of the prepared material. It is well to number the sections and record them in a catalogue, in which also a description of the most interesting and principal features of each mineral slice may be given, which will facilitate a future study of the section.

A Railway Relic.—There has just died at Birkenhead W. N. Found, who was at the time of his decease the oldest railway clerk in the world. Found booked the first passenger that ever rode on the Manchester and Liverpool Railway line. The passengers in those early days of railway travelling were booked at what is now the Royal Hotel, in Dale-street, Liverpool, and were conveyed in omnibuses to Edge-hill, thence per rail to Manchester.

Boiler Explosion.—At the works of the Darlington Iron Company (Limited), on Saturday morning, an upright boiler exploded, an interior tube giving way. Fortunately the bulk of the workmen were away at breakfast, or the loss of life must have been serious. One man died soon afterwards, and one or two others are in a dangerous state. A woman living on the opposite side of the road, while engaged in kitchen work, was hit by a flying missile, and cut in the head. Her life is despaired of. The boiler had been regularly inspected. The force of the explosion carried the boiler through the roof 50ft. high, and it fell down 50 yards off through another roof.

Sun Engraving.—The forthcoming number of Petermann's *Mittheilungen* contains a highly interesting paper entitled "The Sun in the Service of Geography," in which the advantages of the process of heliogravure or sun engraving upon copper, as practised by the Austrian Military Geographical Institute, are dwelt upon. The maps of the new Austrian ordnance map are carefully drawn on paper, on a scale of 1 : 60,000. They are then reduced photographically to a scale of 1 : 75,000, transferred upon copper, touched up, and printed. In this manner each sheet of the map can be produced in nine months, while the same amount of work engraved in the usual manner requires nearly 46 months for its completion. The whole of the Austrian staff map, consisting of 715 sheets, will thus be completed in 10, 11, or 12 years. No less than 271 have been published since 1874. The advantages of this process, as regards cost and rapidity of publication are evident, and they fully compensate for any slight inferiority in the appearance of the work. An engraver, to whom we showed one of the maps produced in this manner, firmly believed that it had been engraved upon copper. If the Ordnance Survey Office were to avail itself of this process, the 1in. map of the United Kingdom, for which we shall have to wait under present arrangements for years, might be completed very speedily. The Ordnance survey of Palestine, at all events, might be produced in this manner at comparatively little expense, and in a very superior manner, as an examination of a specimen map in the *Mittheilungen* will show. We ought to mention that a similar process, invented by Colonel Avet, has been in use for several years past, in the office of the Italian General Staff.—*Athenæum.*

SCIENTIFIC SOCIETIES.

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THE METEOROLOGICAL SOCIETY.

THE closing meeting of this society for the present session was held on Wednesday, the 19th inst., at the Institution of Civil Engineers, 25, Great George-street, Westminster; Mr. C. Greaves, F.G.S., President, in the chair. J. C. Philips, Esq., J.P., and W. S. Rawson, Esq., were balloted for and duly elected fellows of the society.

The following papers were then read:—"The Climate of Lundy Island," by A. J. H. Crespi, B.A., F.M.S. Lundy Island, from its geographical position, might be expected to have a mild damp climate, with cool summers and warm winters, and a small diurnal range of temperature, and so, no doubt, it has, although certain local circumstances, in addition to its peculiar configuration, make the climate remarkably inclement, windy, and unpleasant. The island runs nearly due north and south, having an extreme length of four miles, and a breadth of from 200 yards to 1,600 or 1,800. There is a nearly flat tableland or "top" running due north and south, having an altitude of 450ft. Shelter there is none, every current of wind sweeps the whole tableland. From the edge of this tableland the ground slopes away to the sea; sometimes the descent of the sideland is extremely abrupt, at other spots more gradual, while the sidelands are deeply cut by caves, precipices, small bays, and glens. All around the island the water is deep a few hundred yards off, while the currents are formidable, and tremendous seas break upon the rocks almost every day in the year. The one drawback of the place is the wind, so furious and continuous are the blasts, first from one quarter, then from another, for days and even weeks. When gales occur, as they generally do at short intervals, the force of the wind becomes incredible; walls are torn down, gates and doors wrenched out of their fastenings, and the few buildings which cannot be blown down are more or less injured. Fogs are remarkable for their frequency and density, and are nearly always drenching. The rainfall is nearly 50in. per annum. February and March are said to be the coldest months, and August the hottest. The mean temperature of the year is about 50° or 51°.

"On the Auroral or Magnetic Cirrus," by the Rev. S. Barber, F.M.S.

"Contributions to the Meteorology of Natal," by Dr. R. J. Mann, F.R.A.S. This paper is a discussion of the observations taken at Maritzburg (2,095ft. above the sea level) during the six years, 1860–1865. From it we learn that the summer of Natal is a season of copious rain, and the winter a season of relative dryness; also that the former is a time of abundant and frequent cloud, and the latter a time of preponderant sunshine. The summer is consequently cooler in a material degree than it would otherwise be on account of the frequent prevalence of cloud and the abundance of the rainfall; and the winter has its temperature materially raised from the constant occurrence of clear skies and bright sunshine. The mean annual rainfall was 31·13in., of which amount nearly 28in. came down during the six summer months (October to March), and scarcely more than 2in. during the four midwinter months (May to August). Thunderstorms are of frequent occurrence, the average exceeding 7 per month from October to March. The thermometer rarely rises above 85° in the shade, even in the summer months, unless a hot wind is blowing. It then mounts to somewhere between 85° to 97°, according to the strength of the sirocco. The degree of humidity indicated by the dry and wet bulb thermometers, when a hot wind is blowing, varies from 25° to 52° of moisture. The highest temperature recorded during the six years was 97°·6, the lowest 29°, and the mean 63°·3.

"Note on the Mean Relative Humidity of the Royal Observatory, Greenwich," by W. Ellis, F.R.A.S. In this paper the author gives the mean relative humidity in each month of the year at 9 a.m. and 9 p.m., and the mean of the 24 hourly values, derived from the photographic records of the dry and wet bulb thermometers for the 20 years, 1849-1868. The 9 a.m. value is smaller than the mean in summer and larger in winter, and the 9 p.m. value is larger than the mean throughout the year, but most in summer. The mean monthly values change little from April to August and from October to February, and there is a great decrease between February and April, and a corresponding great increase between August and October. The mean for the year is 80°·7.

"On a Method of Sometimes Determining the Amount of the Diurnal Variation of the Barometer on any Particular Day," by the Hon. R. Abercromby, F.M.S.

"On the Relative Duration of Sunshine at the Royal Observatory, Greenwich, and at the Kew Observatory during the Year 1877," by G. M. Whipple, B.Sc., F.R.A.S. The author having instituted a comparison of the amount of sunshine recorded at these two observatories, finds that the totals show that for the whole year the excess in e number of hours the sun shone at Kew over the umber at Greenwich amounted to 171. This difference is, no doubt, due to the direction of the wind, r Greenwich lying to the south-east of the chief rt of London, and having also large manufac- ring establishments on its northern side, is greatly aded by cloud, probably in a great measure due smoke, when the wind blows from W., N.W., or ., while at Kew, which is situated to the west of ondon, and is remote from factories and shipping, njoys a larger percentage of sunshine with these inds. With winds from the N.E., S., and S W., ew has but slight advantage over Greenwich. With . and S.W. winds the London smoke is driven over ew, and its presence in reducing the transparency the air is evident in the diminished amount of sun corded, the quantities being only 81 and 65 per nt. of those registered at Greenwich.

"Account of the Atmospheric Disturbance which ok place in lat. 21° N. and long. 25° W., on Jan. 28, 1877," by J. H. Carden.

"Notes on Some Remarkable Cloud Formations ccompanying Sudden and Frequent Changes of mperature and Wind," by Capt. W. Watson, M.S.

ROYAL INSTITUTION.

Minute and Low Forms of Life.

THE third and last lecture of the Rev. W. H. Dallinger's course was given on Tuesday week. he preceding discourse had described the delicate tails discovered by the use of the very highest agnifying powers, which reveal themselves in the e-history of two of the minutest putrefactive ganisms known; and it was shown by persistent llowing that they originated—like all the orga- sed beings above them—in inexpressibly minute, t still demonstrable, germs or spore. The lecturer w contended that it was a most important matter determine whether these germs could resist the tion of heat better than the adult. He had eady explained how he tested this by means of exposure of the demonstrated germ to dry heat. the very careful application of this in the case of newly-discovered organism, described first in the t lecture, he demonstrated that the germs which produced could resist successfully a temperature 250° F. But this method of heating has one jection: it differs from the method employed in ting the heat-resisting power of the adult. That tested in fluid; and the power of vital istance may be greater in the one con- ion than the other. Yet to practically demon- ate that germs, seen to be on a given plate glass before heating, will or will not develop er the endurance of a certain degree of heat, no er method is conceivable. But the lecturer had n surprised to read in a recent paper by Dr. stian, "On the conditions favouring fermenta- n, &c.," that he considered this heat-testing of ms in fluid "perfectly easy." He told us we l nothing to do but to "put one or two drops of fluid into a small tube . . . hermetically seal and then heat it for ten minutes or more to ferent degrees before subjecting the fluid to a longed microscopical examination." Mr. Dal- ger said that this method was doubtless "per- tly easy," but at the same time perfectly less. What we really need is to be quite tain that the germs, in a freshly emitted con- ion, are in the drop of fluid we are examining. ubtless germs in various stages of develop- nt would be in any given drop, and freshly itted spore might be; but in such a case negative ults could have no conceivable value. The fact t even vegetable seeds in an undeveloping con- ion can resist very high temperatures is now nonstrated; but the same seed in a developing te is destroyed with a very slight elevation of perature. For practical issues, then, we must be e before heating that the undeveloping germ is re, and for this purpose we can only use the thod of dry heating. The lecturer had, however, ployed a method for comparing the difference of perature at which the germ is destroyed in dry and fluid respectively. It depends upon the of extremely delicate glass apparatus, so con- ucted as to allow the effect of heating to be ectly seen with the lens, without the withdrawal fluid from the vessel in which it has been heated, l was fully described and illustrated. It also mitted of the direct testing of the point of tem- ature at which the adult is destroyed. And by eries of controlled experiments this was shown to 142° F., after which temperature no adult of the cial form in question ever survived. Yet its ms in dry heat could resist 250° F. By an angement described the lecturer then made quite tain that the germs were in the apparatus, and by ries of experiments first at the boiling point, ured by melted paraffin, and next by a digester, was shown that the germs of this organism deve- ed, and were watched in doing so, after heating the fluid to 220° F.; but this was the limit. Thus difference of resisting power in dry heat is ater than that in a hot fluid to the extent of 30°

But this is not a universal difference: for the ne method exactly was employed by Mr. Dallinger for discovering whether it applied to other septic organisms of the same series. He was able to test its application to three of the monads, which Dr. Drysdale and himself had worked out together, and whose death-point in a dry heat they had determined; and he found that these three monads produced germs which were killed at 38°, 32°, and 28° F. lower in fluid than in dry heat. But only one of them had its germs destroyed so low as the boiling point of water. But it must be manifest that the capacity in a germ to resist 220° Fah. implied protection. And one thing is certain: the optical condition of the germ is quite different when just emitted and when it has begun to germinate; in the course of an hour it is far less visible, because far more transparent. At the first appearance it is nearly opaque. There is then, in all probability, no activity at all in the new germ. It is only when development begins that the circulation of the heated fluid takes places, and then it is that the too high temperature of the fluid destroys the vital process. But there is no fluid circulating in the undeveloping germ. It is inert—protected—and this has undoubtedly been acquired in the struggle for existence by beneficial survival. For when the nature and vicissitudes of the organisms are considered it must be of immense advantage to them. An instance was then given of the danger of assuming that, because the adult organism is destroyed at a given temperature, any reappearance of the organism itself, even though in a hermetically sealed vessel, is the necessary result of "spontaneous generation." It was shown that Dr. Bastian had made such an inference in relation to a monad; but when the facts came to be tested, the monad was shown to be one that Dr. Drysdale and the lecturer had worked out, and that its germs are destroyed only at a much higher temperature than Dr. Bastian subjected the fluid that contained it, and therefore that it did not arise in the fluid "spontaneously," but arose from its uninjured germ. The nature of the evidence which these researches give in favour of the doctrine now accepted of the origin of species was then considered, and the lecturer showed that if this work was steadily pursued, even in the course of a human lifetime, evidence of development in living things might be clearly and fully given.

A Darien Canal.—Upwards of a year ago an account was published of an exploration made across the Isthmus of Darien by an expedition under Lieutenant Wyse, of the French Navy, with a view to the construction of an interoceanic canal. The project originated with a sort of international company, having its seat in France, and after the most careful exploration, carried on till quite recently, Lieutenant Wyse reported in favour of a line from the point of Gandi or Acanti, on the Atlantic side, along the valleys of the Tupisa and Tiati, to the river Tuyra, near where it discharges in the Gulf of San Miguel. Recently Lieutenant Wyse went to Bogota to negotiate with the Colombian Government for the concessions required for carrying out the project, and news has just been received that a contract has been concluded between the Government mentioned and the international committee. Among other conditions it is stated that the canal will be neutral, and be free to the commerce of the world. The company are to receive a grant of the land for 600ft. on each side of the canal, and, besides, a million acres in any part of the country they choose. Every facility will be given to obtain the use of the necessary material, and the work is to be completed before 1895.

Healing Raw Surfaces.—Nearly a year ago Dr. G. F. Waters, of Boston, stated that bicarbonate of soda, if applied to a burned or scalded surface, promptly subdued the pain. He performed a somewhat impressive experiment, to prove his discovery; he scalded himself severely, on a space seven centimetres broad, all round his wrist. The application of the bicarbonate immediately relieved the pain, and if all had gone well the burn would have been cured in a week. But the Doctor was careless, and permitted his cuff-button to catch and tear the blistered skin, and further trouble of the same sort was caused by friction on the edge of the cuff. The result was that while the rest of the burn was soon cured, the part thus torn became a troublesome, suppurating wound. Studying the subject, Dr. Waters thought that possibly vegetable albumen might answer the same purpose that animal albumen is supposed to, in the formation of dermal scales. He proceeded to test this theory by removing the scab from a portion of the wound, drying the surface with blotting-paper, and then immediately applying the white juice of the common milkweed (*Asclepias syriaca*). Space after space of the sore surface was thus treated, each portion being allowed to heal successively before the next part was tried. According to the depth of the sore, the time of healing varied from twenty-four to thirty-six hours, but in each instance new skin formed completely across. The doctor states, as to this new discovery, that the only essential point is to dry the wounded surface gently and thoroughly with blotting-paper before applying the milkweed juice. From the description it appears that after the juice was applied, and while the healing was in progress, a piece of blotting-paper was also used to cover the surface

SCIENTIFIC NEWS.

◆

THE founder of the Cleveland iron trade, Mr. Henry William Ferdinand Bolckow, M.P., died on Tuesday last week at the age of 72. Born in the Duchy of Mecklenburg, he commenced his career in a merchant's office at Rostock, where he found, as a fellow-clerk, Christian Allhusen, whose brother was settled at Newcastle-on-Tyne. The two friends left Germany, and after serving for a time in the business already established by the brother, they commenced for themselves as C. Allhusen & Co., commission agents. In 1841 Mr. Bolckow retired from the firm in possession of a considerable sum of money, and, in conjunction with Mr. Vaughan, began those undertakings which have done so much to create the Cleveland iron trade, and to develop Middlesbrough. This is not the place to detail the fortunes of the firm. It must suffice to say that in spite of difficulties Bolckow and Vaughan prospered, and the business grew to such proportions that in 1865 it was converted into a company, the shares of which were easily distributed. So much had Mr. Bolckow done for Middlesbrough that he was elected its first mayor, and has since been twice returned to represent it in Parliament. We believe it was mainly due to his personal influence and exertions that the Tees was converted from a shallow stream into a fairly navigable and commerce-encouraging river.

It will be seen from an article on our first page that Mr. Edison claims the invention of the microphone, and in asserting his claim uses language which is unusual amongst English-speaking scientists. Just as we were preparing for the press we received the letter from Mr. Preece, which appears on p. 393.

It is proposed to present Mr. Le Neve Foster with a substantial testimonial in money, in recognition of the judgment, zeal, and energy he has devoted to the interests of the Society of Arts during the quarter of a century he has held the secretaryship.

The present year promises to become remarkable for extraordinary falls of rain, which, besides demonstrating the insufficiency of the metropolitan drainage system, show how hopeless it is to attempt to prophesy the weather. The storm of Sunday last was exceptionally severe in some parts, 0·10in. of rain falling in one-half minute, or at the rate of 12in. per hour. Exactly an inch fell in the ten minutes between 1.57 and 2·7, and the totals of 2·44in. in 40 minutes, and 2·34in. in half an hour, are remarkable by their rarity. Those amounts were registered by Mr. G. J. Symons, at Camden-square, where 3·28in. of rain fell in one hour and a half. So local was the storm, however, that its limits are almost sharply defined by the rain-gauges. At Hamilton-terrace, St. John's-wood, the amount registered was 0·34, at Hampstead (Squire's Mount) 0·35; at Highgate Nurseries 0·40, and at the Orphan Working School, Haverstock-hill 0·56; a line connecting these places shows the fringe of the storm; but further south and east its full fury was experienced, as already mentioned not less than 3¼in. being registered at Camden-square, and about 2¾in. at two stations in the Camden-road. Camden-square, it may be mentioned, is about a mile from Haverstock-hill, and a short distance to the north of what might be termed the iron-yard of London—the large area covered by the metals of the Midland and Great Northern goods stations.

At the conversazione of the Royal Society on Wednesday week, one of the most interesting and most popular exhibits was the phonograph—Edison's patent being exhibited by the sole licensees, the London Stereoscopic Company, and a specimen phonograph by Mr. Shelford Bidwell. Many of our readers will be pleased to hear that in the opinion of many good judges the articulation was better in Mr. Bidwell's phonograph than in that exhibited by the company. Experimenters who have failed to obtain such a result, may take the hint, and try again.

Mr. Ashbury, of Balsall Heath, Birmingham, is introducing Hornbostel's patent oxygenated blast into this country. The apparatus, in conjunction with a Baker's rotary blower, has been fitted to a forge at the works of the L. and S. W. R., Nine-elms, where it is to be experimentally tested. The invention consists in conducting the blast through a vessel in which oxygen is rapidly and steadily generated, and the results are said to be not only economy from the greater heat, but facility in working iron by the purity of the surfaces produced in the forge. A similar remark applies to the melting of iron in the cupola, and for the reduction of ores in the blast furnace.

"The Major" has been asking the President of the Board of Trade whether he could exercise any authority to compel the Great Western Railway Company to refrain from putting into "second motion" trains, which, having arrived at their destination, are supposed by unwary passengers to have come to rest. Of course the Board of Trade cannot interfere, but the "second motion" is nevertheless a fact, and often causes travellers to fall, when they are immediately pounced upon by the officials for getting out of a train whilst it is in motion, and so frightened out of bringing an action for damages. The chain brake appears to be the worst of all, as might, however, be expected from its nature.

Mr. T. Dunman is completing a "glossary" of biological, anatomical, and physiological terms, which will furnish the pronunciation, derivation, and definition of all those terms employed in that branch of science which treats of animal life. It will be a useful work, but what is wanted is a "glossary" of scientific terms, especially now that popular science is a feature in all kinds of serial literature.

Profs. E. J. Houston and Elihu Thomson, whose reaction telephone we illustrated and described last week, have applied the microphone as a telephone relay or repeater, by attaching it directly to the diaphragm of the receiving telephone. The microphone, in this case, is a miniature consisting of three pieces of carbon arranged as described by Prof. Hughes, the blocks holding the pencil in cavities being cemented directly to the diaphragm. The microphone produces such variations in the electrical current as to cause the original message to be repeated to any instruments in circuit.

Mr. Edison has, it is said, perfected the "receiver" of the telephone, so that words spoken at a distance of 100ft. from the instrument have been distinctly heard many rods away. A difficulty was found in the fact that the other sounds made in the laboratory were also heard, but they did not destroy the voice of Mr. Edison. By "receiver" of the telephone it is meant that Mr. Edison has improved the transmitter so much that it is sensitive to sounds made some distance off.

Prosecuting their researches on colour-blindness, Profs. Cohn and Magnus, of Breslau, have recently examined more than 5,000 children. Of 2,761 boys there were 76 who suffered from this blindness, or 2·7 per cent. Of 2,318 young girls, there was only one incapable of distinguishing colours. Further, a curious fact was established. Among 1,947 Christian boys, 42 were unable to make this distinction, or 2·1 per cent.; among 814 Jewish boys 34, or 4·1 per cent.; and among 836 Jewish girls, not one. These results seem to prove that in the case of girls colour-blindness hardly exists at all; and that among Jewish boys it is about twice as common as among Christian boys (though local influences might possibly affect the results). In this connection we note that M. Favre has lately been studying Daltonism in France; and he finds there are in that country more than 3,000,000 persons thus affected. The number of females affected is to that of males as 1 : 10. He says that nine cases of Daltonism out of ten may be easily cured in young subjects; the best mode of treatment being methodical exercise upon coloured objects. Mothers should be careful to develop the chromatic sense in their children. Examinations and exercises in colours should be conducted in all schools, &c.

The singularly low temperature of fusion of the new metal gallium, and the wide limits within which it remains in the state of surfusion, have afforded M. Regnauld an opportunity which he had sought in vain with other metals. He has constructed a couple, the two metallic elements of which are solid and liquid gallium, connected by means of a layer of neutral sulphate of gallium dissolved in water. Notwithstanding the minute size of this hydro-electric couple (about 4 square mm.), it produced a constant deflection of more than 40° in a fine wire galvanometer, the direction indicating that the liquid metal was in a state of negative tension, and the solid plate in one of positive; the former, therefore, acting like zinc, and the other like copper, platinum, carbon, &c., in ordinary voltaic couples. This experiment manifests, in a very simple case, the influence exercised by the heat of constitution of a simple metallic body on the energy of its chemical properties.

The discoverer of gallium, M. Lecocq de Boisbaudran, was recently elected by the French Academy correspondent in the section of chemistry, in room of the late M. Malaguti.

Apropos of a good deal that has been written lately about the poisonous or non-poisonous properties of salts of copper, an observation recently made by M. Balland on copper in oysters, is interesting. A number of so-called Portugal oysters, sent from Oran to Orleans in March, showed a remarkable green colouration. On being pressed against the palate they left a sensation of bitterness or tartness, and when placed in contact for some time with a well-cleaned plate of iron they deposited a thin red layer of metallic copper. M. Balland sought to determine the amount of copper by precipitation with an electric current; two oysters (without their shells) having been triturated and placed in a sulphuric acid solution, in 16 hours 6 milligrammes of copper were deposited, and several other experiments gave this amount of about 3 mgr. for each oyster. Of the persons to whom these oysters were sent some rejected them on account of their colour, others took them, and without any injurious consequences.

According to a recent German patent, M. Ewald, of Zittau, produces from jute, hemp, flax, nettle fibres, and tow of these materials, yarns and tissues which, in their appearance and technical properties, are like those made from wool, cotton, linen, and silk, but which are considerably cheaper. The treatment of the raw material involves two principal operations: The first being decomposition of the fibrous bundle into elementary fibres; and the second a bleaching process, which is different for different kinds of fibre. (Further particulars will be found in *Deutsche Industrie Zeitung*, No. 23.)

It is a remarkable and unexpected fact that the Chinese are beginning to work their own coal. The superstitions which have been an invincible obstacle to exploration of one of the great coal basins of the world, seem to be disappearing. A mandarin has obtained permission to form a company for extraction of coal at a place about 180 kilometres from Chefoo, to employ the best approved machinery, &c., and even to connect the mine with the sea by means of a railway.

Under the ægis of a large number of engineers, architects, and bankers, a permanent exhibition for building and industry has been opened in Frankfort-on-the-Maine. Besides a collection of all the objects connected with building (stone, iron, bronze, and zinc wares, machines, models, house telegraphs, &c.), the exhibition includes a depôt specially American, a collection of newly patented objects renewed quarterly, the model kitchen of the Frankfort Cookery Exhibition, and a periodically renewed collection of paintings.

The owner of a large farm not far from Lancaster (Pa.) had lately an opportunity (according to the *L. Examiner*) of witnessing how an interloper is punished by the marten species of birds. A pair of martens had taken possession of a small box, and were building their nest. One day, while they were absent, a screech owl took possession of the box, and when the martens came home at night would not allow them to enter. The smaller birds were nonplussed for a while, and in a short time flew away, seemingly giving up the fight. But if the owl was of this opinion he was sadly mistaken, for in a short time the little ones returned, bringing with them a whole army of their companions, who immediately set to work, and procuring mud, plastered up the entrance to the box. They then all flew away. In a few days the box was examined, and the owl was found dead.

Some experiments lately made by M. Schuhmeister on the heat conductivity of cotton, wool, and silk, by a method similar to that employed by Stefan for determining the conducting power of gases, have led to the following results:—The heat conduction of air being considered = 1, that of cotton is (on an average) = 37, sheep's wool = 12, and silk = 11. Both the cotton and the wool were unwrought. The latter was washed merino wool; the silk was in the state of cocoon fibres.

A target which indicates instantaneously to the marksman himself the exact result of his shot, has been invented by M. Mantel-Rieter, of Winterthur. He is content at present to use numbered circles, but the system can be easily adapted to any division of the target. The mechanism (which is still kept secret) is placed behind an ordinary target; the shock of the ball produces a mechanical contact, and closes an electric circuit, so that an index at once rises from a table at the side of the marksman. This table is divided, like the target, into numbered concentric circles. Four holes are pierced in each of the zones, in the direction of two diameters at right angles, inclined 45° to the horizon; the small circle in the centre has only one hole. When a ball strikes the target a number is presented automatically on the table, in the hole corresponding to the quarter of the zone touched. At the same time there rises on the right side of the table a small card, bearing the same number, which may be delivered to the marksman. By a simple mechanism the numbers are pushed in again, and the target is ready to indicate a fresh shot. The inventor is constructing a second apparatus, in which the table will indicate not only the numbered zones, but will give a complete image of the target, so that the marksman may judge more certainly as to the point he has struck. All the balls which reach the target are retained in it.

A new rifle, devised by MM. Krag and Pettersson, has (we learn from *Revue Maritime et Coloniale*) been adopted in the Norwegian navy. It is of the repetition type, but differs from most repetition rifles in that the introduction of the cartridge does not take place automatically, but requires a particular movement to be made. The magazine may contain nine cartridges, so that, with the cartridge in the chamber, ten shots can be fired without reloading.

The use of the compass on board ships made of iron, or charged with magnetic matter, is known to be attended with considerable difficulty. Up to a certain point the indications of the instrument may be corrected by addition of magnets in certain positions determined by experience, or ascertaining, by calculation, the disturbing action of the ship. But these corrections, good in one locality, are influenced by the magnetic climate, and so vary in the course of a voyage. Besides, a slight displacement of magnetic masses on board will change all; thus, in some steamers with telescopic funnels, it is found that the compass gives different indications, according as the funnel is drawn in or out. In view of such facts, M. Faye has lately suggested a new mode of determining a ship's route at sea—viz., by means of the log. With the sextant the angle is taken which the cord of the log makes with the direction of the sun or a star, and thus the ship's direction is determined. The method seems to deserve experimental trial.

The Microphone.—Mr. Th. Wiesendanger has improved the microphone we described on p. 366, in the direction indicated by the remark that a copper wire answered as well as the carbon rod. A small bar of brass with a sliding weight renders the microphone adjustable to adapt it to louder sounds, whilst it still retains its marvellous sensitiveness. The "sound" made by the fall of a small piece of paper on the platform of the microphone is heard as a distinct tap in the telephone, while every noise made in the house, steps in the room, and even whispers, are recorded by the microphone which in this case is capable of being graduated to the sounds it is desired to hear.

LETTERS TO THE EDITOR

[We do not hold ourselves responsible for the opinions of our correspondents. The Editor respectfully requests that all communications should be drawn up as briefly as possible.]

All communications should be addressed to the Editor of the English Mechanic, 31, *Tavistock-street, Covent-garden,* W.C.

All Cheques and Post-office Orders to be made Payable to J. Passmore Edwards.

*** *In order to facilitate reference, Correspondents, when speaking of any Letter previously inserted, will oblige by mentioning the number of the Letter, as well as the page on which it appears.*

"I would have everyone write what he knows, and as much as he knows, but no more; and that not in this only, but in all other subjects: For such a person may have some particular knowledge and experience of the nature of such a person or such a fountain, that as to other things, knows no more than what everybody does and yet, to keep a clutter with this little pittance of his will undertake to write the whole body of physicks: a vice from whence great inconveniences derive their original." —*Montaigne's Essays.*

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WHO INVENTED THE MICROPHONE?

[14503.]—As you may probably in your next number give prominence to certain wild statements made in the American press respecting me, perhaps you will kindly publish the following telegrams which have been sent to New York:—

> "To Norwin Green, New York.
>
> "Pray give the most absolute and unqualified denial to the statements made by Edison respecting me. Hughes has not brought out any thermopile. His microphone is quite a different instrument to Edison's telephone. It was worked out without any communication with me, or information imparted by me, in any way whatever. I knew nothing of it until it was shown to me, together with Professor Huxley and Mr. Norman Lockyer. I am in no way whatever a coadjutor of Hughes
>
> "W. H. Preece."
>
> "I emphatically endorse every word of the above message. "D. E. Hughes."

June 25, 1878. **W. H. Preece.**

ADJUSTABLE MICROPHONE.

[14504.]—I forward for our readers description of a handy form of adjustable microphone that I have made, and find superior in many ways to any I have come across yet. Of course I give full credit to Mr. Lancaster's neat and handy microphone and battery combined. I have made one, and it gives very good results, but many experimenters would prefer to have the battery separate, and others like to try various forms of the instrument, so it is to those that I address myself.

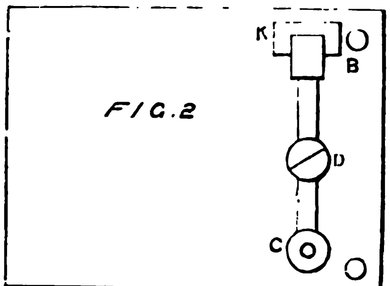
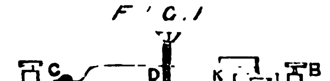


FIG. 2

FIG. 1



In the first place I get a piece of ¾in. deal, about 6in. by 3in., polish it up and ebonise it (recipes for ebonising will be found in Vol. XXV., p. 644 and 645) Underneath four corner pieces, two of which are shown at H H, Fig. 1. We next want to fix one of the carbon pieces on the board. In one corner of the board cut a square hole through, as at A, then get your carbon block and bore a hole half-way through it, making the hole wider inside K, Fig. 1). The carbon block is sunk slightly into the hole at A, a piece of copper wire inserted, and melted lead poured into the hole, binding the carbon block on and making a good connection between it and the wire, which is then connected underneath to the binding screw at B. Then get a slip of thin "latten" brass about 2in. long by 3-16in. broad, and punch two small holes in it, one at one end, C, the other in the middle, D. At the other end a piece of gas carbon, about ⅜in. by ¼in., by ⅜in., is fastened by means of melted lead. The end, C, is then fastened down with a screw and washer; the carbon end in this position being about ⅛in. from the carbon block. A small spiral is made with No. 32 copper wire—this is put on a taper wood screw, which is screwed through D till the two carbon surfaces touch. If small sounds are intended to be shut out, the screw is tightened. It may, of course, be used with a soundboard if desired. **Crux.**

SIMPLE FORM OF MICROPHONE.

[14505.]—Thinking some of the readers of the English Mechanic would like particulars of a simple microphone capable of making the tramping of a fly, &c., audible, I inclose a sketch of one I have made which is extremely sensitive. All the battery it requires is a piece of carbon and zinc or copper and zinc, about 3in. square. with a piece of blotting-paper between, damped with vinegar. It answers equally as well as an expensive battery. F, Fig. 1, a box, size immaterial, say, 4in. square. Over the top is stretched a piece of vegetable parchment. AA, pieces of carbon filed to a knife-edge at top to support small stick of carbon, B; C, piece of wood glued to AA and to parchment top; DD, wires connecting AA with binding screws, EE. An old sewing machine needle makes a good drill for drilling the holes into which the wires, D, are wedged tight with the point of a pin Fig. 3 is another form scarcely so sensitive as Fig. 2, but less liable to accident from flies walking over it. AA are two pieces of carbon about ¼in. square, fastened together by being glued to a thin piece of card which reaches about half-way up. The top of the carbon, in the centre, is cupped so as to hold a small pellet of carbon, ranging in size from a mustard seed to a pea. BB, wires to binding screws. When all the connections are made, place a watch on the bottom of the box at G, and gently push the carbon piece, B, till it is almost falling over. A little practice will soon enable any one to get a very fine balance. The finer the balance the better the result. When the ticking of the watch can be heard distinctly take it out and place it on the top of box, resting the ring on the piece of wood, C With a moderately good telephone the ticking will be sufficiently loud to be heard across a good-sized room. For flies, cover the top with a bell glass, or put them in the box and close up the opening. When using a common pin instead of B, I have heard flies running about almost as distinctly as with the carbon. A human hair drawn across the parchment is heard as a rustling sound in the telephone. I need scarcely say that the experiments should be conducted in a quiet room, as the slightest conversation or movement affects the microphone and produces a jarring noise in the telephone. **T. Cuttriss.**

FIG. 2

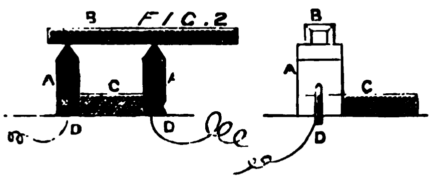


FIG. 1

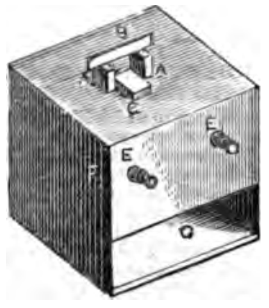
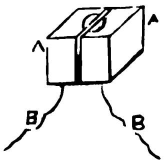


FIG. 3



NOTES ON OUR SATELLITE.

[14506.]—Vitruvius, Lee, and Doppelmayer. Appended is a diagram of these objects, the results of observations on 1878, March 15d. 11h. to 11h. 50m., and 1878, June 11d. 11h. On the former occasion the terminator lay along the W. wall of Schichard, whilst the summit of Reiner's western wall was illuminated just beyond the terminator, the definition being good On the latter the terminator passed through Aristarchus, and along the W. wall of Mersenius. The definition was good, but wind rather troublesome. The 2 25in achr. was used on both occasions, with powers of 132 (on March 15), and 115 (on June 11).

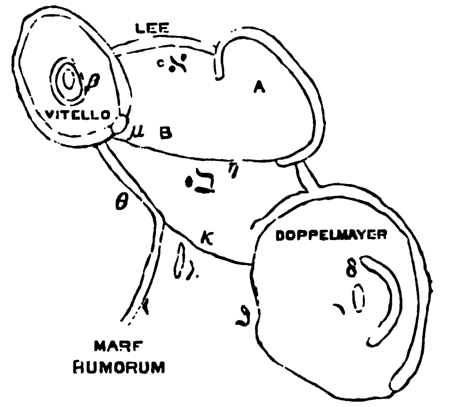
These three objects are shown in the little chart (from Mayer), in Keith's "Use of the Globes," as a ring with a central mountain, in the place of Vitello, having an oval dark bay of about the same size close E. of it, which is, of course, the bay enclosed by the formation Lee.

Doppelmayer is shown as a smaller, somewhat semi-circular (but rather angular), bay N E. of the last. In a reduced copy of this quadrant (18in. to the moon's diameter) from B. and M.'s map, which I examined a short time ago, the region was represented very imperfectly. In "Celestial Objects," Mr. Webb only mentions Vitello, which he says "is unparalleled for having, within a second concentric rampart, a central peak overlooking the whole ring." In the index map he depicts the form of the region Lee as a ridge, but shows in some degree the form of the more ring-shaped portion, A, in the subjoined figure, though it is represented too large: the ring of Doppelmayer, too, is shown complete, which it is not at present.

Vitello is a ring of no very great elevation, but larger than is represented, proportionately, in the diagram with which Mr. E. Mawe-Smith has so kindly favoured us (letter 14388, p. 290). This crater contains a central mountain, a, which is surrounded, somewhat closely, by a ring, omitted in the sketch of Mr. Mawe-Smith. Upon its N.E. wall, upon the last occasion, I saw what I take to be a hill, or tower. μ. Vitello is not circular, but flattened on W.N.W. side.

Lee is actually composed of portions of the walls of two large rings, A, about the same size as Vitello, and B, W. of A, nearly as large as Doppelmayer. A seems to be of more recent formation than B, through whose eastern wall it has broken. I did not see, on either occasion, any trace of the three objects depicted upon the western wall of B by Mr. Mawe-Smith. The surfaces of A and B both seem to be at the same level (this which I am now referring to is what I noted upon June 11), and that more depressed than the surface of the Mare Humorum close bordering upon it; the edge being bordered by η, which does not appear to rise as a bank from the Mare, only from the floors of A and B. ι is a short ridge connecting Lee with the formation Doppelmayer, which I will describe presently. Upon March 15 I suspected two objects at the points marked by the Hebrew Aleph and Beth, upon the floor of B. The elevation of A is, although not very great, much higher than that of B.

Doppelmayer is a partially destroyed ring, little more than half of which is now in existence, having, apparently, like the rings of Lee, Fracastorius, Le Monnier, &c., suffered from an invasion of the *maria*, the sharp edges of the destroyed parts being rounded off, worn, as it were, by the sea. The remaining portion is of somewhat considerable elevation. The western boundary is left unmarked, save by the edge, ζ, of the more elevated mare. The ring contains a considerable central hill, χ, which is encircled on the eastern side by a semi-circular ridge, δ, the remainder apparently of a ring partially destroyed by the same influx which demolished the boundary of the larger ring



θ is a ridge leaving the northern wall of Vitello in a north-eastern direction, which, after an almost straight run, about equal to the diameter of Vitello, bends suddenly towards the N N.W., a line κ (kappa) extending from the angle to the border of Doppelmayer, marking the northern boundary of the slightly more elevated (above the general floor of the Mare Humorum) ground ν. λ is a short ridge less elevated than the continuation ι of the ridge θ. All the details η, ι, λ, κ, and ζ were first seen on June 11. More sketches of this district would be very acceptable.

In letter 14390 there are one or two errors:—Line 2, above the diagram, δ should be printed 8. In the diagram χ is printed X.

Frank C. Dennett.

10, Terminus-terrace, Southampton, June 15.

THE SUN'S DISTANCE.*

[14507.]—Yet another change has been made in the determination of the sun's distance from the measures made by the British observing parties. The first estimate of about 93,375,000 miles was diminished some time since, as your readers were informed to about 92,800,000 miles—a satisfactory approach towards the value (about 92 1·3rd millions) which other measurements have shown to be approximately correct. We learn from the Greenwich report that the present estimate from the British observations is about 92,600,000 miles. This result, unlike the result first published, is a satisfactory one.

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* Times, June 22.

The photographic work ended in failure, the distances deduced from the best measurements being not far from 100,000,000 miles—a result hopelessly incorrect.

I would commend to the special attention of students of astronomy Professor Newcomb's discussion of the subject in his recently-published "Popular Astronomy," a work in that respect and otherwise of great value. Albeit I must warn your readers against the certain statements made by the critics respecting this work.

Despite Professor Newcomb's acknowledged skill as a mathematician, the book is not, as they assert, absolutely free from mistakes. Strangely enough, such specially mathematical subjects as the tides and the precession of the equinoxes, are among those which have been quite incorrectly dealt with. If this is not noted we shall have all the smaller popular astronomies repeating these imperfect explanations, the errors in which are by no means obvious, though really fundamental.

Richard A. Proctor.

SUNSPOTS.

[14508.]—On May, 21d. 5h. 30m., I found one small macula spot on the disc, the umbra rather pale, and the penumbra rather narrow. The granulation of the disc was very visible, very especially round the spot. I was using a very deep bluish tinted screen.

May 26d. 7h., two 3 macula spots had come round the E. limb, with a good deal of facula mottling between them. Both spots followed a rule which I have often noticed with sunspots—to have by far the greatest extent of penumbra S. of the umbra: two or three bridges of light were thrown across the penumbra of the more eastern larger spot. May 31d. 5h. 15m., when the spots had passed the solar meridian, I found the larger one to consist of a mass of no less than 11 umbræ in one very faint penumbra. Eight of the smaller umbræ were situated N. of the largest one, which was apparently divided into three parts by bridges. Considerably W. of the large group were two smaller spots, the northern of which was double. Near the E. limb there was a good deal of facula, which contained two grey (tinged with brown) blotches, indicative of spots to become visible at a later date. I have not looked at the sun since.

Frank C. Dennett.

SUNSPOTS — OPTICAL ILLUSION — DOUBLE STAR NEAR 1 GEMINORUM.

[14509.]—I am obliged to Mr. Markwick for pointing out my almost inexcusable slip concerning the sunspot of April 7. On looking into my notebook I find I too saw this dwarf spot, which I had entirely forgotten. At 11 a.m. I did not notice it, but saw some very faint faculæ, which I had seen for the first time near the E. limb on the 4th, and which I thought to be the remains of the spot group which I had last observed on March 16, but at noon (April 7) I saw an "extremely minute spot in the faculæ before mentioned; it was seen with the utmost difficulty on the white paper screen." About 3 p.m., when I again observed the sun, I could not pick it up, though the sun was clear from cloud, &c., at the time. This agrees with Mr. Markwick's supposition of the little spot's very rapid disappearance.

In connection with the phenomenon mentioned in letter 14459 I remember one afternoon, some little time ago (I have not my notes of the occurrence by me, so cannot refer to exact day, hour, &c.), turning my 2·8in. telescope on to the moon, it being still broad daylight, when I was greatly astonished to see every crater and other concavity on the disc as decided and strongly-marked convexities; all the S. portion of the moon appeared, in fact, covered with many closely-packed domes. I stared for some time, trying to reason myself out of this extraordinary illusion, for of course I knew that illusion it must be, but in vain. I fixed my attention on a single formation, and tried to force it to appear as I knew it should appear, but the dome-like effect persisted. I got up, walked about, shook myself together, sat down again, looked through the telescope, and—saw just the same appearance still. I then substituted a terrestrial eyepiece, power about 40, and found that everything appeared normal and as usual, so I went carefully over the telescope and first eyepiece, and, having cleaned and adjusted them, felt certain that I should now depress these obtrusive "domes." I was really very much annoyed to find them as marked as ever, and after some more ineffectual observation I gave them up as a bad job, and waited till the evening to see what would happen then. I suppose it was about 8 p.m. when I again looked at the moon, with the telescope just as I had left it. The "domes" had vanished, the craters were craters, and the moon was again the sane sensible luminary she had up to that afternoon, and has always since, appeared to me. I send this simply as a curiosity, and will not venture on explanations of the phenomenon, which I leave other more competent correspondents to inquire into, should they think it worth while. It so happened that there was no proper person available at the time who might have examined into the appearance independently. I am not aware of any difference of condition in my own eyes at the times of observation. I may add that there is a certain engraving of, I think, a portion of the crater-full surface near Tycho in which my brother assures me he regularly and always sees the craters as convexities or "domes," and I myself can make them appear either as concavities or convexities as I choose; whereas in the case of the moon itself no amount of reasoning or persuasion could make the "domes" into craters. The effect of raising the craters was, I suppose (I did not specially notice it at the time), to make the illumination appear to come from a point exactly opposite where it really did come from; or could it possibly be that a mistaken but persistent idea of the direction of illumination raised the craters?

I beg to thank Mr. Espin for examining my double *p* 1 Geminorum.

Mac.

MR. DENNETT'S CAUTION TO YOUNG OBSERVERS.

[14510.]—The phenomenon to which Mr. Dennett alludes in letter 14390 does not appear to be the same as "Brickwall" refers to in letter 14459. The cases adduced by Mr. Dennett are four objects seen at one time as depressions, and at another as billocks, having used on both occasions an eyepiece to which he was *unaccustomed*. If I have misinterpreted his meaning in letter 14390, Mr. Dennett will doubtless set me right in a future communication; also if the objects surrounding the four he specifies participated in the phenomenon mentioned —*i.e.*, craters in the immediate neighbourhood appearing as elevations, and mountains as depressions. It is a general appearance of this kind, *seen over the whole moon*, to which, I apprehend, "Brickwall" refers, and with which I am quite familiar. I have no recollection whatever of connecting it with, or attributing it to, a change of eyepiece, but have rather considered it as a pseudoscopic effect, having its seat in my own eye, and warning me to cease from observing, the eye having become fatigued. Now, if the depressions mentioned by Mr. Dennett in Thebit, and on each end of Schröter's χ, were the only objects affected, the appearance they presented of hillocks must have depended on something else, and not on using eyepieces to which the observer is unaccustomed, or to anything of a pseudoscopic character. All lunar observers, from Schröter onwards, have seen objects more or less of this doubtful nature. Many craters are opened on low cones which appear as hillocks when the visual ray *from the side of the cone* enters the eye; but when, from changes of libration, the opening is seen, they appear as craters. "Young observers," if they are really attentive to what they see on the surface of the moon, would soon find no difficulty in referring such phenomena as quoted by Mr. Dennett to their true source—viz., changes of libration, and need not trouble themselves about eyepieces to which they are unaccustomed, for it is clearly beyond the power of an eyepiece to change the appearance of a crater into that of a mountain.

As to the pseudoscopic effect, no one, after having once seen it, would think such appearances as mentioned by Mr. Dennett could be explained by it. "Brickwall" speaks of having distinctly seen an object as a circular concavity in one lunation; perhaps in the next lunation he has seen it with equal distinctness as a convex hill. My own experience certainly exceeds his, for I have seen Theophilus in its ordinary character as the fine deep crater which it is, and five minutes afterwards—not a month—it has been suddenly transformed to the appearance not so much of a hill as of—shall I give the simile as it occurred to me at the time?—a bun having a cross upon it. The depressed appearance of the fine central mountain—this pseudoscopic effect can be produced at will by allowing the light to fall the wrong way on any photogram of the moon taken near the first or last quarter. Young observers, whenever you may meet with an appearance of this kind, regard it as an intimation to relinquish your observations until your eyes once more attain their normal powers of vision, for you cannot proceed to any useful purpose while elevations take the places of depressions, and depressions those of elevations; but when you find that a well-known small crater assumes the form of a cone, you may rest satisfied that libration has more to do with the apparent change than either your eyes or eyepieces. The intimation is to determine the libration under which the cone only is seen, and that under which the opening is seen.

W. R. Birt.

TELESCOPIC APERTURES AND "8¼in. O.-G."

[14511.]—I was certainly not aware that I had given more than *one* extract from Dr. Kitchiner's "Economy of the Eyes," Vol. I. The date of the volume is 1824. I may say that I should *be very much surprised* to find the drawings of Jupiter by the persons mentioned in the extract which was given resemble mine on p. 433, Vol. XXV., considering the wondrous changes that take place in the planet even from year to year, leave alone 50 years. I am not going to dive into the depths of his second paragraph, or, indeed, going to argue with "8¼in. O.-G." at all.

Frank C. Dennett.

MUSICAL TONES.

[14512.]—In letter 14467 "H. C. K." gives a musical passage from a "violin suite," and asks to have the values of the flat and sharp symbols defined. Taking them in the same order as they are played, these values, expressed in the notation of p. 509, Vol. XXV., and derived from the principles laid down by Helmholtz, are C♯^{2}, B♭$_4$, A♯^{3}, F♯^{3}. These are values that would render all the intervals concerned the most consonant possible. The value of B♭$_4$ = B $\frac{2048}{2187}$, as shown in letter 14486, p. 314. Speaking mathematically, the note required is one schisma higher than this. In the notation of p. 509 it is A♯^{3}, but the difference of these two is too small an interval to be detected by ordinary human ears. I may state that in this and similar questions I agree with Helmholtz, but I have very little acquaintance with the composer of the music quoted. I believe Leclair, the composer, would play the music as here indicated, although he would not, perhaps, understand the notation used.

J. S.

P.S.—Will "H. C. K." kindly quote volume and page of his previous letter on this subject as referred to in his present letter?

[14513.]—The answer to "H. C. K.'s" letter (14467, p. 344) seems to me perfectly attainable on the harmonic theory, but on no other.

The passage quoted is a modulation by enharmonic change from the key of C major to that of B minor, the modulation being effected by that "protean chord," as Macfarren calls it, the minor 9th. The chord here consists of the following intervals:—G, the perfect 5th; E, the major 3rd; D♭, the minor 9th; and B♭, the minor 7th (C♯ being, as is so often the case, written for D♭ merely to avoid another accidental at D♮, four notes further on). Let us examine the vibration frequencies of the notes of this chord on the harmonic theory. G is the 3rd harmonic of a fundamental C on the 2nd line below the bass staff, which note has at the normal pitch 64 vibrations per second. The value of G is therefore 3 × 64 = 192 vibrations. E is the 5th harmonic, and its value is 5 × 64 = 320. D♭ is the 17th harmonic transposed an octave lower (called the minor 9th, the 18th harmonic being the major 9th). It is not, however, necessary for the present purpose to consider this question of D♭, which is a debated one, as nearly all harmonists allow that the B♭—the note in dispute—is the 7th harmonic transposed an octave higher. The value of B♭ is then 2 × 7 × 64 = 896 vibrations. The C above this B♭, being four octaves above the fundamental C, has 16 × 64 = 1,024 vibrations, and the value of the B♭ is therefore $\frac{7}{8}$ of 1,024 = 896. Now, the B♮ is, by the diatonic or so-called natural scale, $\frac{15}{16}$ of 1,024 = 960; and by the same theory A♯ is $\frac{15}{16}$ of B♮ = $\frac{15}{16}$ × 960 = 900; and I am quite prepared, if necessary, to prove that the harmonic theory agrees with the natural scale in respect of this interval of the sharp 7th; therefore the A♯ is higher than the B♭ by four vibrations per second—a difference which is perfectly perceptible at the pitch of the note in question, Helmholtz giving about one vibration in 885 as the limit of audible differences, and the difference in this case being more than four in the same number.

I am aware that it is the practice of violinists and horn-players to intonate the harmonic 7th rather sharper than its true pitch, in deference, as I believe, to the effect produced upon the ear by the temperament of organs and pianos; these instruments being infinitely more often heard than any of the just ones, and consequently infinitely more potent in forming the cultivated ear. But, allowing this, the temperament cuts both ways; it would make the value of the A♯ over 906, so that the B♭ could be sharpened 10 vibrations, or about $\frac{1}{12}$th of a tone, without even then rising to the pitch of the A♯. As, however, I understand "H. C. K." to look with a certain amount of contempt upon temperament, these details are for his purpose unnecessary.

In conclusion, I would point out that the raising or lowering of a note by the ratio 25 : 24, called the diesis, is quite arbitrary and an expedient of tem-t (not equal temperament, the diesis being rence between a major and minor 3rd, or a limma and a minor tone). If "H. C. K." Macfarren's Lectures on Harmony" he ember that, on p. 216, it is stated, as a ed fact, that violinists always play, and lways sing, B♮ flatter than A♯, so much so n the black keys of the Temple organ used ided so as to sound both the sharp and the d on "mathematical" principles, Mr. Hop- obliged, in order to assimilate his accom- t to the intonation of the choir, to play the note to that which was written on the

A. Coates.

PHYSICAL "GENERATION" OF HYPHARMONICS.

.]—I NOW write with the endeavour to ose correspondents who cannot yet accept armonic aspect of the relations of the notes ving of any consideration because these have been shown only in a mathematical does not appear to them to be of any con- that the two concords, the equally deter- lements, as I assert, of scale form, and of lationship of musical tones, are equally of lest possible mathematical constitution— itution of the one being the converse of that her, for the ratios defining one concord are ocals of those defining the other. "What," , "if these hypharmonics are the mathe- osites of the harmonics? We can compre- monics, for Nature herself produces them ny reference to mathematics. We believe to be independent of, and superior to, tics, but if it can be shown that Nature nce hypharmonics, although the notion is t absurd, we will accept them. The funda- ne of a string or pipe generates harmonics— ll know, but did any one ever hear of its g hypharmonics?" This mode of argument preferred by objectors, ignoring the fact ere considering the mathematics, not the f the question. Nevertheless allow me to e highly the efforts of these correspondents, l endeavour now to meet their objections own ground, selecting the remarks of (letter 13907) as typical of these objections. writes :—"It seems to me that Mr. Jack- theory, as to the 'hypharmonic series,' has ient reason in it to be upheld. The har- ies is founded on fact. A musical sound y generate the 3rd and 5th of the scale, e never heard that the return journey has accomplished. Just as if a man could s own great grandfather! Take the note erates C, G, and E^1, and then we are asked that E^1 generates E, A, and back again to t, begetting itself after many generations." very well, "P. L.," but you have outrun ve not yet given you this special occasion xercise of your sceptical faculty. I have you to believe in the seeming miracle you as I have not hitherto touched anything to the physics of the question; but coming is physical aspect there is no knowing, let ou, what I may do if I only knew how far ul to stretch the meaning of the word ."

sistance in making my researches on this question in music I have had recourse to holtz's "Sensations of a Tone" (Mr. Ellis's n), and on p. 70 I find the following in- respecting subtones (*i.e.*, hypharmonics) ion with the use of the professor's reso- 'Apply one (*i.e.*, a resonator) to the ear, piece of harmonised music, in which the e of the resonator frequently occurs, be by any instrument. As often as this tone he ear to which the instrument is held will dently contrast with all the other tones of This proper tone will also be heard when sical tones occur. Such deeper musical called the harmonic subtones [hyphar- f the resonator. They are the musical se periodic time is exactly 2, 3, 4, 5, and ater than that of the resonator." That is t, if the proper tone of the resonator is E^1, heard when a musical instrument sounds hypharmonics, which are E A$_1$ E$_1$ C$_1$, and is experiment, though it does not make lish the return journey spoken of by proves that there is as close and regular a elation between a tone and its series nonics as there is between a tone and its rmonics. But this is not enough probably hose musical science rests on the foundation ical generation. I will endeavour still erefore, to accommodate my view to their aking by advancing some proofs that hyp- are also susceptible of physical generation act they are not monstrosities, but as true g of unconstrained nature as harmonics lves.

again to Dr. Helmholtz's work, by atten- the paragraph on pages 74, 75, it will Dr. Helmholtz has ascertained, in experiments with the pianoforte, that motion occurs in the strings of this instrument, the dampers being raised, when any of the partials of those strings are sounded. Thus C will vibrate if C^1 or G^1 or other of its partials be struck. Now, it is evident that the uppermost tone of the hypharmonic concord is actually a partial of all degrees to the several tones of the concord; consequently every one of these notes will respond when this partial, common to them all, is struck. Take for example the hypharmonic concord of E^1, which is E^1, E, A$_1$, E$_1$, C$_1$ A$_2$; these notes will all vibrate if E^1 only be struck. By the evidence, then, of Dr. Helmholtz we prove that this miracle of the generation of hypharmonics has been done; and now I ask "P. L." to believe it, or rather to go to the pianoforte and perform it for himself.

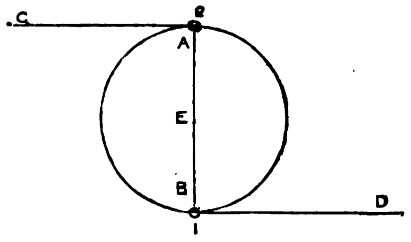
I will only add that I regard it as inexplicably strange that Dr. Helmholtz, above all others, has never perceived that the hypharmonic or subtonal order of tones, as seen in its origin in the minor or hypharmonic concord, has as much to do with the structure of music as the harmonic order of tones has—a fact exemplified, at first hand, in the composition of the so-called major diatonic scale.

June 15. Fred. J. Jackson.

FINDING THE INITIAL VELOCITIES OF BODIES THAT HAVE CIRCULAR MOTIONS ABOUT A CENTRE OF ATTRACTION, THE POWER OR EFFICACY OF WHICH IS ABATED IN A DUPLICATE RATIO OF THE DISTANCE FROM THE CENTRE OF ITS EXERTION.

[14515.]—IT has hitherto been considered that as the chord of a small portion, or arc, of the path of a body having circular motion so nearly measures the arc itself, and also as such chord may represent and be equal to a portion of the path that a body would describe in a straight line if freed from influence of central force, in same time as it would otherwise move through the same arc itself whilst under the influence of central force, we may accept the measure of a small arc and the time taken in describing it as data for finding initial velocity.

This principle, of what I shall name "taking the smallest measures," in order to find the velocity requisite to maintain circular motion, has led to very erroneous results, and such results, as only the peculiar character of circular motion, has prevented the mind detecting the errors of.



In applying the doctrine of the "parallelogram of forces" to ordinary cases in which two forces shall act at right angles to one another, the mind at once recognises the fact that the resultant will be greater than either of the two components; but in the case of circular motion the mind has become so habituated to accept the principle of "least measures," and the consequently assumed equality of one component, initial velocity, with the resultant, circular path, that even in the half or the whole of a circular path it is generally accepted that no corrections on account of the repetitions of the minute difference between a small arc and a small portion of a straight path that would be described under the influence of initial velocity alone, need be made. Consequently, we agree that a measure of a circular path will be the measure of the straight path that a body would describe if freed from the pull of central force; in other words, we agree that the resultant of two forces acting at right angles to one another is but equal to one of the forces.

The writer uses the term force where others would perhaps confine themselves to the term velocity; and so he represents circular motion as being the resultant of a force whose direction would be at right angles to a line of descent, and whose measure would be "velocity" in a straight path, and of a central force whose measure would be as the time of fall to centre. It will be, perhaps, necessary to briefly point out there is as much foundation for this view of circular motion as for the view that is generally taken that circular motion is not the resultant of two forces, but of a central pull or one force, and a mysterious "velocity," which is neither the measure nor the cause of "force."

Now, the mind cannot separate or disassociate matter from any of its qualities; the mind, in fact, only knows of matter by its qualities, and we must accept it that it is reasonable to suppose that matter has always possessed the qualities we are now cognisant of, and that when matter may have been put in motion it would be in possession of the quality to which we give the name of attraction, and that such quality would control and guide motion, so that equally as well as those who say that "a planet has motion in a straight path, but the sun's pull of attraction deflects it from the straight path," the writer may say "a planet, because of attraction, is falling to the sun, but a force overcomes the 'inertia of direction' of its tendency to fall, and endows it with an 'inertia of direction' and tendency to move in a straight path at a right angle to line of descent to centre, the resultant being circular motion." Indeed, just as much as we know that to move a body at the surface of the earth in a direction at a right angle to a radius we require to apply force, which force may be measured by the formula $\frac{v^2}{2g} = s$, so we have knowledge that at the summit of the highest mountain, and even at the distance of the moon, if we wished to move a mass in a direction at a right angle to a radius of the earth, we would have to apply force, and we could find measure of such force by using a modification of the foregoing formula, which modification would be

$$v^2 \div \frac{2g.}{\text{D. in semidias. of E}^2}, \text{ or } \left(\frac{v^2}{\frac{2g.}{\text{D. in semidias. of E}^2}}\right)$$

$= s$; and we know equally as well that when we had set a mass in motion at distance of moon from the earth that it would be capable of giving out again the same energy that we communicated to it, just as we know a mass in motion near the earth's surface would.

The writer will now endeavour to show that the principle "of taking the greatest measures" in order to find initial velocity (or the measure of the force that would cause a body to maintain circular motion) should be used. Axiom: If a body be moving under the influence of a force at a certain rate of velocity, and said body be also acted upon, or solicited, by a second force whose tendency shall be constantly in a direction at a right angle to the path the body will (under the influence of the two forces) describe, then the initial velocity of the one force whose tendency would have been to cause the body to have moved in a straight line, will be neither retarded, nor will it be accelerated.

Let A and B be two bodies that shall have mutual attractions and circular motions about one another, and about E as a common equidistant centre. It may be shown that such bodies are each under the influence of or acted upon by two forces. That each is acted upon by a force whose tendency is in a direction at a right angle to the line of motion each body would have if under the influence of attraction alone, and each is acted upon by the force of attraction whose tendency is constantly in a direction of a line joining the two, but which direction is constantly changing, although at same time constantly towards the centre of motions, and constantly at right angle to the motion of each in its path.

Also, that such forces and their magnitudes will be as A C and B D, and A B or B A, and that A C and B D will each be equal to A B or B A.

Take the case of body A, the force of B's attraction for it is constantly changing its direction, but is always acting at a right angle to the path described by A; consequently, the initial velocity of A (as by axiom) will not be altered; then, as A moves to 1, whilst B moves to 2, the measure A 1 will be the measure of the path A would have travelled through if under the influence of one force alone in the same time as it has travelled through the semicircular path from A to 1 under the influence of two forces.

The measure A 1 will also be the measure of the mutual attractions of the bodies A and B, for as we are allowed to represent equal forces by equal lines, then equal lines will represent equal forces and A 1 or A C, which is the force tending to cause A to move in a straight line, being equal to the diameter of the circle of motion, or equal to the line connecting A and B, the line A B must represent a force equal to A C, and constantly acting in the direction A B or B A, but the force that would act thus would be the force of mutual attractions of A and B—that is, if A were fixed, B would fall to A in same time as A would otherwise move uniformly to C, or through space equal to A C, and if B were fixed, A would move to B in same time as B would otherwise move to D, or through space equal to B D.

The measure of A C or of A 1 will, therefore, be the greatest measure of force required to act at a right angle to line of descent to centre during the time that A would take to fall to distance A B, in order that circular motion may be maintained.

Now, although if nought else but two equal masses existed in space, their motions and their forces would be as stated; in actual fact, we have to deal with cases of revolutions about centres of attraction and not about common centres, as, practically, the common centres of motions of planets and sun lie in sun's centre; the question then, is, how are we to find the "greatest measures" of velocities in such cases.

The law that "centrifugal is to centripetal force as velocity in a given time squared, divided by the diameter, to the space through which a body moves in falling from a place where it was at rest in the same time," will afford us means of arriving at such "greatest measure" required.

Formulating this law we have $\frac{v^2}{\text{dia.}} = \frac{g}{2}$, and, generally, $\frac{v^2}{\text{dia.}} = \frac{\left(\frac{g}{2}\right)}{r^2}$, or = gravity.

Taking the case of a body having circular motion at distance 1 from a centre, the time of fall to centre will be as 1, and G, or gravity, as 1, then applying the foregoing formula we have $\frac{v^2}{\text{dia.}}$ = G or 1, and consequently $v = {}^2\sqrt{2}$—that is, velocity will equal the chord of a quadrant of the circular motion, or will likewise equal the diagonal of the square on the radius, and generally velocity will equal $\frac{{}^2\sqrt{(r^2 \times 2)}}{A}$ when A equals time of fall to centre.

It follows, then, that the time in which a body completes one quarter of a revolution, whilst maintaining circular motion, is as the time the body would fall to centre of motion, if under the influence of attraction of gravitation alone.

Below is a table showing the distances, times of falls to centre, periodic times, velocities, centrifugal forces, and gravities of four cases of circular motion about a centre, whose efficacy or power of attraction is diminished in a duplicate ratio of the distance from the point of its exertion.

Distance.	Time of falls to Centre. The squares of times of falls are as cubes of distances.	Periodic times. Equal 4 times of fall to centre, and agree with Kepler's 3d law.	Initial velocity $= \frac{{}^2\sqrt{(r^2 \times 2)}}{f.}$	Centrifugal force $= \frac{v^2}{\text{dia.}}$	G, or Gravity = inversely as r^2.
1	1	4	$\frac{{}^2\sqrt{2}}{1}$ or 1·4142	$\frac{1\cdot4142^2}{2}$ or 1	1
2	${}^2\sqrt{8}$ or 2·8234	11·3136	$\frac{{}^2\sqrt{8}}{2\cdot8234}$ or 1	$\frac{1^2}{4}$ or ¼	¼
3	${}^2\sqrt{27}$ or 5·195	20·78	$\frac{{}^2\sqrt{18}}{5\cdot195}$ or ·822	$\frac{\cdot822^2}{6}$ or 1-9	$\frac{1}{9}$
4	${}^2\sqrt{64}$ or 8	32	$\frac{{}^2\sqrt{32}}{8}$ or ·707	$\frac{\cdot707^2}{8}$ or 1-16	1·16

The errors in the usual method of constructing such tables may be best shown by quoting the words of a modern writer when he is exhibiting the usual accepted proof that the relation, observed by Kepler, between periodic times and distances is a necessity of the law that the force of gravity varies inversely as the squares of the distances.

This writer's words are:—"We may now compare together the intensities of the forces which act at different distances, or on different planets, by means of the third law of Kepler. In order to do this, let us suppose that planets, moving uniformly in circles round the sun, be situated at distances from that central body proportional to the numbers

1, 2, 3, 4, 5, &c. (A).

To obtain the velocity of one of these planets in its circular orbit we must divide the length of the circumference by the number of seconds occupied by describing it, and to get the square of the velocity we must divide the square of the circumference by the square of the number of seconds. But the squares of circumferences are as the squares of their radii—that is, in the present case, as the numbers—

1, 4, 9, 16, 25. &c.

Also, from the third law of Kepler, the squares of the times of revolution are as the cubes of the radii of the orbits—that is, in the present case, as the numbers—

1, 8, 27, 64, 125, &c.

The squares of the velocities of the several planets will, therefore, be related to one another as the numbers—

$$1,\ \frac{4}{8},\ \frac{9}{27},\ \frac{16}{64},\ \frac{25}{125},\ \&c.$$

Or as the numbers—

$$1,\ \frac{1}{2},\ \frac{1}{3},\ \frac{1}{4},\ \frac{1}{5},\ \&c.\quad (B).$$

And, as the force acting on each planet is measured by the square of its velocity divided by its distance, we shall evidently discover the law by which the intensity varies from one planet to another by dividing the several numbers (B) by the corresponding numbers (A)—that is to say, the forces at the several distances (A) will be as the numbers—

$$1,\ \frac{1}{4},\ \frac{1}{9},\ \frac{1}{16},\ \frac{1}{25},\ \&c.$$

Or inversely as the squares of the distances (A); and in this way is the solar attraction law established."

Now, there are three errors in the foregoing—there is the error of accepting a measure of the circular path as a measure of velocity; there is the gross error of dividing the squares of the radii by the square of the times instead of the squares of the circumferences by the squares of the times, in order to get the squares of the velocities, for even if the squares of circumferences are as the squares of their radii, that is no reason why the lesser may be exhibited for the greater in the particular work before us, and the square of velocity can only be found by dividing the square of a circumference by the square of number of seconds. There is also an error in using the formula $\frac{V^2}{r.} = G.$, as $\frac{V^2}{r.} = g$ and not G., and it is $\frac{V^2}{\text{dia.}}$ that equals G.

Even admitting for the present that velocity is to be a measure of motion in a circular path in a certain time, and taking the cases of the planets at supposed distances of 1 and 2, then by the quoted method, but after allowing correction in division to obtain V², we have at distance 1 $\frac{6\cdot2832^2}{1^2} = V$, and consequently $\frac{6\cdot2832^2}{1}$ equals centrifugal force and gravity; at distance 2 $\frac{12\cdot5664^2}{8} = V$, and consequently $\frac{19\cdot7393^2}{2}$ equals centrifugal force and gravity; and, after using correct formula for centrifugal force, we have at distance 1 C f and G = $\frac{6\cdot2832^2}{2}$; and at distance 2, do. do. = $\frac{19\cdot7393^2}{4}$, so that centrifugal force and gravity would be at a distance of 2 from a centre (if we accept velocity as usually found by measuring the circular path), near 1·5th what they would be at distance 1 from a centre, and not 1-4th as taught by the law of gravitation.

It is quite correct when we know the value of the accelerating force of gravity in one second of time (as we do in the case of the moon's motion about the earth) to use the formula—

$$\frac{V^2}{r.} = \frac{g.}{\text{distance in semidiameters of earth}^2};$$

but, in considering general cases of circular motions, and in considering the cases of motions of the planets about the sun, when we have no value of g at distance 1 from centre wherewith to compare the reduced values of g. at various distances, and when we have to deal with periodic times, and not one second of time, it is utterly wrong to apply the formula $\frac{V^2}{r} = \frac{g}{r^2}$, and we must fall back upon the true formula for such cases, which formula, is $\frac{V^2}{2r} = \frac{G}{r^2}$, or, as by the law of centrifugal force, we must compare the velocity, squared and divided by the diameter, with the space through which a body would fall in same time.

Bearing in mind the law that "the times of falls to centre are as the rules of distances" (this is not Kepler's law), and that at distance of 1 we must allow that G, or gravity, must equal 1, we may soon learn how the errors of present tables of times, velocities, and forces of planets have arisen, and we may also readily correct the present imperfect formulæ that are applied to cases of circular motion.

G. Pinnington.

P.S.—The foregoing will explain the portion of my letter on finding the density of the earth, p. 295, where it refers to the true velocity that maintains the moon's circular motion.

MICROSCOPICAL—STARCHES.

[14516.]—The letter of "B." (14501, p. 373) has puzzled me considerably, and I should like to ask for a drawing of his new combination of spot lens and polariscope. I have given a good deal of attention to starches recently, and one or two facts I have discovered may interest "B." and others. I have found that wheat and barley starch take a permanent stain from a few minutes' immersion in Judson's magenta dye. No other starch I have tried will do this, but maize starch stains with green, as does also the starch of the yam. After these starches have been dyed they require to be thoroughly dried and mounted in damar, then the concentric markings and the hilum become very conspicuous. The starch of the potato does not stain readily, but an alcoholic solution of carmine dye stains the rings strongly, and thus renders them easy to see, but for some unexplained reason the alcohol destroys their polarising power. This will distinguish potato starch from every other instantly. I have also found that starches mounted in a solution of one part salt and ten parts water are differently affected. While this appears to increase the polarising power of the starch from cereals it entirely destroys that of all other plants, thus affording a valuable means of distinction. But a solution of 1 part nitrate of silver in 10 of distilled water has yielded the most important results of any mounting medium I have tried for starches. Almost all I have tried show a granular internal structure when mounted in this and sufficiently magnified. I use a Tolles' duplex 1-10in., and an E eyepiece, illuminating with a truncated parabola; with tube drawn out I have then a power of 6,000 diameters. The nitrate apparently deposits on internal cell walls, rendering them visible when otherwise not so. The cells of potato starch are square, the interior looking like a section of cork. Those of wheat are about twice as long as wide, and those of barley starch are triangular. I am preparing drawings of a variety of starches under different modes of treatment, of which I inclose copies of two. Fig. 1, structure of part of grain of potato starch; Fig. 2, structure of part of grain of barley starch. I should be glad to send "B.," or any other correspondent, some illustrative slides, if they advertise address, and will pay carriage.

George Sims.

Fig. 1.

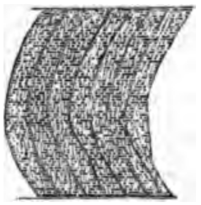
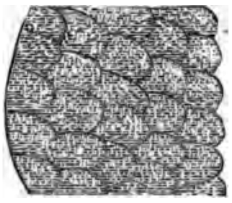


Fig. 2.



A POLARISCOPE SPOT LENS.

[14517.]—I have read "B.'s" description of the above with interest, and would be glad of further details as to the arrangement of the apparatus he uses. Would he be kind enough to give us a diagram of the several parts? It will be a pity to let the matter sleep till the next meeting of the Royal, which will not be till November. If "B." does not wish to anticipate his paper, why not read it at the Quekett Microscopical Club, where he will find a few workers who are always pleased to welcome as a friend any one who makes an addition to the method of investigation at present in use?

X.

[We have received a similar invitation from another scientific association, but were requested to communicate it privately, which we were unable to do.—Ed.]

CHROMIUM.

[14518.]—I think Mr. Streatfeild has done right in bringing before us for discussion a subject which perplexes not only himself, but others who have attempted to master the peculiarities of the chromium compounds. Mr. Streatfeild evidently thinks, with myself, that since there are laws governing the high and more intelligible branches of science in general, and of chemistry as it concerns us, that there must, therefore, exist laws governing the more intricate portions. And, therefore, he has asked us to give our ideas with regard to the acidity of the bichromates. I note that he has given us Cr_2O_3 as the formula for chromous oxide, which should be CrO, and chromium trioxide should be CrO_3, but I take it that these are clerical errors. I wish to know in what manner the evolution of oxygen from chromic acid and chromates under certain circumstances affects the point in question. The difference in colour noticed by Mr. Grey (letter 14436, p. 317) may certainly be taken for granted. But is it not likely that the bichromates act just in the same way as other acid salts. Given a solution of potassium bichromate, neutralise it with potash, and we get a neutral salt, chromate of potassium

$$K_2CrO_4,\ CrO_3 + 2KHO = \begin{cases} K_2CrO_4 \\ K_2CrO_4 \end{cases} + H_2O.$$

And may we not, from theoretical grounds, view the preceding equation in this way? Considering the formula of potassium chromate as K_2CrO_4, and that of potassium sulphate as K_2SO_4, in the same way as we have one of the hydrogen atoms of the sulphuric acid displaced by one atom of potassium, forming $KHSO_4$, so may we have $KHCrO_4$ doubled when we get $K_2H_2Cr_2O_8 = K_2CrO_4,\ CrO_3 + H_2O$.

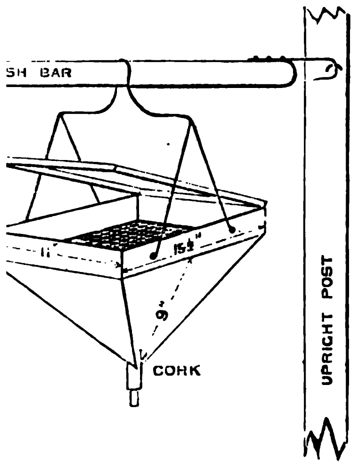
Theo. Pitt.

HONEY EXTRACTOR.

[14519.]—The following very simple apparatus I have found perfectly efficient for extracting honey from combs without damaging them. It can be made by any tinman, or, in fact, by any one who can use a soldering iron, and costs but a trifle compared to other extractors.

It consists of a rectangular box of tin or zinc, 15½in. long, 11in. wide, and 2in. deep, inside measure. The bottom is movable, and can be taken out to be cleaned, and is made of wire netting of 4 wires to the inch, having a frame of strong iron wire soldered round the edge. It may be further strengthened by two diagonal iron wires crossing each other at the centre and soldered at opposite corners of the frame, they being on the lower side when the bottom is in the box, where it rests upon a ledge made to receive it. The lid may be hinged or not, but should have a hook to keep it close when in use. It is much better not hinged.

This box fits on and is soldered to a funnel shaped like an inverted pyramid (made of very thin zinc to make it as light as possible), at [illegible] e is a round tube, to be closed by a cork ise. The handle is of thick iron wire, shown in the sketch, and fixed at two ach of the two longer sides of the box. e a stout bar of ash or other hard wood long and 2in. in diameter. on which the e handle will fit, and fix with screws a n hook on one end, and into any upright a strong iron staple, about 3ft. from the ıd the apparatus is complete.



now a honey-comb from which we wish to honey, if any of the cells are sealed they haved off with a sharp thin knife, heated ter, care being taken not to bruise the it may now be placed upon the wire the box, and the lid shut down. Having l the bar through the loop hook the iron the staple, the operator holding the other bar, letting the extractor hang about fron his hands.

ng the stick, swing the extractor rapidly ıt a dozen times, open it, turn the comb to take the honey from the other side. ıg the extractor round the stick, and, if one, all the honey that was in the comb ad in the funnel, and may be drawn off e tube at the bottom.

isable to bind a piece of wire across the event it slipping out of the staple during ion. To learn to swing the extractor, ice with it empty; also practice stopping funnel points downwards, by catching e iron handle with one hand; but no one ny difficulty in using it after trying it once ınd having used it myself many times I n found it throw out a grub or young bee, an egg, although I have used it many ombs partly filled with brood.

ısurements I have given are those I use it just takes the Woodbury frame in th which I always work, and is wide take larger combs, which I sometimes collateral and other hives; but of course ıy vary them to suit their own fancy. The be 9 or 10in. deep, and the handle must ough to allow the lid to open.

w this machine described in a little book 'he Italian System of Bee-Keeping," pube *Field* office, but have made some slight suggested by practice with the machine, d an improvement upon the original plan.

Portugal. **H. Athailey.**

EARTHQUAKE AT LISBON.

–THE following may probably be interestne of our readers:—On Saturday, 8th l.38 p.m. (Greenwich mean time) we were a rather severe shock of an earthquake. e I was in my workshop, which is on the or (I should here mention that the old uilt on arches, somewhat similar to the oss station. I am told the arches are to me degree the rocking motion occasioned of earthquakes, which are by no means rare workshop is under one of these arches.) I l a steady rumbling, as if a carriage was wn the avenue towards the palace. This ıcreased for some seconds, when I felt the ich I was working give a lurch. I was for t spell-bound, and on looking round discoils of wire which were hung on the wall, ıck to their original places, also a rattling l bottles, and the sediment of a bottle of course of preparation was shaken up. s on a basement floor must be self-evident rity of the shock. On going upstairs I duration of the shock was beautifully a a Thomson's siphon recorder, and on calculated it to have lasted 7 to 8 seconds. Yesterday being in Lisbon (about 10 miles from here) I made inquiries, and found only a slight shock had been felt there but a few minutes previous to the time recorded by me.

I should like to hear if any earthquake has been felt elsewhere about the same time.

H. G. Cheesman.

The Eastern Telegraph Co.'s Station, Quinta Nova,
Carcavellos, Lisbon.

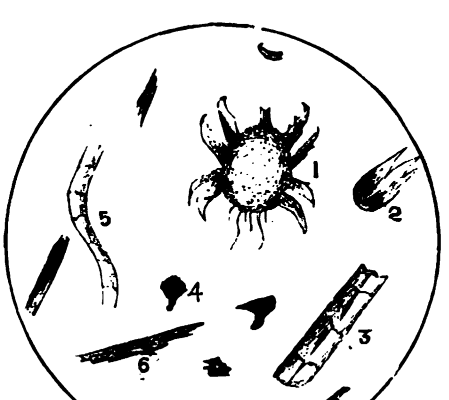
ADULTERATIONS OF FOOD DETECTED—SUGAR.

[14521.]—THIS important substance is a constituent part of a number of plants. It is afforded especially by the sugar cane (Arunda saccharifer), it has a specific gravity of 1·6; it is soluble in about one-third of its weight of cold water, and is much more soluble in boiling water; it melts at 160°C. into a viscous colourless mass, which, on cooling, forms the solid known as barley sugar. Some of the moist sugar sold is very impure, caused by the dirty practice of exposing the sugar in the window. In one sample I examined I found hairs, coloured cotton, fibre, sand, and minute sawdust-like fragments, and sugar insects (Acarus sacchari). Some of the cheap moist sugar contains salts of iron, which has the effect of blacking the tea used with it.

The principal adulterations consist of the additions of glucose and dextrine. Other adulterations are said to have been used, such as sand, starch, chalk, &c., but I have only found them as an accidental impurity. The presence of grape sugar in cane sugar can be detected in the following manner: Put into a flask 150 grains of the sugar to be tested, then add 300 of distilled water, 8 grains of caustic potash, and boil. If the sugar be pure cane sugar, no change will take place (or it might take a green tinge), but if grape sugar is present the solution will turn a brownish colour.

But a more delicate test is that originally contrived by Trommer. Dissolve some sugar in some distilled water, and add a little sulphate of copper, and then add caustic potash in excess (an excess of potash is productive of no harm), and boil for a few minutes. If dextrine is present the liquid will become green, but if grape sugar is present the salt of copper will become reduced into the red oxide of copper.

Another portion of the sugar should be dissolved in water and a small quantity examined under the microscope, when sporules of sugar fungi, sugar mites, and various other things equally nasty will be plainly seen. If iron is present a drop or two of potassic ferrocyanide will produce a beautiful blue, due to the formation of Prussian blue.



1, sugar mite; 2, ova of sugar mite; 3, hair; 4, sand; 5, wool fibre; 6, minute splinters of wood.

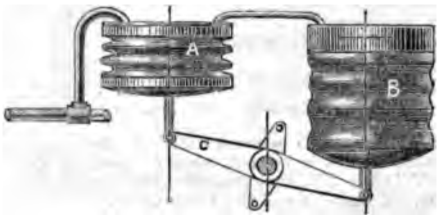
Albert Smith.

CONTINUOUS BRAKES.

[14522.]—I NOTICE in your issue of the 7th inst a letter from "C. E. S." giving a drawing and description of my automatic vacuum brake. Having before me a copy of Mr. Westinghouse's own circular, dated April 8th, 1878, in which he (Mr. Westinghouse) has thought fit to compare my brake with his own, in "a fair and impartial manner," (?) I cannot fail to notice that "C. E. S.'s" letter and drawing are merely a *réchauffé* of the statements and inaccuracies contained in that circular. From this fact your readers will be able to draw their own conclusions, and further remarks are not necessary.

In order, however, that your readers may have a correct idea of what the "automatic vacuum brake" is, I send you a drawing of it as applied on the Midland Railway, which, if your readers will compare with the illustrations given by "C. E. S." in some of his former letters, of the brake which he makes it appear he so disinterestedly upholds, they will be able to form a right judgment of the simplicity of the one and the complications of the other.

The brake blocks are applied to and taken off the wheels by the lever, C. The two drums, A and B, are attached to the opposite ends of the lever as shown. The area of the drum, A, being greater than that of drum, B, the pressure of the atmosphere on A pulls the lever into the position shown for keeping the brake off, but when air is admitted into the pipe along the train by the driver, or by either of the guards, or by an accidental separation of the carriages, the power of the drum, A, is destroyed, and the pressure of the atmosphere on drum, B, is then free to act independently on the lever, reverse its position, and instantly to apply the brake. Just before starting it is necessary to withdraw the air from the pipes and drums throughout the train; this is done by the driver opening the steam ejector. On the train being set in motion the ejector is shut off, and the vacuum is then maintained by the pump, which is worked from the engine. Air can be admitted into the pipe along the train, for the purpose of applying the brakes by simple cocks, one of which is conveniently placed within reach of the driver on the engine, and of the guards on each brake van.



I also send you the results of some experiments made with trains of equal weight, fitted up with the two descriptions of brakes, which are sufficient to show the relative efficiency of the two systems, and to contradict "C. E. S.'s" statement as to the time required to set my brake, which statement he seems to have copied word for word from Mr. Westinghouse's own composition in the circular above alluded to. With reference to the concluding paragraph of "C. E. S.'s" letter about cocks at the ends of the carriages, in which he attempts to shew that the want of them is a defect in my system, I simply remark that if the action of a brake is to depend upon a porter turning a cock the right way I would rather not introduce such a dangerous element into my brake. Such a cock might be left open when it should be shut, or it might be shut when it should be open, in which latter case the driver would be deceived by the gauge in front of him, and most disastrous accidents might be the result.

EXPERIMENTS MADE WITH SANDERS' AUTOMATIC VACUUM BRAKE, ON THE GREAT WESTERN RAILWAY, JULY 27th, 1877.

Total weight of train			Speed in miles, per hour.	Distance run in stopping.	Time in stopping.	Vacuum
Tons.	Cwt.	Qrs.		Yards.	Seconds	lb.
166	9	0	45	157	15	10·0
166	9	0	53	223	16	12·5

NOTE.—The vacuum in these experiments was the same as that used in every day working.

EXPERIMENTS MADE WITH WESTINGHOUSE'S AUTOMATIC COMPRESSED AIR BRAKE ON THE NORTH BRITISH RAILWAY, DECEMBER 22nd, 1876.

Total weight of train.			Speed in miles, per hour.	Distance run in stopping.	Time in stopping.	Pressure of compressed air.
Tons.	Cwt.	Qrs.		Yards.	Seconds	lb. per sq. in.
166	10	0	40	183	16	90
166	10	0	50	259	18·75	101

NOTE.—The pressure ordinarily maintained in this brake is 60lb. to 70lb.

June 19. **R. D. Sanders.**

MIDLAND SPECIAL EXPRESS.

[14523.]—I OBSERVE, upon page 352, that a correspondent mentions the "special express" which left St Pancras for Scotland at 9.15 p m. on Monday night, June 3. This train was the Duke of Argyll's special express, and conveyed the remains of the late Duchess of Argyll, and also the ducal party and friends to attend the funeral. The train consisted of 2 Pullman sleeping cars, 1 bogie carriage, 1 saloon carriage, and 2 vans, or equal to a load of 10½ ordinary coaches, and it was fitted throughout with the Westinghouse automatic brake.

It has been stated, in some of the newspapers, that the speed at which this train ran was "something extraordinary." The length of the runs without stopping is worthy of note, but the actual running speed was the same as the ordinary night express. The train, as far as it ran over the Midland line, was at first intended to stop at Leicester, Cudworth, Water-lane Junction, Leeds, Skipton, and Carlisle; but, by a special order, Normanton was substituted for Cudworth and Water-lane Junction—the booked time being as follows:—

M. Chns.				June 3, p.m.
— —	...	St. Pancras	dep. ...	9.15
99 9	...	Leicester	arr. ... dep. ...	11.25 11.30
				June 4, a.m.
185 6	...	Normanton	arr. ... dep. ...	1.23 1.33
220 77	...	Skipton	arr. ... dep. ...	2.20 2 25
307 60	...	Carlisle	arr. ...	4 30

The ordinary 9.15 express followed the special at 9.18. It will be noticed, upon reference to Vol. XXIV., page 271, that this train ran the shortest route, viâ Staveley and the Leeds curve.

This train could, if necessary, have performed the journey in very much less time, but as the party did not require to arrive at their destination until the morning, there was no object in booking the train at a high speed. The longest run without stopping, it will be observed, was from St. Pancras to Leicester, 99 miles 9 chains, the train for this part of the journey being drawn by engine No. 804, which is one of those rebuilt last year, with cylinders 18in. diameter, and 26in. stroke, the coupled wheels being 6ft. 8in. diameter. This train kept most admirable time, notwithstanding that it was slackened three times on the journey by other trains.

June 19. C. E. S.

ORIGIN OF LANGUAGE.

[14524.]—Although a very tyro in knowledge of the wonderful art of language, I venture confidently to think that the letter on this subject (14483, pp. 368-9), while displaying many interesting points that bespeak a thoughtful writer, yet contains one or two prominently fallacious statements. The study of language, however truly fascinating a science, is not yet but complex art, bearing indubitably the impress of human inventiveness. Respecting the broad generalities of speech countless volumes have been written. It remains for some one in the future to reward the weary student by describing exhaustively the nature and science of the simply subtle bases of language—vowels and consonants.

Mr. Toy believes that originally gestures and simple vocal sounds, now used as interjections in speech, were the only means of communication of ideas. I am surprised to find no mention made of "knotted strings," which were believed to have been in use for transmission of ideas amongst some of the ancient inhabitants of that marvellous, almost mystical, region, Central America.

The earnest—one might say passionate—plea for primitive language reminds one of the narrow defence of naturalism once put forward by a strange French philosopher. If it be admitted that simple vocal sounds were useful as adjuncts to gesture, why could not such a system of expression be infinitely extended?

And now I come to consider the most important portion of the letter. Mr. Toy does not seem to share the belief of some *savants* that vocal sound in some cases is, and has been purposely formed to appear approximately analogous, in some manner subtle or palpable, to the thing or idea it represents. I am one of those who would emphatically express a belief in the intrinsic poetry and music of language, or, in other words, in onomatopœia, and confess to being to some extent a "bow-wow" theorist. Could our Aryan ancestors in their pastures have been prosaic men? It happens that we, their remote descendants, speaking a language which is mainly formed of one part of the many ramifications of the primitive tongue, possess onomatopœic words agreeing with those in ancient and distinct branches of that parent language.

I leave to some more capable and erudite correspondent the task of precisely comparing the resemblances between ancient and modern words belonging to the great and well-named Indo-European family of speech, and of discussing fully upon the vexed questions connected with the large subject of the antiquity of language. How richly expressive are many of our ordinary words. Take the word cruel; what intensity of fierceness it bespeaks. How softly indicative of the strongest yet most tender passion of life is the word love. What resignation of grief in the word sad, what pall of woe is spread by gloom! The vulgar word "mum," it has been pointed out, allied as it is with the old word "mystery," well indicates because expressed quite labially, the close silence desired in the person addressed. Is there no rough music in buzz, whirl, burr, crash, splash, crack, murmur, ripple? Contrast soft, gentle, meek, with hard, harsh, stern, bold. What quickened joy is expressed by glad, and boundless buoyancy by joy! Caligraphy, as an art of fixing and forming a depository for the thoughts of man must always be ranked second in importance to the art of expression of ideas by articulation, which must have been the great forerunner to symbol writing.

The weak point, I imagine, in the English and some other written languages, lies in their unphonetic aspect. Volumes of arguments, however, it is obvious, could be hurled against the recent proposal to radically alter the existing orthography of our language. The wealth of knowledge and ideas transmitted through the ages by writing it is impossible to conceive and estimate. This art and its great modern attendant one of printing have, by degrees, systematised the known forms of spoken language and developed modes and styles of varied yet accurate expression. How vast the world of modern literature alone with its diverse throng!

A word or two, by the way, as to criticisms upon a certain favourite style. There is no doubt often an air of superficiality surrounding the popular examples of "fine writing," but the men who usually denounce such a style are those who adopt an opposite and cold mannerism, whose knowledge of the form of language is unlimited, yet for whom its true fulsome spirit has only a negative charm. They are the consonants of life, the men they deride being sometimes its tuneful vowels. Such critics are the kind of men who would sanction free trade in everything but speech. If, as learned men tell us, nearly all the European dialects are derived from one great fountain-head, the Aryan language, why should there be attempted to be imposed for any European race a precise restrictive use of simply one of its branches instead of a broad cosmopolitan view being adopted?

Finally, when the studies of mathematics and metaphysics are brought from the student's closet and applied in the elucidation of all the ordinary phenomena of life, then may the study of language be fuller, and more properly receive the name of science, and deeper beauties be shown of that wonderful creation which springs from the chaos silence.

H. Woollen.

ORIGIN OF LANGUAGE—RATE OF INCREASE OF POPULATION.

[14525.]—Your correspondent, Mr. Toy, has omitted one very good argument in favour of the gradual development of language—and that is, that a child who is born deaf is also dumb as far as articulate speech is concerned, although the organs of speech may be fully developed. Such children would articulate correctly could they be made to understand the sounds to be uttered.

Were language an innate faculty we should have but one universal system, which would require no teaching, and a child should learn as he learns to walk or eat.

I have just had a conversation with a friend as to the rate of increase of the population of the earth, with a view of calculating from that rate the time that man has existed. It would be interesting to know whether such calculations have been made, and whether there are any reliable data for such. I should think civilisation tends to increase the population (notwithstanding the many directions in which it also tends to shorten life), as we seem to value existence more than savages, and to place a greater value on the lives of our offspring. Take the Chinese nation for instance. I do not think they increase in the same ratio as the English or other Continental nations. Within the last 150 or 200 years the English nation has increased immensely. What other people can boast of so many colonies and offshoots, and what country is more thickly populated than ours? Other nations certainly have more ground at home, and do not so much require to seek fresh pasture; but they do not seem to have developed themselves pari passu with Great Britain. But this is wandering from mathematics and statistics. Have any of our friends figures on which the above-mentioned calculation could be based?

Os.

Erratum.—In letter 14478, p. 367, the full stop after "train," in line 6, second paragraph, should be placed after "interference" in line 5.

Erratum.—Sunspots.—In my letter, p. 367, for "2, May 28, evening," read "morning."—James Durrant.

Errata.—Two misprints in letter 14456 (E. M., No. 690, June 14, 1878) need correction. The paragraph relating to O^1 O^2 Cygni should stand thus:—

O^1 O^2 Cygni Σ. (A.D.) 323° 41′ 9 : 337″·838 : 1839 95
Smyth (A D.) 333°·8 : 338″·0 : 1838 67

and not as printed. In the same paragraph for "Smyth gives his measure *and* weight of g" read "*a* weight."—H. Sadler.

REPLIES TO QUERIES.

*** *In their answers, Correspondents are respectfully requested to mention, in each instance, the title and number of the query asked.*

[31943.]—**Slip Coupling (U.Q.).**—Carriages are slipped by means of a slip-coupling, which is like an ordinary link coupling, excepting that the end of one of the loops is hinged something like a padlock. The end of this link is kept shut by a pin, to which is fastened a cord, passing over a pulley into the guard's brake van. When the guard wishes to slip the carriages, he pulls this pin out by means of the cord, and that releases the end of the link, and the draw hook then passes out free. Two cords are fastened to the swinging end of the coupling, and the other ends to the sides of the roof of the brake van, which prevent it from striking the ground.—Murano.

[32209.]—**L. and N.W.R. Tunnel (U.Q.).**—The report cannot be true, as trains now (May 15) run through the new tunnel. A new station is being made at Loudoun-road, and Kilburn and Chalk Farm (Camden ticket platform) Stations have had new tiled platforms, with stone bordering, and of a convenient height. Kilburn, also, has a new and commodious signal cabin, and when all is finished, the North London trains will run through to Kilburn, calling at Loudoun-road.—Murano.

[32218.]—**G.N. Four-Coupled 7ft. Engines.**—There are six built by Messrs. Fowler in 1866; I believe there were two as built, Nos. 264 and 268—at all events, No. 268 had not been rebuilt in the autumn of 1876, and 264 had not last November. The other four were rebuilt as single engines in 1875, I think, and they are used for express trains. In 1876 the "up" day Scotch express was nearly always worked by them from Peterborough, and two of them, Nos. 265 and 266, always take the 4.15 p.m. train from King's-cross, and are the only engines on the G.N. fitted with the Westinghouse brake. I have only seen 268 on goods and fish trains.—Murano.

[32608.]—**L. & N.W. "Bloomer" Engines (U.Q.).**—These all have "inside" cylinders, and the driving wheels have inside bearings only.—Murano.

[32639.]—**Pitch of Screws.**—The following is the table of standards of size for taps and dies:—

No. of screw threads per inch.	Old sizes.	New standards of size decimals of an inch.
48		·100
40	⅛	·125
32		·150
24		·175
24		·200
24		·225
20	¼	·250
20		·275
18		·300
18		·325
18		·350
16	⅜	·375
16		·400
14		·425
14		·450
14		·475
12	½	·500
12		·525
12		·550
12		·575
12		·600
11	⅝	·625
11		·650
11		·675
11		·700
10	¾	·750
10		·800
9	⅞	·875
9		·900
8	1	1·000
7	1⅛	1·125
7	1¼	1·250
6	1⅜	1·375
6	1½	1·500
5	1⅝	1·625
5	1¾	1·750
4½	1⅞	1·875
4½	2	2·000
4½	2⅛	2·125
4	2¼	2·250
4	2⅜	2·375
4	2½	2·500
4	2⅝	2·625
3½	2¾	2·750
3½	2⅞	2·875
3½	3	3·000
3¼	3¼	3·250
3¼	3½	3·500
3	3¾	3·750
3	4	4·000
2⅞	4¼	4·250
2⅞	4½	4·500
2¾	4¾	4·750
2¾	5	5·000
2⅝	5¼	5·250
2⅝	5½	5·500
2½	5¾	5·750
2½	6	6·000

—Murano.

38.]—**L. N. W. and G. N. Bogie Engines**).—I think the rolling from side to side, when ıg, that "Short Stroke" has noticed, is due to ıge of the rails being loose, more than to the ınd outside cylinders I have seen the same with engines of the "Precedent" class (inside ers and one pair of wheels leading) at Euston, know the rail gauge is very loose there, which the case at King's Cross.—MURANO.

70.]—**Whitening Bells.**—In reply to "Un- ı" the process I wish to ascertain is by boiling. ve, in acids; the other processes I understand. t not replying sooner, having been away from —WISEMORE.

3.] — **Metropolitan Railway Coaches**).—All these run on two four-wheeled bogie .—MURANO.

8]—**Marks on Coins.**—No; the marks I vere stamped, apparently some years after the f the coin, and are right on the head, in all r of positions.—MURANO.

8.]—**Invisible Ink.**—Milk makes a good in- ink, and I believe buttermilk answers the e better. It will not show if written with a ıew pen, and ironing with a hot flat-iron is ıt way of showing it up. All invisible inks ow on glazed paper; therefore unglazed paper be used.—MURANO.

5.]—**Three-Cylinder Engines.**—Replying M.'s" inquiry on page 347, whether it is rhood's or Willan's three-cylinder engine I was inquiring about, I have since got that ıation which I wanted, for it was close on six from my inquiry to receiving a reply from .," and if he could give me a little information e-cylinder engines, only in rather less time, I be very glad, as follows:—Is there found the in three-cylinder single-acting engines that first anticipated? I have been informed that quire a tremendous amount of back pressure the pistons and connecting-rods up to their If that is so a user must lose as much in fuel ains by not requiring the adjustments that are d in high-speed short-stroke double-acting s. If "J. M." is practically acquainted with ylinder engines I should be very glad of future ation respecting same, as well as the above.— HANIC.

4]—**Gold.**—By "reducing the metal to pow- meant that it should be brought to as fine a f subdivision as possible by any means that suggest itself to "Daghbert." He might file ıammer it out. The idea in subdividing the is simply to allow its solution to take place ıcility.—THEO. PITT.

0.]—**Chemical.**—To the other replies on this ın I beg to add the following arithmetical and ıical solutions:—The arithmetical solution is by calculating the amount of chlorine in the weight of KCl and NaCl respectively, as taken assay, and taking the difference of these two ties, which is the excess of chlorine which ıes with sodium above that which unites with ium, then subtract the weight of total chlorine mixed chlorides from the weight of chlorine ned in an equal quantity of NaCl, and call ference the partial excess, and the proportion ıe whole excess of chlorine is to the partial so is the weight of mixed chlorides to the of HCl in the assay. For instance, the ng example, where the weights are taken he atomic equivalents of the elements, will the above rule more intelligible. Let us e 74·6 grains of KCl mixed with 58·5 grains of consequently the weight of mixed chlorides is rains, and the weight of total chlorine 71 grains.

133·1grs. of NaCl contain 80·77grs. chlorine,
133·1grs. of KCl „ 63·34grs. „

Excess ... 17·43grs. chlorine.

lucting the total chlorine from the weight of ıe contained in 133·1 grains NaCl we have—

80·77grs. chlorine in 133·1grs. NaCl
71·00grs. „ mixed chlorides

l excess, 9·77grs.

en 17·43 : 9·77 :: 133·1 : KCl in mixture; leducting the weight of chlorine contained in ıe weight of KCl from the total chlorine we proportion—

17·43 : 7·66 :: 133·1 : NaCl

the percentage of NaCl and KCl are desired llowing solution may be useful:—Let W = of mixed chlorides, C = total chlorine, a = ıt. potassium in KCl, b = per cent. sodium in x = KCl in mixture, and y = NaCl in mixture.

$$ax + by = 100\,(W - C)$$

$$x + y = W$$

$$y = \frac{100\,W - 100\,C - a\,W}{b - a}$$

$$x = W - \left(\frac{100\,W - 100\,C - a\,W}{b - a}\right)$$

DAL.

4]—**London Paving Stone.**—The querist ıean Bridge-street, Blackfriars. The light d stone is York flag, which is the only de- m of stone used for foot pavements now, ng Scotch flag, in some rare instances; but much more expensive, and is sawn like marble, of being split like slate, which is the way lag is done. Now, the grey-black stone is probably, something like half a century old, if not more; it is almost unwearoutable (!), and is one of the only two things the paviours of a century ago could "do" in paving stones. There is some of it in front of Eusten station, and also in the church-yards (pavement) of St. Mary, Islington, Hackney, and Limehouse, and in most old parts of London. This same stone was used very much at Gravesend. There is a great deal of it in Windmill-street. As an illustration of the durability of it I may mention that, in front of the kitchen door in the front area of No. 38, Theberton-street, Islington, is a slab of this stone, with an inscription cut on it in first-rate preservation, which is as follows: "Castle Hill Stone, 1833." I should like to know where this stone was quarried, and also the white stone that used to be used. Perhaps Mr. J. H. Collins can throw some light on the subject.—MURANO.

[32909.]—**Paper Canoe.**—"Australia" does not say whether he means a miniature or a full-size canoe. Paper would be of no use for a working boat, and as to a mere model, as it is called—why, it does not much matter how he makes the frame.—DORYPHORA.

[32910.]—**Japanning Clock Dials.**—The enamelled surface is put on in the usual way, only, if the base is a thin sheet of metal, copper or zinc, the frit must be more fusible than when it is applied to porcelain. This is easily done by using a greater proportion of flux. The black may be either burnt in with a suitable enamel or painted with "drop-black" and gold size. But these operations are only for good clocks; the cheap things are simply painted, and glazed with a varnish.—EROS.

[32912.]—**Mustel Organ.**—Take the sectional drawing given in Vol. XXIII., and reduce the scales in proportion. You say you want the extreme end of treble. The top note of flute, instead of a channel the size shown, should have no channel at all; but the reed aperture would be a trifle longer than the pallet aperture, so that the reed would be exactly under the pallet, only the thickness of the veneers separating them. The distance between the frames would be the same as shown in the drawing, but the veneers would be close together, thus rendering a block to shorten channel unnecessary. Why ask for a drawing, so troublesome to make, when you can easily do one yourself? The other registers must be treated in a similar manner to the flute, but the top note of the 16ft. will have a channel about the same as the top C but one of the flute.—HENRI ETIENNE.

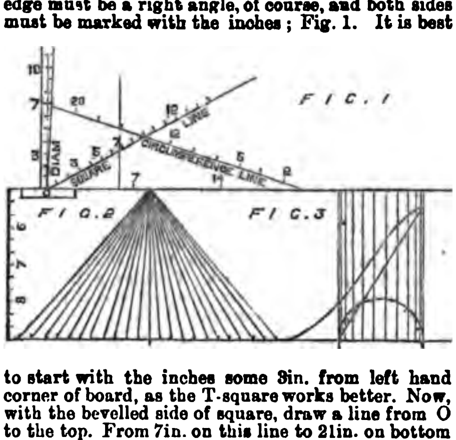
[32915.]—**New Zealand Railways.**—Appointments can be obtained by applying to the agents of the companies in this country; but I would advise the querist to address a note to the agent-general of the colony first—Sir Julius Vogel, 7, Westminster-chambers, S.W.—J. W.

[32919.]—**Hot-air Engine.**—The best form of this kind of engine was illustrated and described in No. 597.—OBERHOF.

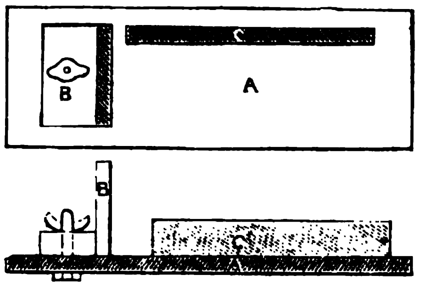
[32922.]—**Repairing German Concertina.**—Get a set of new plates; they can be had for a trifle at almost any music-shop. The reeds are of brass and German silver.—HENRI ETIENNE.

[32923.]—**Scarlet Tunic.**—If by "coal-gum" tar is meant, benzoline will remove it, and then a weak solution of ammonia will, probably, restore the colour. I saw in these columns not many weeks ago a number of recipes for the removal of the different kinds of stains. Perhaps the querist might find something suitable there.—J. SMITH.

[32930.]—**Pipe Angles.**—"John" must provide himself with a drawing board 3ft. long and 1ft. wide. Mark the bottom edge with inches the same as a rule. Make a T-square, the blade to be 1ft. long, and the point must be a full ¼in. wider than at the root. One edge must be a right angle, of course, and both sides must be marked with the inches; Fig. 1. It is best to start with the inches some 3in. from left hand corner of board, as the T-square works better. Now, with the bevelled side of square, draw a line from O to the top. From 7in. on this line to 21in. on bottom line draw a straight line, and mark the inches on it from right to left. This line gives the circumference of any circle where cut by the square. Thus, at 7in. it gives 22in., and at 3½in. it gives 11in., and so on. This is without substance. Suppose I had to make a ring on a hoop of iron ½in. thick, and to measure when turned 7in. outside, butt jointed. Take off the substance, and that would leave 6¼. But if for 7in. inside add the substance, which would be 7¼. Again, with the right angle of square, at 6⁷⁄₈in. on bottom edge of board, draw a line, and from O, with a radius of 7in., cut the perpendicular, draw a line through this, and mark with the inches. This line squares the circle near enough for all practical purposes. Fig. 2. Now for the other side of the board. Mark the left side with inches, the T-square will do for the other side, and at about 12in. from left side draw a perpendicular, measure from this line at bottom on each side 11in., draw a line from these marks to the top of perpendicular, making a triangle. Divide each side into eleven equal spaces, and from those marks draw lines, all of which will come to the same point. We will suppose you have the zinc cut for a 7in. tube; lay it against the triangle, and copy the divisions with scratches, and mind you start from a true centre. From all the marks raise perpendiculars, and now it is ready for any angle you choose to work from. Fig. 3. The next process is to describe a semicircle on the right hand side of board, about an inch from the end, raise a perpendicular, and from this at bottom draw the semicircle, and divide it into eleven equal parts, and with the square draw lines through all the marks. Having marked the height of angle on the perpendicular draw a line to the other side of half circle, and with the compasses take the height of each division, and mark on zinc.—GEORGE BOURN.



[32930.] — **Pipe Angles.**—"John" will find as much trouble in trying to mark off an angle in the sheet as it would take to make the pipe, unless he was to make a proper pattern; but for every different angle he would need a different pattern. I think if he was to make a template board like the following sketch, it would answer all he requires:—A, being a slab of wood; B, being two pieces of wood nailed at right angles to each other, and adjusted to any angle "John" wants, and fastened with the screw; C is a ledge to hold pipe in position.—T. CLARKE.



[32931.]—**American Dried Apples.**—The following extract from *Scribner's* for June will probably be the best answer to this question, and at the same time interesting reading:—"Since the old days when Norseman navigators named New England "The Vineland," this country has rejoiced in an abundance of fruit. Three million peach trees bloom each spring on the sunny plains that lie between the Delaware and Chesapeake Bays. The apple crop of the country is almost past counting; our surplus fruit if rightly saved would keep all Europe in table luxuries. The birds on New Hampshire hills are feasted with raspberries, while the mountains of North Carolina and Tennessee are purple with blackberries that go to waste. The time has been when an extra good crop of peaches in Delaware meant a million baskets of fruit left untouched upon the trees. The primitive work of drying fruit in the sun is still followed in many parts of the country. Maine is noted for its sliced apples; New York is the chief dried apple State, and sends its sun-dried product for export in halves and quarters. Ohio and Michigan, Illinois, Indiana, and Kentucky, produce large quantities in the order which we name them. Georgia makes a sun-dried apple of a fine golden colour, and North Carolina, with only seedlings and wild fruit, produces sliced dried apples and peaches, delicately coloured from light straw to pale flesh colour. Everywhere in Tennessee, North Carolina, and Georgia, one may see at the farmsteads rows of boards tilted up to the sun and covered with sliced fruit. Sometimes it is spread between sheets of muslin to keep away the insects, and to give the fruit a finer colour. These small lots of fruit are collected by the country store-keepers, and thus find their way to the great cities and a market. The first improvement made in drying fruit was tried in the North, and consisted of covering the fruit with glass. The hot-bed sash idle in the barn found a new duty. Wooden boxes or frames made to fit the sash were prepared and set upon legs to raise them above ground. Holes were cut at the front near the bottom, and at the back near the top, to secure a current of air through the frame; within these glass-roofed frames the fruit was spread on trays in the full sun-light. The glass kept out rain, birds, and insects, and the fruit dried more quickly and with less labour than in the old way, and with a decided improvement in its appearance. Experiments were also made with stoves. The cooking stove dried the fruit more quickly than the sun, but it was wanted for other purposes. The next step was to erect drying closets. A small inclosed place or closet of any convenient shape or size was put up in the farmhouse or shed, and in this was placed a small stove. The sides of the closet were protected from the fire by brickwork, and above the stove were placed shelves for the fruit; inlets for the fresh air were made at the bottom, and at the top ventilators were provided for the escape of the heated air and vapour. Such appliances answered a very good purpose, and are often used to save the surplus fruit of a small farm for domestic use or for sale. Besides these domestic appliances there is now in use a very good iron stove or drying machine, costing about 70 dollars, and serving to dry all kinds of fruit in a much better manner than the wooden closets, which are liable to take fire. This stove is portable, and may be used out of doors or in a building, as is most convenient. A fire is kept up in the fire-box at the base, and above it are movable shelves for apples, peaches, berries, corn, grapes, or other fruits or vegetables. A constant stream of hot air passes through the apparatus, sweeping across the trays of fruit and quickly extracting all their moisture. The smoke flue from the fire passes through the escape for the hot air, and materially assists the movement of the air. Dryers of this form are largely used in the peach districts of the East and the grape-growing country of the Pacific coasts. They are easily managed, and will dry as much fruit in a day as a family can peel and slice in that time. Between Chesapeake Bay and the Delaware is a broad and level peninsula—the centre of the peach garden of the continent. Here the peach trees stand in rows a mile long, luxuriating in a warm and mellow soil and a genial climate. Every farm counts its hundreds or thousands. There are forests of 20,000 trees standing in prim and stately lines. The ploughman, guiding his horses between the trees, seems to be travelling off to the next county. Here, also, blackberry and strawberry, pear and raspberry, spread wide in the mild and sunny air, growing up to new stateliness, or covering the ground with a fruit and foliage in a luxuriance unknown to New England gardens. The white and sandy soil, free from stones, invites to culture. Plants and trees grow as if it were a pleasure to reward the labour spent on them Here and there the pines make a pleasing contrast with the monotonous peach groves, and immense fields of wheat and corn alternate with acres of strawberries. Each farm in the vast peach garden, which covers the whole of Delaware and a part of Maryland, Pennsylvania, and New Jersey, has an average of 1,000 peach trees. Some large estates count 10 000, 15.000, or 20,000 trees in one block. With a fair crop there will be 5,000,000 baskets of peaches on these trees. A good crop will yield 6,000.000 baskets—more peaches than the nation can eat while they are in good condition."—S. M.

[32935.]—**Grinding Glass Tube.**—If the tube is not already tolerably true it must be rough ground with an iron grinder, sharp sand, and water (Wimbledon sand); then bring up true with a slate grinder, using fine emery, and finish with a willow or alder stick and crocus. Could not say what is best speed, but a fair rate in a lathe.—J. T.

[32937.]—**Le Floral.**—If "R. G. L." will look in the back numbers of this magazine he will find much information about manures. I have not seen the new manure, and do not feel inclined to pay the price asked for it; but if "R. G. L." wants a really powerful manure (to be used with caution) let him see No. 403.—HORTUS SICCUS.

[32941.]—**Powerful Telephone.**—Mr. Gower's telephone harp was illustrated on p. 203. The most powerful telephone is one invented by Mr. Edison—not yet brought out.—DACO.

[32942.]—**Interest.**—"A Banker's Clerk," referring to my replies to this question, asks (on page 375) how I obtained the exact rate of interest from the rates given in the table. This was performed by what is known as "interpolation," and the details of the work are as follows:—We find from the tables the following values:

At $4\frac{1}{4}$ or 4·250 per cent.	...	£8 011
At $4\frac{3}{8}$ or 4·375 ,, ,,	...	7 962
Differences ... + ·125		− ·049

An *increase* of ·125 in the rate is therefore represented by a *decrease* of ·049 in the value. Now, the value for which we require a rate is 8 exactly. We thus have a rule-of-three sum:—If a decrease of ·049 in the value represents an increase of ·125 in the rate, what increase in the rate will a decrease of ·011 in the value represent? Stating this we have—

$$\cdot 049 : \cdot 011 :: \cdot 125 : x;$$

$$\text{or, } x = \frac{\cdot 011 \times \cdot 125}{\cdot 049} = \cdot 028.$$

Adding ·028 to 4·250 gives 4·278, the rate required. This is, of course, only an approximation, but it is, in this case, very nearly exact, as the table given in my former reply is correct to the nearest penny. Lieut.-Colonel Oakes' "Tables of Compound Interest" are published by C. and E. Layton, 150, Fleet-street, E C. The price is two guineas.—A FELLOW OF THE INSTITUTE OF ACTUARIES.

[32944.]—**Musical Telephone.**—I send the following clipping as a reply to this query. Does "Sincub" really think that the possessor of a successful instrument for rendering a distant concert audible would furnish him with "working drawings," &c., for the pure love of the thing? "Musical Motophone: This machine needs but a brief description, because, except as a toy, Mr. Edison said, 'It isn't worth five cents.' There is a sounding board before whose face are a number of highly-strung wires. Attached to the board is an arm, and on the end of the arm is a blunt needle. This needle falls upon a strip of paper, through which an electric current is continually passing. This paper is rough, and enables the needle to bite the paper except when the current is passing through it. The arm presses on the paper with a weight of 15lb. The paper is chemically prepared, being saturated with chloride of potassium. Mr. Edison has tried 20,000 different chemical solutions and combinations in order to find that one which would be the best and surest conductor of electricity, and the most suddenly take away the friction from the paper. 'Sweet be thy repose' was sung through this motophone with considerable beauty and power." I believe this instrument was described in its primitive form in these pages under the name of the motograph.—S. MAYER.

[32951.]—**Organ Orchestrion**—Does "Union Jack" want to know how to put the pins in the barrels, or merely what should be the order of the different kinds of music? If the former see the back volumes.—HANDLE.

[32953.]—**Indian Museum.**—No.—JOSEPH.

[32960.]—**Lamp for Burning Tallow.**—An open vessel, with metallic float carrying wick, is, probably, as good as any thing. Inclosed in glass shade if you like.—M. S.

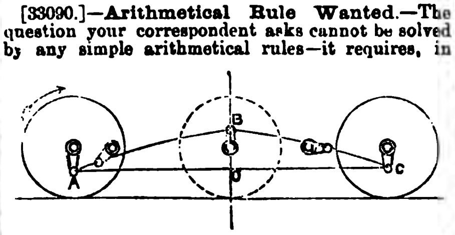
[32992.]—**Gold Lettering Books.**—"J. A." must get a suitable knife, to be obtained at an "artist's colourman's," and with it place a leaf on a velvet cushion (this may really be a hard cushion or a square of velvet about 5in. by 5in., glued to a piece of board); the leaf must then, when on the velvet, be cut with the knife into pieces of a size and shape to suit his inscription, &c. Then take the pieces of leaf up separately with the tip of the knife, and place where he wishes to gild. When the gilding is fixed and cold, wipe off the superfluous gold with a piece of cotton wool. For gilding on paper, I think painting the letters in gum-arabic and honey diluted, then applying the gold, and when quite dry wiping off carefully with cotton wool, would answer; but painting with the gold paint (in shells and bottles, 6d.), and burnishing with an agate burnisher when dry would be best.—MURANO.

[33036.]—**Mensuration.**—I beg to thank Messrs. M'Guire, Liverpool, and Buttershaw, Bradford, for their courteous reply to my query. But as they both enter considerably into algebra, I cannot avail myself of Mr. M'Guire's remarks, and but imperfectly of those of Mr. Buttershaw. With the latter's mode of working there is the advantage of the diagram, and I am sanguine of becoming able to understand it, and apply it when required to problems of a similar nature, although I know nothing of algebra. Nevertheless, I am pretty well up in mensuration of solids, square and cube roots, fractions (vulgar and decimals), &c. I do not understand what Mr. M'Guire means by the "continual product" of the length. Those two words, I believe, are the only ones I do not understand in the last rule that he mentions. I can hardly trouble them again with the same thing. But did not Mr. M'Guire intend accompanying his mode of working with a diagram? I am inclined to think so from his frequent and alternate employment of italic and capital letters.—OMICRON.

[33030.]—**Exaggeration of Power of Eyepieces.**—This was an error, and was corrected on p. 297 of the number in which this query appeared.—F. C. DENNETT.

[33077.]—**Zinc of Fuller Cell.**—I venture to give my experience. I use sealing-wax, laid on rather thick by heating the zinc over a Bunsen's burner or common glass flame, rubbing the wax on it, and then diffusing the wax uniformly by gently heating it in the flame. Mine has been on for two months. I have just examined the zincs, and find them as perfect as the day they were first coated. Perhaps the "chipping" is caused by the zinc knocking against the porous cell. I will state how I arranged mine: I first put a dish of cork, ¼in. thick, cut fully the size of the cell, into it, and press this down to the bottom, to take off the shock if the zinc should fall heavily into the cell; I then put another dish of cork on the stem of the zinc, so that it fits into the mouth of the cell. The zinc is thus kept secure from moving, and if the cork is coated with sealing-wax varnish, the appearance of the battery is improved. A two (glass) cell battery in a mahogany frame or stand which I use for parlour experiments, is thus a very sightly object, and all danger of the zincs knocking about when the battery is being moved is guarded against. Perhaps a little more mercury is required where the cork dish is put in the cell, but this is not wanted.—W. H.

[33090.]—**Arithmetical Rule Wanted.**—The question your correspondent asks cannot be solved by any simple arithmetical rules—it requires, in fact, the use of the higher mathematics. Supposing the crank-pin to start from its lowest position (as shown at *a* in the accompanying sketch), then in completing one revolution, so as to bring it into the position *c* it will describe the curve, *a b c*, the chord of which, *a o c*, is equal to the circumference of the driving-wheel, and the height, *b o*, to twice the crank. Taking *o* as the origin, the equation to this curve will be:—



$$x = 5' \times 7\cdot 1416 \times \theta \div 360 + 1 \times \sin.\ \theta,$$
$$y = 1' + 1' \times \cos.\ \theta,$$

θ being the angle at which the crank is inclined to the vertical. To find the length of the curve from these equations would require the use of the integral calculus; but if "J. W. B." set out the curve carefully to scale I think he will be able to find a circular arc that will nearly coincide with it, and the length of such an arc can of course be easily calculated.—W. MORSHEAD.

[33091.]—**Raising Water.**—The rule to find the horse-power of an engine for raising water is as follows:—Let H.-P. equal horse-power, D height to be lifted in fathoms, and L quantity of water to be lifted per minute in gallons.

$$\frac{D \times L}{550} = \text{H.-P.}$$

$$\text{Applying the rule } \frac{{}^{*}5 \times 250^{*}}{\underset{11}{550^{*}}} = \frac{25}{11} = 2\cdot 27 \text{ h.-p.}$$

* Erased figures.

or, leaving a little margin, say 2¼ h.-p. The best thing to apply the power with would be a common lift pump.—SPEED.

[33095.]—**Eyepiece.**—If "A Poor Student" is going to order an eyepiece of any particular power, he must state to the optician the power required, and the focal length of the O.-G.—F. C. DENNETT.

[33102.]—**Wire Joints.**—Thanks to "Sigma" for reply; but I notice from the handbook of a firm of electric bell manufacturers that they state positively that all joints must be soldered with resin. The flux "Sigma" means is, I presume, sp. of salt and zinc. May I ask "Sigma" to settle this point for me? I believe resin is much more difficult to manipulate than the flux.—T. J. M.

[33102.]—**Wire Joints.**—The best way to solder wire joint is:—Clean the ends well, then tin them, using resin as a flux (not spirits) then bind them together and solder, still using resin. The best solder to use is that composed of 3 parts tin and 1 of lead. It is the spirits of salts that acts upon the joint.—T. CLARKE.

[33100.]—**Soldering Wires of Electric Apparatus.**—I hardly understand this query aright; but if the joint has to be brazed do it with silver, using as a flux calcined borax. The silver solder can be bought of any working jeweller. I've brazed many copper things with silver, and never found any rottenness attached to them. Perhaps the electric current has something to do with it.—T. CLARKE.

[33110.]—**Steam in Small Boats.**—Both the query of "Mount Trenchard" (33110), and the reply of "Black Witch" to mine (32968), show that the subject is, as I anticipated, of general interest. Were such an arrangement as I suggested made available without much trouble or expense, what a luxury it would be to thousands during the boating season! I regret my inability to give "Mount Trenchard" the assistance he asks for, as the information he requires is just what I want myself. Living on the banks of one of the loveliest rivers in the South of Ireland—as Spenser has it, "The pleasant Bandon, crowned with many a wood"—knowing plenty about boats, but little about steam engines, I should feel much delight in being able to run my 12 miles to the sea and back at anything like the rate "Black Witch" encouragingly speaks of—independently dispensing with the exertions of a toiling crew. Now, the advantage of paddles over a screw is that a less draught of water is necessary—a desideratum in rivers; also that they, with their boxes, may be readily removed, as I proposed, from their bearings on the gunwale, when not required. This would be the most important advantage. As "Black Witch" obligingly offers the benefit of his successful experience, information would be valuable as to the all-important item of cost, size of engine and boiler, manner and position of temporarily adjusting them, consumption of coal per hour, &c. Considering the general application of small steam engines, I have wondered that more has not been done in this direction.—AQUARIUS.

[33112.]—**Dialling.**—I beg to thank "F. R. A. S." for his kind suggestions. The errors arose from trusting to a paper rubbing instead of measuring the hour angles on the dial itself. Deducing the log. tans. from my tables of log. sines, trying all the hour angles, and taking the mean of the results, I find the latitude 52° 55′, to which angle, I presume, I must cut the gnomon. Judging by the size of the mortices and the marks on the dial-plate, the old gnomon must have been nearly an eighth of an inch in thickness, the dial being about 6in. square.—ARGENT SABLE.

[33115.]—**Black Board.**—"Daghbert" has very correctly stated the qualities of a good black-board surface—intense black, without the least gloss. All manner of painting with ordinary black, so often done by the painters who have "done up" the school is extremely annoying to a teacher who uses a black board. I have discovered in an American work—Barnard's "School Architecture"—the secret of the "black art," practised with so much profit by Herr Frankie and others. Here it is:—"For Paintin ards: Lampblack and flour of emery mixed t varnish. No more lampblack and flour should be used than are sufficient to give ed black abrading surface. The thinner re the better. Lampblack should first be ith a small quantity of spirit varnish or free it from lumps. The composition applied to the smoothly-planed surface of ith a common paint brush. Let it become y dry and hard before it is used. Rub it pumice stone if too rough.—D'EVLYNN.

—**Brown Coal.**—Brown coal or lignite many qualities and varieties from the our down to the pitch black. It is usual to term to all coal which is found in a more mation than the true carboniferous period. being a later deposit, the process of minera- s not been so completely effected, and there- ains a much larger proportion of volatile This coal burns with a dull flame, and only about 60 per cent. of carbon and a tity of water, does not give much heat. ipal deposits are on the Continent; in e seams attain the thickness of 50 feet.—

— **Microphone Construction.** — The of which he complains is caused by the of the contact between the carbons, diffe- ds requiring different degrees of pressure. izontal sounding board, and pivot on it a t piece of hard carbon, shaped so that shall only just touch a very thin gas carbon, which should be screwed flat sounding board; the point of the carbon ld be as sharp as possible. One connection made to the pivot, the other to the carbon his arrangement gives a very sensitive ne, far too sensitive for the proper repro- f vocal sounds, but quite capable of detect- ll of half an inch of human hair. But to sounds quite perfect in quality all that added is a thin thread of indiarubber. u may find in any old boot elastic. Fasten of the thread near the pivot, then ross the carbon lever so that it presses on loop the thread on one or other of the ews; the pressure on the contact points be increased as the loop is moved from ft. In this way you will, by making a few ts in the adjustment of the pressure, get perfect results. For very small sounds, e footfall of a fly, the elastic should not be ind that it is best to fix the square sound- (which should be of very thin dry deal, and by a coat of thin varnish), to four stout h legs are fixed to a stout base board rest- o or three pieces of felt. This insulates, k, the instrument from sounds other than ing place on the sounding board. It is also nnect the pivot and the carbon plate by a ire to set-screws fixed on the base, and so e inevitable vibration of the wires going ring apparatus from affecting the sound- In many cases it is this vibration which for the "fly's" footstep. The battery uld be very small. For a hundred yards a rbon 4 × 5in., separated from a piece of wet flannel, is ample. A high power through e rather decreases than increases the clear- e sound. Of course, the battery power ncreased according to the resistance of the bj ct to using one of the battery plates as g board, because the sound of the chemical ing on in the battery interferes with the ich you wish to hear, if it be very delicate. arrangement does well for vocal sounds.—

— **Power of Astro Eyepiece.** — The t a perfect object-glass will bear on stars known as 100 to the inch (the grammati- acy of the wording I will not guarantee); object-glass 1in. in diameter would, if it ect, and the conditions favourable, bear a 100; a 2in., 200; a 2¼in., 225; a 2½in. or ich means just the same, 250; a 2¾in. or 75; a 6in., 600; or a 12in., 1,200. I hope lear away "Eyepiece's" difficulty.—F. C.

—**Paint for Cart.**—As I see so many specting coach-making left unnoticed, I hat there are few subscribers of the coach- raft, or else they must be more selfish than hanics, who so very liberally attend to all For the past ten years I have asked many which have all been answered except those to, and I am glad that I can now help ." First give two coats of equal parts of d and patent driers, coloured with lamp- slate colour; then two parts turps to one oil, to thin it with. Two or three coats of ing must then be given, according to the quired, which is gained by pumicing off to surface with pumice-stone and water. ling is mixed with equal parts of gold size with a little drying oil. All holes must d with dry lead, wetted like putty with size , before the filling. Next apply one coat of r, and glass-paper off; but care must be t to get through the colour in both the rses, and each coat must be perfectly dry next is given. Also, in pumicing, there reat care taken to keep the superfluous ashed off with sponge and water; and watch close that there are no scratches, or else the full course will probably have to be gone through once more. When a perfect surface is gained a ground coat is given; but "E. B. F." leaves me in a hole now, as I do not know the colour. All colours have not the same drying properties; light colours, as a rule, dry best. However, equal parts of turps, gold size, and drying oil will about do the last-named coat, which, when dry, is followed by one or two coats of glaze, mixed with carriage varnish, except a little oil to grind the colour in, and a little gold size to dry it quick; then the picking colours, wetted with oil, turps, and varnish, or gold size for the varnish. Each glaze coat must be rubbed down with finely-powdered pumice-stone and a piece of good strong cloth, such as pilot (worn cloth is best). Sponge the panel first with water, to prevent scratches. Keep the work sufficiently wet to let the powder work freely, which must be used sparingly. Then pick out with your favourite colour, mixed as above. Use best sable pencils—the longer the better—dip occasionally in turps, and work your pencil well on your pallet, so that you have a proper quantity of colour; then place your pencil flat, but don't let the quill touch; draw gently—a little practice will make you right. Now varnish all over.—AN OLD SUB.

[33162.]—**Soap Bubbles.**—If "F. B. L." will take some ordinary white soap, and with a wetted flannel make some suds, and add a few drops of gum-arabic, sufficient to colour the water, he will obtain bubbles of more than ordinary strength.—HAWKS.

[33163.]—**Works on Chemistry.**—To answer "F. C. F." correctly "which is the best work on chemistry?" one would need to know for what purpose he is studying. Is it for general knowledge? for a special examination? or for laboratory practice that he desires analytical knowledge? If for either of the former let him use Fresenius' or Thorpe's "Qualitative and Quantitative Analysis" or Valentin's handy little book, "Chemical Analysis." If the latter, Francis Jones's "Inorganic Chemistry for Junior Classes" and Sutton's "Handbook of Volumetric Analysis" will be found among the best for the purpose published.—J. M. W., Manchester.

[33163.] — **Works on Chemistry.** — Fownes' "Chemistry" is, I think, the book which will suit your requirements best for theoretical chemistry. For analytical chemistry Fresenius's "Qualitative and Quantitative Analysis" are decidedly the best, and if you have these you will seldom fail to find what you want in one of them.—LAWRENCE BRIANT.

[33163.]—**Works on Chemistry.**—A good book for "A Young Chemist" is Griffin's "Chemical Recreations," which will convey a fair knowledge of analysis. Slater's "Chemical Analysis" is a very good book, but much more advanced.—W. J. C.

[33166.] — **Asbestos.** — "Cardinal" had better purchase asbestos sheets, used for packing steam joints, &c. It is made up in different thicknesses, and looks like mill-board.—W. J. C.

[33171.]—**Battery.**—Sawdust Daniell's.—W. J. C.

[33172.] — **Anti-Corrosive Oil.**—Neutralise the acidity by the addition of caustic soda or potash; do not put too much, or you will make soap.—W. J. C.

[33172.]—**Anticorrosive Oils.** — In reply to "Cripple's" query, it is impossible to prepare them, free from oxygen, on a small scale. I should advise him to use Harrison's Anticorrosive Paste—a new discovery, and advertised in these columns.—CRUTCHES.

[33173.]—**Electricity.**—In thanking Mr. Lancaster for his kind offer and giving full particulars I am sorry to say I have rheumatism, more or less, all over. I was first attacked about two years ago in the long muscles of the legs, and was attended by two medical men (one called it rheumatic inflammation, the other rheumatic neuralgia), with but little benefit. I got about again with an effort as the weather got warmer. The malady has continued to spread since to the knees, hips, loins, under the blade-bones, shoulders, elbows, wrists, and fingers, with I do not know whether to say acute but yet very trying pains and aching. The joints stiffen at the least exposure. I have some heat at times in the knee-joints, am troubled very much with a cold clamminess at the bottom of the feet, legs, and shoulders, am extremely susceptible to the least draught, and weak and debilitated. Digestion bad; age, 50. I tried a magnetic battery lent by a friend some time ago, which intensified the pain, and was afraid to continue.—C. ENGINEER.

[33175.] — **Midland Express.** — In reply to "Passenger," the following is the running of the 10.45 Liverpool to London:—

	Arr.	Dep.	Speed.	Dis.
Liverpool	—	10.45	—	
Stockport	11.32	11.35	47.19	37¾
Marple	11.45	11.49	33	43¼
Derby	1.0	1.5	41.19	92
Trent	1.19	1.26	41.78	101¾
Leicester	1.54	1.59	42.32	121¼
Bedford	3.3	3.6	50.15	175
Kentish Town	4·7	—	45.14	221

This train makes a conditional stop at Warrington at 11.8 a.m.; average speed per hour Liverpool to London, including stoppages, 40·18 miles; speed per hour, exclusive of stoppages, 43·77 miles. It will be noticed that the speed between different stations is the reverse of even, although coupled engines are used. The brake "Passenger" alludes to is the vacuum brake. If "W. H., Salford Engine Driver" will look on the wall of the departure platform for Leeds (L. and Y.) at Victoria he will see a photograph of two Festiniog Fairlie engines. I can send him some dimensions if he wants.—L. L.

[33175.]—**Midland Express.**—In answer to "Passenger," p. 352, No. 33175, the 10 45 a.m. express from Liverpool to St. Pancras performs the journey in five and a half hours. The following is the booked time for which he asks:—

	arr. a.m.	dep. a.m.	Time at Stations, min.
Liverpool, Central		10.45	
Warrington	*	*	
Stockport	11.32	11 35	3
Marple	11.45	11.49	4
	p.m.	p.m.	
Derby	1 0	1.5	5
Trent	1.19	1.26	7
Leicester	1.54	1 59	5
Bedford	3 3	3 6	3
Kentish Town	4 7	4.10	3
St. Pancras	4.15		

Time standing at stations, total, 30 minutes.

* Stops at Warrington to pick up London passengers when required.

Since the 11th of March last this train has been fitted throughout with the Smith's vacuum brake.—C. E. S., June 20th.

[33180.]—**Closing Spirit Levels.**—I should advise the blow-pipe flame if "J. L. H. S." could use it; if not, try oxide of zinc, made into a paste with strong solution of zinc chloride.—GALLIUM.

[33180.]—**Closing Tubes of Spirit Levels.**—The only effectual mode of doing this is by hermetically sealing the end in a blowpipe flame. This is not difficult to do if you wrap a rag wet with water round the tube, and as close up to the end to be sealed as possible. The wet rag prevents the heat from the flame from causing the spirits to boil, which would spoil the operation. You will, probably, not succeed unless you draw the tube out afresh to a tolerably fine capillary point, having previously emptied it of spirits; then refill to the requisite extent. Let the sealing be done quickly, and direct the flame as much as possible just to the point to be sealed.—H. E. H.

[33181.]—**Life of a Watch.**—I have a good Geneva watch which was worn by my father. For 8 or 9 years he had it in constant use, and then gave it to my mother; she has not had it in as constant use as it was before, but out of the last 12 or 14 years she has had it, I dare say for certain it has been going half its time. This makes up about 15 years' good work. Well, it's a good watch to-day, and as reliable as any watch for good timekeeping. A great fault (and sometimes a deception) in watch repairers is to put in soft and untempered hair-springs. Hair springs cost about 1d. each when untempered; when made hard and tempered the price of a good one is about 4s. 6d. each. Hundreds of watches that will not go simply want a good hair spring.—W. J. C.

[33182.]—**Valuation.**—The desired object can be effected if A and B are the only persons interested. A's interest is 64 per cent. or 64 parts of the whole. B's is 36. A's interest is, of course, liable to succession duty, the amount of which can be ascertained by an application to Mr. Hanson, Legacy Duty Office, Somerset House, stating all the particulars. Less duty will be payable now than would be the case at B's death.—J. W. S.

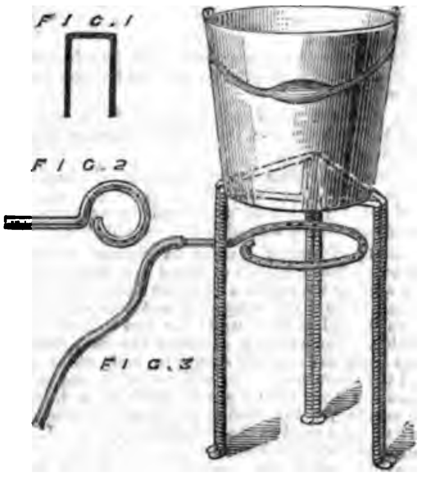
[33184.]—**Raising Water.**—Yes; a pulsometer will do, providing you have a steam-boiler to work it, and the boiler power must be greater than to work a pump. I would advise a pump for economy.—W. J. C.

[33189.]—**Luther's Chorales.**—Cocks and Co. publish a fine collection of tunes arranged by Rinck, whose arrangement cannot be otherwise than completely satisfactory. But, I think, if Mr. Bell would drop a line to Herr F. Weber, organist to the German Chapel Royal, St. James's, that gentleman would willingly give all the information required, and he is better qualified to do so than most persons.—NE SUTOR.

[33192.]—**Keeping Colliery Engine Bright.**—There is no good practical way to keep your engine bright under such circumstances. I would advise you to paint the bright work; clean paint always looks better than dirty polish. Respecting the smoke and sulphur injuring your health, you can have only one remedy—viz., to remove the nuisance.—W. J. C.

[33193.]—**Iron Pianoforte.**—Will Mr. Davies oblige me with the thickness of a solid iron back, and could it not be cut out as a series of columns or pillars, and the soundboard fitted in between these pillars or past them, if you please, in one piece? Again, would it be possible to have two soundboards, one on each side of iron frame and columns, and both strung to equalise the strain and improve the sound and tone, because two strings on two soundboards must (?) sound better than two strings on one soundboard? Is not cast iron likely to give at any moment with disastrous results? But I suppose it is well hammered. Why have a wooden pin piece when a series of holes in the iron frame would seem to suffice for carrying the strings; and, indeed, if two soundboards have to be strung, a notch in the bottom edge of iron frame would hold a string or wire carried through from front side to back? You see I have to think of my own finger-keyed viol, and would like an iron plate cut out, if the inside uprights would be strong enough to bear the strain. My action works equally well back or front. Don't forget to tell me how thick your iron back is, what weight it has to bear when strung, and what thickness it ought to be, to bear same strain, when cut into five pillars or uprights, two outside (making the frame with top and bottom) and three inside.—FIDDLER.

[33199.]—**Rapidly Raising Temperature of Water.**—The simplest method for "A. C. R." would undoubtedly be to place in the pail containing the water to be heated the end of a pipe conveying steam from a boiler. As this, however, might not be convenient, and as he might wish a supply of warm water at a few minutes' notice, I would suggest to him the following method (not patented):—Take three pieces of stout iron wire or thin rod and bend them into the shape of Fig. 1, then lay one of the longer limbs of one piece beside one of the longer limbs of another piece and bind tightly together with thin iron wire; repeat the operation with the other corresponding limbs till a tripod is formed which will support (if the rod be decently thick) any moderate weight. Let him now take a piece of leaden tubing (of course iron, copper, or even brass would do better if obtainable) and first bend into the shape of Fig. 2 (having first closed up one end); then afterwards file at intervals (as shown in figure) small holes on the surface. If the holes are filed first the tube will probably break. Tie the unperforated projecting limb of this to one of the legs of the tripod and connect it with the gas supply. Fig. 3 will shew the arrangement intended. Of course, if he has a large Bunsen burner, or any means of admitting air into the ring burner, so as to mix with the coal gas, he will obviate the deposit of any soot on his pail, and also obtain a greater equivalent of heat from his gas.—J. M. W., Manchester.



[33202.] — **Algebra.** — Subscript numerals are merely distinguishing—*e g.*, three unknown quantities may be represented by x_1, x_2, x_3, instead of by x, y, z. Subscript letters and dashes are similarly used—*e g.*, x', x'', x_a, x_b.—W.

[33202.]—**Algebra.**—In the resolution of equations of the higher orders, series, &c., this form of notation is frequently employed. In investigations where there are two or more quantities which have any peculiar relation to each other, such as when each is constantly derivable from the one preceding it by the same process, it is often advantageous to represent them by the same letter, marked for the sake of distinction with the numbers or letters placed commonly to the right of them, and lower than the general line—thus, x_1, x_2, x_3, x_n, &c., and is read x one, x two, &c., or first x, second x, &c. I have no doubt "Roscoe" may be better able to understand the application of this notation by examining the following equation:—

$$x^n + p_1 x^{n-1} + p_2 x^{n-2} + \dots + p_{n-1} x + p_n = 0,$$

where n is a whole positive number, and p_1, p_2, $\dots p_n$, co-efficients, either whole or fractional, positive or negative, and independent of x. If in this equation we take $x = x^1 q^{-1}$, so that $x^1 = qx$, we shall get $x^{1n} q^{-n} + \dots + p_n = 0$, and by multiplying by q^n, we have—

$$x^{1n} + qp_1 x^{1n-1} + q^2 p_2 x^{1n-2} + q^3 p_3 x^{1n-3} + \dots q^n p_n = 0.$$

"Roscoe" can easily perceive from the above how to understand his query.—BERNARD MCGUIRE, Liverpool.

[33207.]—**Capital Investment.**—The best adviser is a leading stockbroker or banker. The most experienced financiers are frequently mistaken in their investments. Don't put all your eggs in one basket. If you are advanced in years you may invest in a life annuity (Government is best), and get high interest; but don't be unjust to those who come after you and sink your all. There is nothing like experience and personal knowledge to enable you to invest to advantage, but, remember, you are mortal and fallible.—SENEX.

[33207.]—**Capital Investment.**—There are two things a man can do with his money—spend it, or save it. The first is not so foolish a proceeding, as he gets the enjoyment of it, and that, according to an ancient financier, is all he can expect to get this side the grave. But our moderns desire the cake and its enjoyment too—so they speculate. Now, no one can ever gain by speculation any more than he can win at cards without understanding the game, and some of the games are very pretty and amusing—to the winner. Never invest in any thing you don't understand. Buy a house and live in it—save the rent—and before the capital is returned something will turn up for its investment. Don't invest in building society shares, unless you are sure, because, if anything happens your money will go to reimburse the depositors, therefore be a depositor in preference, and be thankful for what is a good interest with tolerable security. It is true that there is plenty of waste land, but if we could buy it the distance is too great, and I'd rather invest in New Zealand or the Transvaal, and await the results. But people won't wait. As a rule they buy dear and sell cheap, and it's astonishing how easy this is to do. The French proverb is "If you wait long enough you'll win," but this infers soul-sickness. So, unless a man can afford to lose, he had better not speculate. Fortune is a fickle jade.—FIDDLER.

[33212.]—**Prussiate of Potash.**—The formula for the yellow substance bearing this name is K_4FeCy_6. It is manufactured by heating together bone shavings and waste from the combcutter's, old hoofs, horns, dried blood, scrap leather from brace manufacturers, &c., with potashes in iron vessels. The resulting grey mass is lixiviated with boiling water, which, on concentration, leaves the impure yellow crystals of ferrocyanide of potassium, having the composition, according to Sheridan Muspratt:—

Potassium cyanide ...	61·80
Iron cyanide	25·47
Water	12 73
	100 00

The red prussiate is formed by passing chlorine through a solution of the above salt. I do not know of any simple test for the purity of the product other than the ordinary laboratory methods of estimating it—viz., the yellow salt by permanganate of potash, the red by iodine and sodium hyposulphite standard solutions.—J. M. W., Manchester.

[33215.]—**Arsenic in Violet Powder.**—I think Reinsch's test is the most simple one that might be relied on in all cases. The only re-agents necessary are a small quantity of pure hydrochloric acid free from arsenic and a small supply of sheet copper, also free from arsenic. Get both from a druggist, and name to him the purpose for which you require them. The mode of procedure is as follows:—Take a small quantity of the powder—as much, say, as will lie on the point of a knife or small spoon—introduce into a little glass tube (also to be obtained from any chemist) and boil over an ordinary gas flame with a little of the acid and some water. Now insert the end of a small strip of the copper and allow to remain for a minute. On removal it will be covered with a shining grey deposit if the powder in question is adulterated with arsenic. In lieu of this test, any person possessed of a microscope may detect with certainty the minute octahedral crystals lying amongst the starch granules by moistening a small quantity of the adulterated sample and placing it on a slide.—J. M. W., Manchester.

[33215.]—**Arsenic in Violet Powder.—A Simple Test.**—A portion of the powder should be dissolved in water and gently heated in a glass tube, open at both ends. The arsenic will be sublimed, and collected as minute brilliant octahedrons. The pure violet powder would not show crystals of any kind. The hydrated peroxide of iron is the great antidote in cases of arsenic poisoning, and should be given at once if the presence of arsenic is suspected, as in any case it can do no harm. The hydrated peroxide of iron can be made in a few minutes. Mix together equal quantities of the tincture of muriate of iron and of liquor ammoniæ; a precipitate will soon form, which is to be used after pouring away the liquid.—R. P. G., Harcourt House, Anerley.

[33215.]—**Arsenic in Violet Powder.**—In reply to "N. Sirch," there is not any simple test by which arsenic can be distinguished from other metallic substances. If he is at all nervous about violet powder, let him be supplied with pure starch powder unscented, which answers all the purposes of violet powder. There is not any doubt about the arsenic getting into the powder by mistake, but it is not so easy to find out how the accident happened. If "N. Sirch" will compare the quantity of terra alba used in the second quality violet powder, he will find a close resemblance in amount by weight to the percentage of arsenic in average samples.—A CHEMIST.

[33215.] — **Arsenic in Violet Powder.** — In answer to "N. Sirch," I may say that no simple test for arsenic is, in itself, quite conclusive. Let him get a piece of pure copper foil, make it bright and clean by heating it red hot, and polishing on stone. Then boil a portion of the suspected substance in distilled water, acidulated with a little strong hydrochloric acid, chemically pure. After boiling for about 15min., let it cool, filter the solution through paper, then take a portion of the clear solution, place with the copper foil in test-tube, and
boil for a few moments. Be sure th
is strongly acid to litmus paper before
copper foil. Should arsenic be prese
foil will be coated with a livid greyish
are many other tests, but the presence
of the violet powder compels the analy
precautions, and makes the process te
fusing to any but a chemist.—GALLIU

[33210.]—**Electric Light for Wo**
depends on how well you want the wo
nated. Henry Wilde's machine is
small size, I think, would take about
power.—W. J. C.

[33219.]—**Electric Light for Wo**
of Siemens' machines, driven by a two
would light your workshop, but the co
would be much higher than that of
The effect, however, would be very di
gas, and would render the air in th
instead of more impure, as in the use
W. J. LANCASTER.

[33221.]—**Analysis of Alum.**—T
follow in analysing alum cakes is a
weigh out a portion, dissolve in water
to a known quantity, withdraw an al
add a few drops of nitric acid, boil fo
two, and then add solution of bari
slight excess. I allow to settle, an
wash with hot water till free from ch
I tell by testing the filtrate with nitr
as long as a turbidity occurs I know
present), then dry at 220° Fahr., a
precipitate in the usual manner.
generally estimate along with the
cipitating both as hydrated oxides w
boiling off excess, filtering, igniting,
as usual. I then dissolve the weighe
in hydrochloric acid and estimate
presence of the alumina either by
potassium permanganate solution or b
tion test with standard ferric chloride
the amount is respectively large or s
"Dunsebarky" find any further diffi
analysis or calculations, if he will
name and address I shall be glad t
privately, as I have already, I am afr
on the good nature of our Editor.
Manchester.

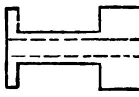
[33222.]—**Mining Engineer.**—No
all. M E. may be used by anybody;
mechanical engineer, mining engin
evening, or mere emptiness.—W. J. C

[33223.]—**Apprenticeship.**—All de
the articles of apprenticeship were fr
starting times or number of hours we
he cannot be compelled to work; but,
tice is to obey all the master's reasonab
he must work to time, but he must be
extra time.—W. J. C.

[33224.]—**Channel Islands.**—"Re
will find much fuller and more compreh
to most of his queries in Black's "
Channel Islands" (a cheap manual to
through any bookseller) than could pos
within the limits of a letter. There
however, upon which I may be able
some little additional information—v
climate of the islands. "Respice F
doubt, fully aware that bronchial asth
capricious complaint, and that it is
sible to predict what locality will su
suffer from it. Some cases do best
bracing, and others in a more humid
atmosphere. I should therefore strong
to pay an experimental visit to the Ch
before attempting to settle there. T
Jersey and Guernsey is mild, equabl
insular in its character. It does not,
consumptive patients; but it suits s
bronchitis and asthma fairly well. I
limited experience I am inclined t
climate of Guernsey to that of Jersey
mind, St. Pierre, the capital of the for
a pleasanter, more home-like, and alt
"livable" place than St. Helier's,
town of Jersey. With regard to que
should incline to the opinion that t
Ventnor (or, in some cases, that of I
would, on the whole, be found prefera
the Channel Islands in most cases
asthma, as an air that is too relaxing
the state of the digestive organs that a
panies that complaint. But, on the ot
cost of living is considerably greater i
watering-places than it is in eith
Guernsey.—M. R. C. S.

[33225.]—**Halse's Galvanic Batte**
but one coil (primary), containing
cotton-covered wire. The wire only
the length of the cylinder, which is o
sketch, having a hole right through, a
a small bundle of wires the length of
is solid; and, by means of an endle
small bundle of wire "is run in," whe
the machine is at its weakest. To incr
there is a small brass stud over the
this, which carries a bevel wheel; it re
wheel carrying pointer on dial, and at
pointer wheel actuates the endless s
the bundle of wires inside the coil o
makes the current stronger. The wi
are lateral expansions of the primar

stud carrying the vibrating spring to pillar holding platinum tip. As to quan- is no more of that article from using 12 n a single pair, as they are coupled up for without which the machine would not



ie battery plates, being always in the acid soon destroy ; but, however, a dozen sheets ied silver is not of much consequence to have plenty of the article known by these . s. d.—MEDICAL GALVANIST.

— **Gelatine.** — Place cold water upon gelatine, and in an hour or so the gelatine swelled up very much : now drain all the and then add hot water to the right con- or working. Alcohol or carbolic acid l improve its keeping qualities.—W. J. C.

—**Green Pavement.**—Get a piece of hook at end, and scrape all the dirt out reen the stones; afterwards fill in with mortar.—TELESCOPE TELE.

—**Adulterated Carbonate of Lead.**— he carbonate of lead in hydrochloric acid, sulphuretted hydrogen gas through the Filter off the sulphide of lead, and then nia till alkaline and ammonium oxalate, a cipitate indicates the presence of calcium. d the filtrate is then evaporated down to a k or to dryness, and a small portion is stened with hydrochloric acid, placed on a wire, and then put in a Bunsen burner. A our indicates barium.—A. E. MENKE.

—**Phonograph**.—If you wish to use a phragm make it of iron. Paper is in- affected by the moisture of the breath. The st be fixed below the diaphragm, as in nger's sketch at page 323. Place the spring rer to the diaphragm than it appears to be connect it to the centre by a small piece ubber. The point should turn slightly ls (not upwards), making an angle of about he spring. Use tinfoil, not lead.—SHEL- WELL.

—**Boot and Shoe Making.**—There is a lished at the *Crispin* office, price about should recommend you to make friends workman in the line, where you will pick t deal more knowledge in a week than you reading books on the subject in a twelve- TELESCOPE TELE.

—**Gas and Formula.**—To find the per- composition of CH_4, CO_2, CO, H_2S the is the best method :—

C = 12
H_4 = 4

16 = molecular weight of CH_4.

cular weight is then taken and divided into ılar weight, first of the carbon and then of gen, taking care first to multiply by 100.

16) 1,200 (75 per cent. of C
112
80
80

16) 400 (25 per cent. of H
32
80
80

= C = 75·00
H = 25·00
100 00

s are done the same ; (*b*) the volume, must taken and then divided by the specific nd the result gives the atomic weight.— NKE.

]—**Silverlike Polish on Brass.**—The employed to put a "silverlike" face on itrate of mercury. Let me advise "Nom- " to avoid it, for (1) it is a sham, and (2), ams, it eats away everything that is noble rt. Surely brass can be had white enough ; n be highly polished enough to please any- ile, above all, it is honest.—S. MAYER.

]—**Silver-like Polish on Brass.**—A tem- olish may be obtained by rubbing on a solu- e by dissolving a globule of mercury, the pea, in just sufficient nitric acid, and adding ur ounces of water. Alexr. Watt recom- solution of one ounce of nitrate of silver in a quart of water, then add hyposulphite until the precipitate formed is re-dissolved. , have not been successful with this solu- he cost of the former would be, say, three- f the latter perhaps five shillings. But how urface they would cover I cannot say.—

]—**Ice Creams.**—Strawberry Ice-Cream : h. of fresh strawberries, and put them in a sieve, and rub them through with a wooden ext, add ½lb. of powdered sugar, the juice of 1 lemon, colour with a few drops of cochineal; cream, 1 pint. Of course, you must use the saccharometer to test if the sweetness is correct; if too sweet it will prevent the freezing. This will make about 1 quart. Raspberry and Currant Ice-Cream : Take 1lb. of raspberries, ½lb. of red currants, ¾lb. of sugar ; strain, colour, and freeze. Pineapple Ice-Cream : Take 1lb. of pineapple, when peeled bruise it in a mortar, pass through hair-sieve, add ¾lb. of powdered sugar, and 1 pint of cream, then freeze. Ginger Ice-Cream : Bruise 6oz. of best ginger in a mortar, add juice of 1 lemon, ½lb. of sugar, 1 pint of cream ; well mix, strain through sieve, then freeze. Lemon Ice-Cream : Rasp 2 lemons on some sugar, which, with their juice, add to ½lb. of sugar and 1 pint of cream. Mix, strain, and then freeze. Italian Ice-Cream : Do same as above, adding a glass of brandy. Vanilla Ice-Cream : Pound up 1 stick of vanilla (or sufficient to flavour to palate) in a mortar, with ½lb. of sugar, strain through a sieve upon the yelks of 2 eggs ; put into a stew-pan, with ½-pint of milk, simmer over a slow fire, stirring all the time, the same as custard ; when cool add 1 pint of cream and the juice of 1 lemon, then freeze. This makes about 1 quart.—TELESCOPE TELE.

[33246.]—**Chemical.**—(*a*.) The equation for the action between SiO_2, CaF_2, and SO_2HO_2 is the following :—

$$2\,CaF_2 + SiO_2 + 2\,(H_2O\ SO_3) = 2\,(CaO\ SO_3) + SiF_4 + 2\,H_2O.$$

(*b*.) The name of Fe_2O_3 is sesquioxide of iron.— A. E. MENKE.

[33248.]—**White Rats.**—You cannot have anything better than bread soaked in hot water, and then squeezed dry ; then milk added. You might give them now and then a few oats by way of a treat. —TELESCOPE TELE.

[33255.]—**Electro-Plating Birds' Feathers.**— For this purpose make a solution—phosphorus in bisulphide of carbon (1oz. of the former to 15oz. of the latter). Dip your feather into this solution, and afterwards into a solution of nitrate of silver (½oz. to 1 quart of water). Keep it here till it assumes a black colour (caused by the reduction of the silver). Wash in water, and place in a weak solution of chloride of gold. Wash again in water, and allow it to dry. It is now ready for the plating or gilding bath, for which see back numbers. Ferns, flowers, insects, &c., can be treated in this manner. I have not tried this method, but presume it to be correct, as it is given in nearly all works on electro-deposition.—Os.

[33256.]—**Photographic.**—Your best plan would be to purchase some albumenised paper at a photographic depot. Cut this into pieces the size you require. You must now make a bath of nitrate of silver, 80 grammes to the ounce of distilled water, and float your paper face downwards on this. Leave it so for about 3min., and hang up to dry to print it. You will require a "printing frame"—a small picture frame with the picture removed will answer the purpose, or, if you like better, you can buy one made for the purpose at the above-named depot. Place the fern against the glass, and on it place the prepared paper. Now, expose it to the sun till the visible part of the paper is slightly bronzed. Remove it from the frame, and wash with water, and then immerse for half an hour in a solution of hyposulphite of soda (2oz. hypo to 6oz. water) ; but before you do this it will be better to tone the picture. Toning bath is made with 2 grains of sodio-chloride of gold, and 15 grains bicarbonate of soda, dissolved in about 8oz. of water. Let it remain in this solution for 10min. or 15min, wash, and transfer to the hypo bath ; after which, it may remain in water all night. You can then dry between blotting-paper, and mount while still damp. The sensitive paper should be prepared by candle-light, by which also the subsequent operations should be performed.—Os.

[33261.]—**Crayon Drawings.**—I have found the best way of fixing these to be by blowing on, with a perfume spray-producer, a solution of isinglass in water and methylated spirits. I have seen Rouget's liquid recommended, but have not tried it.—R. G. L

[33261.]—**Crayon Drawings.**—If "J. I. C.'s" crayon drawings are the soft Swiss crayon, if he has any regard for them he will not use any means to fix them. I always strain the paper on a frame, and use a mount, which prevents contact with glass.— NEVER TRUST.

[33267.]—**Milk, Oh !**—According to Dr. J. Muter, a "preservative" for milk has been invented, which consists of borax, 6·6 ; potassium carbonate, 1·7 ; sugar, 2·5 ; water, 89·2. This fluid is diluted with so much water, and added to milk, the water being undetectable by the "solids not fat" process. Perhaps the milk referred to by Mr. Jinks is dosed with this "preservative." I need scarcely say that Milky did not discover this preparation, but purchased the secret of some "chemist." An Adulteration Act that touches only the small men, and allows the prime mover to escape, is what might be expected from legislators of the modern type.—S. MAYER.

[33271.]—**Leclanche and other Batteries.**— The details of construction have been given over and over again, and are to be found, sufficiently precise for any handy person to work from, in any of the numerous books on the subject. That is why I suggested a look into the shop windows, as of course I could not know that the querist was out of reach of them. On the other hand, he cannot expect such very elementary matters and things so readily obtainable by any one to be constantly repeated to convenience a single individual at a time. It is throwing away money and work to use flower-pots for porous cells, as they involve most extravagant construction and consumption. A Léclanché needs no porous cell, its only use is to keep the mixture in place. A cylinder of pasteboard, made by winding brown paper, or better still parchment paper, as sold by stationers for covering jam-pots, wound on a slightly-tapering stick, and the edges secured with sealing-wax or shellac varnish, answers perfectly. I have had cells thus made working for years. Such porous cells will also work in Daniell's cells, but not in nitric acid ones. Ordinary batteries can, of course, be made with plates of zinc and copper or carbon mounted on a strip of wood in the manner of the common Smee cells.—SIGMA.

[33273.]—**Defective Lathe.**—It is because the head-stock of the lathe is out of centre—it is not in a line with back centre. The bolt that holds the head-stock to lathe has, I expect, worked loose.— TELESCOPE TELE.

[33275.]—**Dispersion of Sound.**—Sound may be refracted, as Mr. Grey states, by means of a "sound lens" filled with a denser medium than atmospheric air ; it might also be dispersed with a concave sound lens ; but how could this be made to keep its shape ? It can be dispersed by causing the wave to impinge on a small convex mirror, such as a watch-glass, and again collected to a focus by a larger concave reflector, which, I take it, would be the only method of proving its dispersion, as it is hard to observe a negative result.—W. H. DAVIES.

[33278.]—**Plating on Britannia Metal.**—The silver is sure to strip off if the different pewter metals are treated, as the querist says he does, in the same manner as brass. The final cleaning and preparation should be effected in an alkaline solution, caustic soda or potash, instead of acids, and the object should be at once transferred to the depositing solution without rinsing in water.—SIGMA.

[33279.]—**Composition.**—This is made of thin glue or strong size and whiting worked up to the proper consistency, so as to set firm as it cools, and to dry without too much shrinkage, so as to avoid cracking.—SIGMA.

[33280.]—**Straightening Horns.**—Boil them in a copper, and when sufficiently soft, mould to shape by forcing a pattern of the horn (drinking) in wood into it, and then allow to cool, and when dry take pattern out, file, scrape, and polish.—TELESCOPE TELE.

UNANSWERED QUERIES.

The numbers and titles of queries which remain unanswered for five weeks are inserted in this list, and if still unanswered are repeated four weeks afterwards. We trust our readers will look over the list, and send what information they can for the benefit of their fellow-contributors.

Since our last "Murano" has replied to 31943, 32209 32668, 32733.

32672.	Cornish Double Beat Valves, p. 150.
32684.	Reversion, 150.
32688.	Cattle Spice, 150.
32692.	Polishing Machine, 150.
32693.	Chemical Reaction, 150.
32697.	Camera Obscura, 150.
32698.	Refrigerator, 150.
32699.	Plain Turning, 150.
33700.	Powerful Telephone, 150.
32701.	Pony Bicycle, 150.
32702.	Bicycle Improvements, 150.
32709.	L.N.W.R. Engines, 150.
32712.	Secondary Batteries, 151.
32713.	Stables, 151.
32726.	Scholarship, 151.
32727.	Ochre, 151.
32730.	Rolling Photos, 151.
32733.	Railway Coaches (Metropolitan), 151.
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32914.	Hair Dye, p. 251.
32916.	Wing or Throttle Valve, 251.
32917.	Romping Twist, 251.
32925.	Hjorth's Magnet, 251.
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32938.	Fireworks (Japanese), 251.
32939.	Glass Staining, 251.
32940.	Plaster of Paris, 251.
32940.	Great Northern Engines, 251.
32954.	Old Music, 251.
32959.	Incorporation of Building Societies, 252.

QUERIES.

[33284.]—**Trigonometry.**—Could any reader of the MECHANIC oblige me by recommending a plane trigonometry for third stage mathematics ?—STUDENT.

[33285.]—**Cutting Grindstone.**—I have a small grindstone, about 6in. dia., which does not run quite true. Could I cut it true, and if so with what sort of tool ?—H.

[33286.]—**Midland Passenger Carriages.**—Will some contributor give the proportions and working dimensions of the Midland passenger carriages, particularly the distance of axle from end of carriage ?—BRAKE.

[33287.]—**Marine Zoology.**—Can any one who has access to good works of reference on the above subject kindly give me information on the following points ? 1. What are the distinctions between the common porpoise (Delphinus phocæna) and the classical Dolphin (Delphinus delphis)? Which is the larger of the two? What is the habitat of each? Which of the two is it that usually accompanies ships far out at sea? 2. What is the scientific name of the fish that is called the Barracouta in Australia and the Snook at the Cape of Good Hope, and what are its peculiarities? I should be greatly obliged by concise replies to each of these queries, with a statement of the source from whence the information is derived.—M. R. C. S.

[33288.]—**Grammar.**—Will some one kindly aid me in answering these questions? 1. Can you account for the absence of inflection in the third person of may, can, shall, dare? 2. Why are the forms wots, wotteth, and wotting incorrect?—READ AND MARK.

[33289.]—**Fiji Islands.**—A young man, age 21, a joiner, desirous of emigrating to the Fiji Islands, would be glad of trustworthy information as to cheapest route and prospects of employment at his own trade or in any other capacity, or if there is any chance of working his passage carpenters' mate, or otherwise.—YOUNG SCOTSMAN.

[33290.]—**Nodules in Limestone.**—In the neighbourhood in which I live there are several beds of limestone shale lying above what I believe to be the carboniferous limestone. In this shale, which is very soft, there are large numbers of little round stones (very hard), many of them about the size of a boy's marble, others larger. I have also found some of them more or less flat, with a hole pierced in the centre of them sufficiently large to allow the point of a pencil to be inserted. I once asked a geologist what they were; he answered, "Oh, these are nodules." This does not satisfy me. I would like to know (1) what is a nodule? (2) What is its origin, and how did it come to be in this limestone shale? I may say that the brachiopod shells, genus spirifera, and productous are common, also corals and crinoids in great variety, as well as other small shells I cannot name. If any learned reader would kindly notice this and reply, or refer me to a cheap work on the subject, I would feel greatly obliged.—J. Y., Quarter Iron Works.

[33291.]—**Organ Pneumatic Action.**—Will some kind correspondent oblige me with a description of the patent pneumatic action connecting slider to the stop knob? Also what is the tubular atmospheric contrivance mentioned in the description of the Albert Hall organ as dispensing with pedal trackers?—C. A. L.

[33292.]—**Tour in Southern Europe.**—I am thinking of making a tour through Southern Europe and the Mediterranean. Can any of your readers give me any information as to the cost, the route being as follows:—Through France to Marseilles, thence to Alexandria, and down the Red Sea to Aden, returning by sea? I think I should prefer to travel alone than by an excursion ticket.—W. JONES.

[33293.]—**Mustel Organ.**—To "ELEVE" OR OTHERS.—Could any one give us any information concerning a question that has appeared several times asking for information concerning the Mustel organ, which "Eleve" either has overlooked or does not care to answer? He said, "If, in the course of making the drawing, any difficulty presents itself then state in the plainest possible language what the difficulty is." What plainer statement does he want than the question asked in query 32912, No. 686? The same question was asked several times before. A friend of mine waited some time before he began to make his Mustel for the same information, but as it did not appear he has managed without it and has a good result for his trouble, but still he feels like myself and others that "Eleve's" directions would be best.—A. N.

[33294.]—**Anti-corrosive Metal.**—I am in search of a metal or alloy that will withstand permanently the corrosive action of ordinary black inks, if possible to be not much dearer than brass, and of a good workable character.—GUIDO.

[33295.]—**To "56in. Superb."**—Many thanks for your letter of last week. Would you further explain the front bearing? How is the steel cylinder fixed in its place, and how can the wheel be taken out of its fork when wanted? The crank is detachable with cutter and nut, but how is it got into the recess shown on crank? Is the axle flattened on one side to let it on and then twined round?—NIMROD.

[33296.]—**Noise in the Ear.**—Can any of your numerous correspondents tell me the cause of, and suggest a remedy for, an incessant crackling in the right ear?—AUDITOR.

[33297.]—**Magnesium.**—Can any of our readers inform me whether or not magnesium can be stored up for use in the vaporous state? Also what is the relative cost of magnesium as compared with coal-gas for equal illuminating power?—IGNORAMUS.

[33298.]—**Solar Microscope.**—To MR. W. J. LANCASTER.—I should be glad to know what alterations would be necessary to a solar microscope to use it with an artificial light. Also what light you would recommend for this purpose. I have heard that a good light has lately been introduced, made by burning coal-gas and air together in a certain proportion. If there is such a light I should be glad to know more about it.—VORTICELLA.

[33299.]—**Anatomical.**—I wish to know the proper way to proceed to prepare the bones and construct the skeleton of some small mammal, say a rat or mole, to serve as an anatomical specimen, especially how to get out all the bones uninjured, and the method of connecting them together. Is there any inexpensive book on the subject?—VORTICELLA.

[33300.]—**Drying Closet.**—What amount of heat would it be possible to get in a drying closet 15ft. by 8ft. and 6ft. in height, from sanitary pipes, viz., 12in. diameter, twice down the closet, and the feed steam to come from a four-horse engine, the exhaust constantly running through as the engine is at work? Would the pipes stand the heat, and would it make any difference to the engine?—A READER.

[33301.]—**Telephonic.**—I have constructed a pair of telephones of which the following is a description of one: Compound magnet composed of three horse-shoe shaped ones, 6in. long, the centre one being drawn back about a quarter of an inch, and the two outside ones gripping the two cores, which are 1in. by ¼in. On these cores I have fitted two bobbins half an inch long and an inch and a half in diameter, and wound with No. 28 (B. W. G.) silk-covered wire. The sound chamber I have turned — block of wood, dimensions 6in. × 6in. × 2in., and the diaphragm is 5¼in. diameter, but they won't talk. Will some one tell me where I have gone wrong? I am inclined to think I have used too large sized wire, but, before winding the bobbins again, would like to get advice. I have placed one in circuit with a microphone, and the ticking of a watch is produced, but very faintly, and not so loud as in a pair of small hand telephones I have constructed. If the wire is wrong size what size should I use? I may add that I used some of the same wire to make an electro-magnet, and put about eleven layers of about a hundred and twenty (120) turns each on the bobbin, but could get no magnetism with a two-cell Bunsen. T. J. M.

[33302.]—**Brown Bronze.**—Could any reader inform me how to bronze copper a light brown, same as French bronze figures, and how to lacquer when bronzed?—HAROLD.

[33303.]—**Isle of Wight Railway Engines.**—What are these like, and how many are there, and who built them?—MURANO.

[33304.]—**Old Tin Goods.**—Is there no use for old tin goods and sardine and preserved meat tins, &c.? I know a lane near Gravesend, Kent, that has been twice mended therewith. Could not they be melted and refined the same as iron ore, or would the tin and lead spoil the metal?—MURANO.

[33305.]—**Aniline Test.**—Will N. Sirch, or any of "ours," oblige with the aniline in wine test alluded to in arsenic and violet powder query?—PERIGRINUS.

[33306.]—**Glue for Violin.**—The back of my violin at the end has come undone. Will any of "ours" inform me what kind of glue to use to fasten it and also how to make and apply the glue?—THA SHAY.

[33307.]—**Geological.**—What is the character of the rocks around Tunbridge Wells, and what is their history? Title of any published history of same would oblige—A TYRO IN GEOLOGY.

[33308.]—**Photography.**—I have one of Ross's rapid symmetrical lenses for pictures 8½ by 6½, and shall be very thankful if somebody will tell me how I can take copies of engravings with it, for as it is at present I can only take an object when about 12 feet or more off, and at that distance the engraving comes out much too small.—ALAUDA DIGNUS.

[33309.]—**Repairing Pocket Compass.**—A year or two ago I bought two small sundial compasses; they were quite correct then, but now one evinces a decided preference for the N.W., and the others obligingly point any way you like. Can any one tell me what is the matter with them, and how I can put them to rights?—MURANO.

[33310.]—**Varnishing Walking Sticks.**—I want to stain and varnish some walking sticks of thorn, holly, and crab. What materials should I use to produce the appearance these sticks have when finished for sale in shops?—DUBLIN.

[33311.]—**Smell of Creosote.**—How can I free the interior of a writing desk from the smell of creosote, which was accidentally spilled in it some years ago? Time has not diminished it, and it taints everything kept in the desk, rendering the latter useless.—DUBLIN.

[33312.]—**Engine for Boat.**—Will "Black Watch" kindly publish the size of boiler, and how made (upright or horizontal), tubular or not, &c., also diameter of cylinder and length of stroke? I have a boat 20ft. by 5ft. 4in. I want to put an engine in, and think his will suit.—H. F.

[33313.]—**Gt. Northern Engines.**—The chairman of the G.N. said the other day that "they had only 38 engines over twelve years old, and six duplicate engines, and they had 16 engines in course of construction." Can any one oblige with the numbers of the 38 and six aforesaid, and tell me if there are any 8ft. engines building? Who built the old six coupled shunting engines 111, 134, 140, 144, 149, and 117A, and when, and the same of 101, 102, &c.?—MURANO.

[33314.]—**Watchmakers in Australia.**—Would any correspondent kindly inform me what chance of success a practical watchmaker would have in Australia or New Zealand, and in what part of the country is there the greatest demand?—W. G. H. A.

[33315.]—**Distance Indicator.**—Would some reader inform me how to construct a distance indicator for a bicycle? I have made an attempt to construct one and have failed. The one I have in hand was an old gas-meter dial, constructed to register nine miles, and I find it a difficulty to get it to register beyond that distance.—R. PILGRIM.

[33316.]—**Preserving Moths, &c.**—I should be glad if any of your correspondents would inform me how I may effectually prevent insects from destroying my moths, &c. I have always kept camphor in the cases but find it only presents an unpleasant smell, and does not guard them against the attacks of mites.—MIKE.

[33317.]—**Carbonate of Lead Manufacture.**—Can any correspondent tell me what other chemical preparation of lead forms in the manufacturing of carbonate of lead, as by careful precipitation, by oxalic acid from its solution in acetic acid, I get first a dirty white precipitate, and afterwards, by the addition of more oxalic acid, I get a pure white precipitate which, on reducing, I find to be lead in both cases. What can I do to extract the carbonate from the other admixture of lead?—J. M.

[33318.]—**Magneto-Electric Bells.**—Will Mr. Lancaster, or some other electrical correspondent, inform me how the electric bells can be rung with a magnet (see illustrated advertisements appearing in this journal) so as to dispense with the nuisance of a battery which requires as much looking after as an infant? I suppose the method would be the same as in the beautiful Wheatstone A B C, by revolving an armature in front of a strong steel magnet, but I cannot understand how the induced current thus obtained can magnetise the electro-magnet of bell so as to move the armature and strike the bell.—MAGNETO.

[33319.]—**Phonograph.**—Would not a Morse recording instrument make a good phonograph, a strip of tinfoil of unlimited length occupying the place of the paper tape? It could pass on from the first instrument to a second one, emitting the sounds spoken into the first. If this also would answer it would save the expense of a [illegible] and certainly be more accurate, as the stylus would always bear alike on the tinfoil, which it seem cannot be the case even on the most accurately-turne cylinder, as the wear and shake in bearings must quick interfere with its performance.—MAGNETO.

[33320.]—**Figures on Lens.**—I have recently go in for microscopy, and for highest power have a Seibe 1-16in. This has screw collar which has marked on it i equal parts all round 1, 2, 3, 4, 5, 6, 7, 8, 9, 0. Will a correspondent who possesses this sort of lens tell me wh the figures mean? How am I to adjust it, &c.? Ther is a flat place on one side brasswork, with a single mar and I suppose the others are brought opposite it, but wh or by what rule I do not know.—EDGAR STONE.

[33321.]—**L. and N.W. Engines.**—To what cl do the coupled engines "Isabella," 403, "Hardwicke," 790, "Princess Helena," 1517, "Trent," 830, "Abercrombie," 1525, and "Sphinx," 2156, belong, also those numbered about 1480 and 1670? I should like size of wheel and cylinders. What do the numbers stamped on th motion bars and tenders mean? What engine was in th Abergele collision, and in the accident in which th driver, Shelvey, known as the "Iron Duke" was killed Can "Itzaex" give me the numbers of "President," "Alma," "Antelope," "Princess Louise," and "Prin Leopold"—the number 2183 has been claimed for all th first three in the MECHANIC? How many times has th No. 1 engine been renewed since the incorporation of th L. and N.W.R. Co., and in what year was that? Wh engines were "scrapped" to make room for 861 to 872?—MURANO.

[33322.]—**Cementing Iron Pipes.**—Thanks for th information contained in the answers to my last query, I have succeeded in picking the cement out of the j without breaking any. I shall be much obliged for information as to the proportions of filings, sulphur, sal-amoniac for the cement to refit them; also I shall quire to cut some of the cast-iron pipes. What is the tool to do it with? Would a round-nosed chisel do?—WALLASEY.

[33323.]—**Removing Rust from Iron Pipes.**—Will some reader of the MECHANIC tell me of somethi that will loosen rust from the inside of wrought-i pipes? I have about 600yds. of 1¼in. pipe, from pond surface to two boilers underground. The boilers about 350 yards from bottom of shaft. The water by the head, but is gone to feed much weaker than it did, and I am inclined to think that rust has coll in the pipes. The pipes are buried all the way from to stokehole.—UNDERGROUND.

[33324.]—**Walking Tour—Tender Feet.**—I h been interested in letters that have lately appeared cerning knapsacks, a walking tour being my favou way of spending a holiday. My enjoyment, howev always greatly modified by blisters, a complaint which, I apprehend, most amateur pedestrians more or less. I suffer more. I have tried in vain knit woollen socks, soap, and fuller's earth, and I shall much indebted to any correspondent who can cons tiously recommend a specific. How do the professio manage in a six days' walk? So hard a feat could not done by tender feet.—WALKER.

[33325.]—**Measuring Heating Surface of Fi Box.**—Will some correspondent inform me how measure the heating surface of fire-box of a locomoti and also how to measure the lap and lead of slide valv—C. HARDCASTLE.

[33326.]—**Hard Enamel Paint.**—Will some of kind correspondents tell me how to make a hard and enamel paint, suitable for a zinc bird cage, and oblig AN OLD READER OF THE E. M., &c.?

[33327.]—**Simple Instructions on Org Stops.**—Can any one recommend a small book giving a simple way the information about organ stops, that person learning to play the organ requires? M treatises seem to enter so fully into the construction the organ, more so than necessary.—BRICKWALL.

[33328.]—**Sign Language.**—Would some of readers kindly inform me which is the best system learning the sign language, as I very much fear I sh lose my hearing, as it keeps getting gradually wors Any information will kindly oblige—A SUFFERER.

[33329.]—**Hydraulic.**—Will one of our correspond kindly explain the working of a hydraulic used in dock I mean that part which I should call the reservoir power, which is constantly kept up by pumps worked steam power.—L. W.

[33330.]—**Casting Plaster Medallions.**—W some friend favour me with the best way to cast med lions in plaster, so as to insure a clean fine casting, the best thing to use for a mould to cast, say, 20 or 30? J. B. PARSONS.

[33331.]—**Breadth of Organ Pipes.**—How bro ought a 16ft. wooden diapason to be, and how much oug the pipes to diminish in length and breadth as they go the scale?—C. T. S.

[33332.]—**Violin Studies.**—Spohr, in his "Vio School," requests that experienced teachers, after havi used it, will favour him with their instructive hints as the suitableness, or otherwise, of his method of tuitio and particularly with respect to the first half of the w adding that, although he had finished many pupils, had never been engaged in elementary instruction, was, consequently, wanting in individual experience that matter. Will any practical violinists please sta from their own experience, in what degree they may ha found Spohr's great work useful in elementary tuitio and will they also kindly indicate a generally practic course of study for the violin, say, for the first twel month? At what should the young violinist principal aim, in order, as soon as possible, to render himself use in the orchestra?—TYRO.

[33333.]—**Cricket Ball.**—Would any readers say h these are covered, as I have one which I wish to re-cove if possible to do so without special appliances? Ple explain what kind of leather is used, how to cut, and gi directions for making seams?—W. WILTON.

[33334.]—**Flickering Lamp.**—Can any of "our kindly inform me what is the cause of the bobbing of th flame in a petroleum lamp? It is in no way caused being badly trimmed.—HAWKS.

[33335.]—**Brown Bread.**—Will some one kindl inform me if brown bread made of ordinary flour an holesome and efficacious as that made of rye? aꟿ.

Flower Vase.—I should be greatly obliged ır readers would give me a good sketch of a ' It is to be of cast iron, to stand 2ft. 6in —

French Polishing Mahogany.—I shall) any one who practically understands it who me, through these pages, how to obtain an h, and glossy polish? I make a rubber of ı a flat even face; on this I pour a little of the ır this with a clean piece of fine old calico; rub with my finger a little linseed oil, then y it to the wood. Now if I rub with the grain it is streaky; if circular, it is patchy; the the rougher it gets. If I use the oil too freely lull, if too little it is rough. The first one or can apply very well, but trying to obtain a face I fail. Don't use technical terms without .—A. B. C.

Polishing Veneer Work.—Would any ly assist me in the following?—I propose try-'eneer work, but am at a loss as to polishing taken the Mechanic for nearly nine months. ot noticed anything which will help me. I r glad to know what substances are used, and e applied? My work will not extend beyond le or workbox, &c. Is the process the same s?—W. J. Hatch.

·**Magneto-Electric Machine.**—Would ır readers who possess Guthrie's work on r" give me their opinion of paragraph 294. he direction of current in diagram on page sserted direction of current appears to me to .—Electron.

·**Cadmium Sulphide.**—I should be glad if ld inform me whether the paint, cadmium ın be prepared from cadmium chloride and phide, and if so how. If not, the best and ns of making the paint. Also the way of lt blue.—H. T.

·**Lawn Tennis Balls.**—Can any one please od way to clean lawn tennis balls when they brown from being used on wet ground?—B.

·**Magnetic Meridian.**—It appears that tantly varying even in one and the same d that it is not the same in different neigh-ıt the same time. In the 16th century it was sterly of the zone meridian; about the middle century it corresponded with the zone meri- at present it is—at least for some places in bout 24° westerly. In Germany it is officially the neighbourhood of Bonn, on the Rhine ıt 24¾ east of Ferro, lat. 50⅔), as being resterly. In Mexico it is easterly. What is of this general want of correspondence with ridian, of the variation from east to west in ıere (as also, doubtless, in the western), and ant fluctuations? The difference between the ı England and Germany is, as will be seen, at is this much less in the latter country, ifference of longitude between, say, Greenwich s about 7°. Why is this so, and is it depen-and exactly in correspondence with, the longi-o, knowing the exact variation (declination) ch or at Ferro (first meridian on German l maps, 17° 39′ 46″ westerly from Green-t possible to calculate proportionately for ions at any other geographical point? ıe exact declination of the needle from the an at Greenwich and at Ferro (west point, or Detresa, of that island)? And for practical w are corrections for magnetic variations to be ınection with old surveys and maps? Thus, e map drawn in the year 1740, when the clination was only 16° 10′, and it is required rike upon underground works carried out and that year, how am I to proceed? There is orth point shown on the map, and it is not gnetic or true. I should be obliged for infor-' to proceed. 1. To find if north point shown or true? 2. When this is determined, how to resent declination in order to open upon the d works with certainty? 3. Are the meri-s shown on geographical maps, and marked longitude, the true meridian lines for places ich these lines pass? Thus, as an example, is ' W.) shown as passing through Berwick-on-say, Cheltenham, a true meridian line, and is ic meridian to be laid down correctly from To make my question clear, suppose a compass t Berwick-on-Tweed, with needle pointing to of variation corresponding to that place, "sights" of the compass, then bearing true outh, point direct to Cheltenham alone and vith the meridian line shown on the map?—

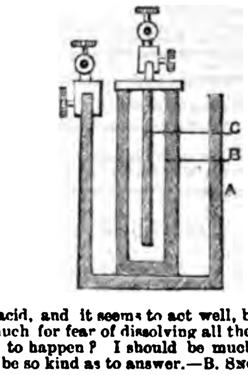
·**Camera Lucida.**—Will some one describe of using the camera lucida? I have a plain t lenses, but cannot work it. Cannot objects ger or smaller by it? If not, of what use are m the telescopic stem?—Marx.

·**Bagatelle Board.**—I purpose putting nd cushions on bagatelle board. Will some nt give me a few practical hints? Also what can I use to fill up to level some inequalities tions in lower end of board? Would not a similar to that used for ornaments on mirror —Ligurian.

·**Duration of Sunshine.**—Please describe by which the amount of sunshine is ascer-ublished by the authorities at Greenwich, and sionally in the daily papers. A search among has yielded no information on this point.—

-**Equatorial and Lightning.**—Many "Sigma" and Mr. Lancaster for reply. loes not say there is to be a connection between nd top of observatory. Does he mean it, or is , as he says, to carry the copper rod from the pillar to earth? It would not be possible, I the former with a revolving top. Another e iron pillar stands on a stone column, which goes below the observatory many feet to the ground. Should the copper rod pass down the stone column touching it, or be carefully prevented from touching it at any point?—Brickwall.

[33347.]—**Battery.**—Can any one tell me what this battery is and how to work it?—The outside, A, is iron, with a porous pot, B, and zinc, C, inside. I have used sulphuric acid, and it seems to act well, but I am afraid to use it much for fear of dissolving all the iron away. Is this likely to happen? I should be much obliged if any one would be so kind as to answer.—B. Snooks.



[33348.]—**Crack in Clarionett.**—Would some reader be kind enough to tell me how I can remedy the following? I have cracked my clarionet. The crack commences from the band around the lower part of tuning joint and runs down the side of the instrument under the stand upon which the octaving key 12 works until opposite the hole on the back. Please say whether I could, and if it would be of any use, having a slated band put around, as shown on sketch, to prevent the crack running any further. If not, what would be the best thing to put into the crack to prevent any leak? It is only a slight opening at present but will soon widen.—Old Woman.

[33349.]—**Running.**—Will any correspondent give a few hints on training, especially to become long-winded like professional runners?—B. C. Acklam.

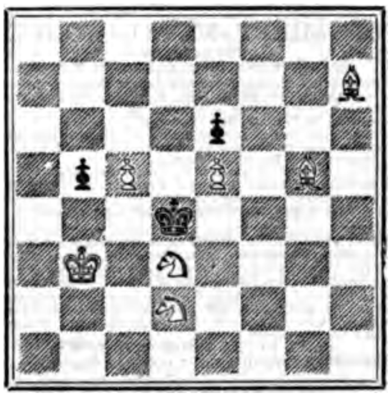
CHESS.

All Communications intended for this department must be addressed to J. Pierce, Copthill House, Bedford.

PROBLEM CCCCXXXII.

By Russell Henry, of Chester.

Black.



White.

White to play and mate in two moves.

Solution to 429.

White.	*Black.*
1. P to Q 3.	1. B to Q Kt 6 or Q R 7.
2. Kt to K B 8.	2. Anything.
3. Kt mates.	

Solution to 430.

1. P to Q 3.	1. P to Q 5 (*a*).
2. R to Q R 5 (ch).	2. K moves.
3. R Mates.	
	(*a*) 1. K to K B 5 (dis. ch.)
2. Kt to K 4 (dis ch)	2. R covers.
3. R or B mates.	

Notices to Correspondents.

L. C. T. Lee.—See notice to Agregog in English Mechanic for June 14.

J. W.—Problems very acceptable; many thanks.

Fruit-Growing in the City.—A correspondent of the *City Press* has forwarded a dozen strawberries which were grown on the roof of a warehouse in a thoroughfare within a hundred yards of the General Post-office. "The strawberries," that journal remarks, "are certainly of rich flavour, and possess an excellent aroma. Our correspondent thinks the growth of the fruit in such perfection is a proof of the comparative purity of the atmosphere, and we quite agree with him. He adds that he has a cherry tree on the same roof, with fruit on, which promises to ripen. To these interesting facts in connection with City pomology, we may add that some fine specimens of figs, likewise grown in the City, were sent to us some time ago; and that another correspondent used regularly to send us some excellent grapes, grown near the London Institution in Finsbury Circus."

ANSWERS TO CORRESPONDENTS.

*** *All communications should be addressed to the* Editor *of the* English Mechanic, 31, *Tavistock-street, Covent Garden, W.C.*

HINTS TO CORRESPONDENTS.

1. Write on one side of the paper only, and put drawings for illustrations on separate pieces of paper. 2. Put titles to queries, and when answering queries put the numbers as well as the titles of the queries to which the replies refer. 3. No charge is made for inserting letters, queries, or replies. 4. Commercial letters, or queries, or replies are not inserted. 5. No question asking for education or scientific information is answered through the post. 6. Letters sent to correspondents, under cover to the Editor, are not forwarded; and the names of correspondents are not given to inquirers.

The following are the initials, &c., of letters to hand up to Tuesday evening, June 25, and unacknowledged elsewhere:—

Rev. J. M. Coates.—J. Smith.—P. A. and P.—A. B. Wilbraham.—W. Coult.—W. A. Ryan.—W. R. Birt.—J. H. Schucht.—E. B. I.—J. Brown, Belfast.—J. R. Williamson.—Hillemine and Sprague.—Cormack Jones.—An Old Mechanic.—Tressilian.—Poor Musician.—J. A. P.—Wiseaf.—X.—S. McIlwrath.—T. J. Mercer.—J. T. W.—L. B.—B.—Black Witch.—Ajax Secundus.—R. N. H.—A. B. M.—Lancashire Fitter.—Polypus.—G. O.—Y. L.—Thomas Bolton.—T. Wiesendanger.—R. N. C.—W. H. P.—J. A. W.—W. J. S.—Henry Palmer.—G. T. G.—S. J.—C. Hamilton Moore.—E. W.—Daghbert.—E. C. C.—J. C. R., Nottingham.—A. A. Watkins.—L. L.—C. E. S.—Another Sand Rat.—Alpha Beta.—Paper Cutter.—Buttershaw.—W. T. C.—W. W.—P. S.—Wild Indian.—Chelt.—F. C. F.—T. Godfrey.—W. Harley.—Novus Homo.—Sidney Jewsbury.—A. T. Barraud.—D. M. L.—F. W. S.—R. G. L.—English Mechanic Apprentice.—Zeno.—Puzzled.—Aliquando.—B. G. N.

J. J. R. (See p. 307, Vol. XXIII., No. 584.)—An Old Sub. (It is due more to the moisture than to manurial properties of the water that grass benefits by irrigation. 2. Judicious irrigation is always beneficial; excepting, of course, rare instances where the water—as is sometimes the case in mineral districts—is impregnated with substances injurious to vegetation.)—Fritz. (Consult a medical man.)—Chemical Student. (See our answer on p. 228, No. 689.)—D'Evelyn. (Certainly you are liable. Engravings are the property of the author or publisher.)—E. Walker. (The prize was awarded for the blowpipe apparatus, but we do not know whether it is yet manufactured for sale. We should imagine not, or it would have been advertised by this time in these columns.)—J. H. C. (Write S. Gower and Son, Week-street, Maidstone.)—Peregrinus. (He is English, unless he has subsequently become naturalised in France.)—Pro Re Nata. (Write to Lockwood and Co., 7, Stationers' Hall Court, London).—Omicron. (Directions for making ginger beer are given on pp. 48, 127, and 330, Vol. XXII., and in many previous vols.)—Markham. (Fly papers are made with a composition of five parts of treacle with one of common glue; dissolve the latter before mixing with the treacle. A correspondent gave another receipt on p. 471, No. 331, which he stated was much better than the former, which is that used by the "catch 'em alive O!" criers.)—J. J. Emery. (The process seems likely to be useful, but as you do not wish to make the details public we do not see the use of inserting your letter. Communications, having for their object the attraction of commercial co-operation or support, are really advertisements, and can only appear as such.)—Blondel. (Yes; you had better employ a lawyer; the charges should be trifling in connection with so small a matter, but it requires to be properly managed, and you might very probably defeat your own object if you set to work yourself.)—Cylinder. (You must apply to some of the managers; in some cases there are examinations, in others the recommendation of a shareholder or director is of service. An advertisement in the *Times* would possibly obtain for you what you seek.)—De Lunatico Inquirendo. (There is nothing new in your suggestion, except the incorrect assumption with which you start.)—W. H. K. (Try paraffin, or see Useful Note on p. 252.)—A Would-be Dancer. (Bad ventilation is frequently the cause of the giddiness complained of; dancing ought to be a graceful and health-inducing recreation, but the conditions under which it is usually "enjoyed" render it harmful rather than beneficial.)—H. Boswell, Jno. Jones, R. A., and others. (We have really no room for queries about red noses, washes to remove freckles, and other matters of the toilet.)—Ed. K. Elliot. (Please send again; it must have been mislaid. We thought it had been forwarded to printers.)—W. T. G. Brooklin, Ont. (The charge for such advertisements is 2s. 6d. On receipt of balance it shall appear.)

Tyne, F. L., Dreizig, W. W.—See indices to back vols.

W. Newman, J. E. Okill, T. Stringer.—Your queries are advertisements.

Murano, Gallium, W., W. J. C., John T. Laurence, Laurence Briant, Noremac, and others have replied to queries already similarly answered.

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USEFUL AND SCIENTIFIC NOTES.

Note on Boiler Making.—Professor R. H. Thurston, of the Stevens Institute of Technology, in arranging the heating surfaces of a steam boiler, lays down as the essential rule that the effort be to impede the draught as little as possible, and so to place them that the circulation of water within the boiler be free and rapid at every part reached by the hot gases. The directions of circulation of water on the one side and of gas on the other side of the sheet should, as much as possible, be opposite. The cold water should enter where the cooled gases leave, and the steam should be taken off furthest from the point. The temperature of chimney gases has thus been reduced by actual experiment to less than 300° Fahr., and an efficiency equal to 0·75 to 0·80 of the theoretical is attainable. The extent of heating surface simply, in all of the best forms of boiler, determines the efficiency, and the disposition of that surface seldom affects it to any great extent. The area of heating surface may also be varied within very wide limits without greatly modifying efficiency. A ratio of 25 to 1 in flue and 30 to 1 in tubular boilers represents the relative area of heating and grate surfaces in the practice of the best-known builders, and this, of course, furnishes a safe criterion. The material of a boiler, says Professor Thurston, should be tough and ductile iron, or, what is better, a soft steel, containing only sufficient carbon to insure melting in the crucible or on the hearth of the melting furnace, and so little that no danger may exist of hardening or cracking under the action of sudden and great changes of temperature. Where iron is used, it is necessary to secure a somewhat hard but homogeneous and uniform quality for the fire-box sheets or any parts exposed to the flames.

Music and Art.—Messrs. John Broadwood and Sons have just completed a magnificent grand piano, made from designs by, and under the inspection of, Mr. Alma Tadema, for himself. It was to be used on Tuesday for the first time, at the artist's reception. It is formed and decorated in a Byzantine manner, and accompanied by a superb seat, or rather throne, in the same style, for the players. The top is enriched with inlays of varicoloured woods, ivory, mother o' pearl, and ebony, of geometrical patterns, in the fashion of *opus Alexandrinum*; and in front the opening over the keys and elsewhere is decorated, in keeping with this, with medallions and monograms of the initials of the artist and his wife, the last in ivory reliefs, and pierced panels of brass and wood. The cheeks of the front are of solid ivory, beautifully and boldly carved with acanthus leaves; the panels on the carved side contain incised figures of owls, nightingales, and cuckoos respectively, with lines of music figuring the notes of each bird; a band of polished ivory guttæ forms the lowest portion of the body of the instrument all round. The front legs are coupled pillars of various dark woods, such as rosewood, with boldly-carved capitals and fine bases; the back leg is a square pier, wrought into keeping with the Byzantine style of the whole design. Inside the cover are large panels of ivory, destined to receive autograph signatures of the distinguished musicians who may favour the owner of this most splendid instrument by using it.—*Athenæum.*

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This work has been examined, practically tested, and received a special note of recommendation from the Gas Meter Makers, Zinc Workers, and Tin-plate Workers.
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"Rugby, May. 1878.—Your Electric Burglar Detectors fitted to my house last month have already proved efficient."
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Sold by all Druggists and Perfumers.

English Mechanic
AND
LD OF SCIENCE AND ART.

FRIDAY, JULY 5, 1878.

ARTICLES.

KLEIN'S NEW CRATER NEAR HYGINUS.

By W. R. Birt,

resident of the Selenographical Society.

newly-ascertained formation has w been under observation for more elve months. The original observa- f Dr. Klein are recorded in his *schrift für Astronomie*, Nos. 13 and hen he first saw it on May 19, 1877, ribed it as a great black crater, full ow, without a wall. On the 18th of 877, it appeared to him as a large spot, with a vaporous margin. In ble moments a sharply-defined separated from the indefinite margin ceived. This margin is referred to in servations, for on the 9th of April, r. Klein says, "the slight depression e new crater] appeared without a surrounded by a greyish-brown , which appeared tongue-shaped the south, and as a little black . From time to time the crater d quite black and sharp, and I be- at the grey margin [the penumbra] y a slope of funnel-shaped preci- this was recorded at 7h. 20m. h. he still records the appearance of er as very black and sharp. At 9h. crater appeared to have become and seemed not so black within as dow of Hyginus, but dark brown. following day, April 10th, between 9h., the new crater appeared as a ffused mark with a central shadow. rence to these alterations of colour, be remarked that during the observa- 1877 the formation at times dis- d altogether; on the 13th of Novem- . Klein writes:—"On the site of the rater appeared a great spot sur- d with an ill-defined margin, the part being black, like a shadow. On owing day, the 14th, the air being t, no trace of the crater could be ed. On the 10th of December, the hining with unusual clearness and ess, the new crater was hardly visible, s recognised as a faint dark spot. on March 15th, 1878, as on Novem- h, 1877, no trace of the new crater e seen—its site was not even marked the faintest spot."

following observations of Dr. Klein's were made in April and May, 1878:—

.—Moon's age at noon, 6·6 days. Mr. Ward, st, saw the black crater in the place assigned Dr. Klein, and described it as a black crater ft edge.

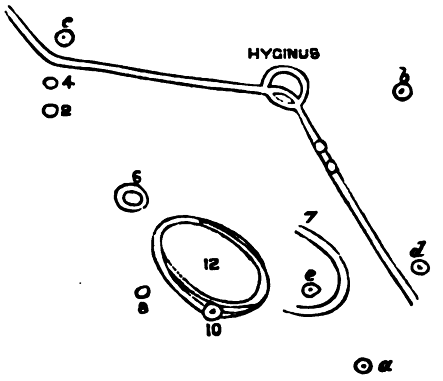
.—Moon's age at noon, 7·0 days. The Rev. utchings, of Salisbury, saw an oval depres th-east of the position of Klein's object, but rger; its longest diameter was three times Hyginus, and its shortest twice (see dia- he describes it as surrounded by wide ridges. son observed through thin clouds an ellip- k grey marking in the position assigned by in to his crater.

10.—Moon's age at noon, 8·0 days. Mr. at Clapham, saw the object as a dark oval , which presented no appearance of a crater.

11.—Moon's age at noon, 9·0 days. Mr. at Cuckfield, had a view under tolerably ble circumstances of the new crater, which , did not present the appearance of a *crater*, n oblong ovoid *shading* in tint and tone pre- milar to the shadings or ground markings dows). Mr. Knott's drawing agrees pre- ith the object as it was seen on the same ith the 18in. equatorial of Mr. Common, at

It will be remarked that the observations of May 9, 10, and 11, agree more or less in the observers having seen an elliptical ovoid or oval marking, described by some as a depression.

There are some noteworthy points connected with the whole of the observations at present on record:—*First*. The absence of a wall surrounding the object or depression observed, which appears to point to the absence of an upheaving force in its formation, and indicates that it has resulted from subsidence. The suggestion of Dr. Klein relative to the margin favours this idea, for if a limited portion of the moon's surface has subsided, it must have left such a margin as described by him. *Second*. The dark colour of the interior and its variability; this may be explained by a sinking down, and at the same time a breaking up of the pre-existing surface; the material which that surface formerly covered being of a low reflective power would produce a dark spot as it welled up among the débris of the former surface—the change of colour from black to dark brown, and the disappearance at times of the object altogether indicating that before the new interior surface had taken up its normal condition, it was in such an unsettled state as to interfere greatly with a constant and steady reflection of a settled tint.



Before closing our remarks on the observed change of colour, it may be well to place before the reader a synoptical statement of all the observations arranged in order of the moon's age:—

Moon's age Noon.	Date.	Character.
5·6	Dec. 10, 1877	Hardly visible round dark spot.
6·3	May 19, 1877	Black crater full of shadow.
6·6	April 9, 1878	Crater quite black and sharp. Greyish brown margin, as if formed of precipices. *Ward*.—Black crater with soft edges.
6·9	June 18, 1877	Large black spot with vaporous margin.
	Jan. 10, 1878	Terminator on west edge, crater undescribed.
7·0	May 9, 1878	*Hutchings*.—Oval depression. *Neison*.—Elliptical dark grey marking.
7·6	April 10, 1878	Greyish diffused mark with central shadow.
8·0	May 10, 1878	*Sadler*.—Dark oval shading.
8·1	Nov. 13, 1877	Great spot, ill-defined margin.
9·0	May 11, 1878	*Knott*.—Oblong ovoid shading.
9·1	Nov. 14, 1877	No trace of crater.
11·4	March 15, 1878	No trace of crater.

Those observations in the above table, not preceded by the name of the observer, are by Dr. Klein. So far as the above observations indicate, this object can be best studied between 5 and 9 days of the moon's age. It is, however, clear that observations are required towards sunset, and also it should be looked for when the sun has a considerable altitude, and especially at full moon. The fact of its being a new formation is pretty certain. What we now want is a knowledge of the appearances it presents during the course of the luni-solar day. Taking into consideration the variation of colour from black, through greyish brown, to a diffused grey, we can hardly regard Dr. Klein's statement of the crater being full of shadow as strictly correct: for the existence of shadow there must be an object to project the shadow. In the new crater this (the wall) is absent; therefore, the blackness in the interior—especially as it is described—could not have been shadow, but rather, as stated by Mr. Knott, "a ground marking," and this is one of the more important features for future observation and study. Within comparatively short intervals the colour has altered; indeed, at certain times, as a distinguishing element, it has disappeared entirely. By constant observation of this object, combined with the knowledge we have obtained during the last ten or fifteen years, we may be better able to penetrate into the operation of lunar forces than we were some twelve years ago, when the celebrated case of Linné engaged the attention of selenographers.

The observations during May, especially those by the Rev. R. S. Hutchings, seem to indicate that there is a new formation, perhaps still more recent, in the immediate neighbourhood of Dr. Klein's crater. It does not appear that Dr. Klein has recorded the *shape* of his crater, except on Dec. 10, 1877, when he described it as "a round dark spot, hardly visible." All the observers in May distinctly speak of the spot observed by them as being oval, elliptical, or ovoid, and one has given a drawing from which it appears that the elliptical spot seen by him is larger than Hyginus, is not in the position of Dr. Klein's crater (6 on the diagram), and he does not describe it as differing in colour from its surroundings, but he says "it is surrounded by wide ridges." Now there is nothing on Neison's map, nor on the outline diagram issued by the Selenographical Society, at all answering to Mr. Hutchings's elliptical spot. He is particular in describing the neighbouring craters on his diagram. He says: "6, 8, 10 are three craters standing in the positions marked, round an oval depression 12, surrounded by wide ridges; 7 is a broad ridge bending round towards 12. The accompanying diagram is a reproduction of the drawing by Mr. Hutchings.

The above records of the observations in May are not sufficiently explicit to enable us to decide if the objects seen and described by Messrs. Neison, Sadler, Knott, and Common were the same as figured by Mr. Hutchings, but we have sufficient information on which to base a series of observations of the greatest importance to selenography.

THE ACTION OF BRAKES.

THE remarkable and unexpected results obtained during the elaborate experiments with railway brakes, made a few weeks ago on the London and Brighton line, formed the subject of the paper read by Capt. Douglas Galton, at the meeting of the Institution of Mechanical Engineers held in Paris. These experiments form the first of a series which it is intended to make with the view of ascertaining (1) the actual pressure required to produce a maximum retardation of the revolving wheels at different velocities; (2), the actual pressure exerted by the different forms of continuous brakes now in use; (3), the time required to bring the brake-blocks into operation in the several parts of the train; and (4), the retarding power of the existing continuous brakes, tested on trains running under similar conditions of weight and speed. From the enumeration of these heads it will be readily understood that, when completed, we shall have the most important contribution to the literature of the brake question which has hitherto been made; and the first instalment, contained in Capt. Galton's paper, is sufficient evidence of the probable value of the series. The experiments described were undertaken to ascertain the co-efficient of friction between brake-blocks and wheels, and between the wheels and rails, both when the wheels are revolving and when skidded. It is scarcely necessary to insist on the importance of ascertaining by actual test the exact value of a co-efficient upon which the whole system of brakes depends, and the engineering world is much indebted to the London and Brighton Railway Company for the manner in which they have taken up the question, and facilitated the carrying out of the experiments. The experimental van, with the recording apparatus designed and constructed by Mr. Westinghouse and Mr. Stroudley respectively, was illustrated on p. 371 in connection with the letter of "C. E. S," but for our present purpose it is unnecessary to give a description of the means taken to obtain the results. The latter are unquestionably as correct as ingenuity and care could make them, and if they are remarkable, they serve to show that it is the unexpected that always happens. The experiments under notice were made at the end of May near Brighton, the first day being dry, the second stormy, and the third fine, with showers. There was thus a sufficient variety of weather to render the experiments of more value than they might have been if made under uniform conditions, but there was not time to collate all the results before sending in the paper. Capt. Galton, therefore, exhibited only a few of the diagrams taken, but these were of so remarkable a character as to excite the keenest attention of the engineers present. In experiment No. 15, May 28th, the brake-van was slipped when travelling at the rate of 40 miles an hour. The pressure on the brake-blocks remained nearly constant during the experiment, and being greater than that required by the co-efficient of friction between the brake-blocks and wheels, due to velocity, the friction increased so rapidly as to cause the wheels to skid immediately. The friction at once decreased rapidly, but rose again as the speed diminished, attaining the maximum as the train came to rest, which it did after many jerks in 12½ seconds. In experiment No. 16, May 28th, the van was again slipped—the speed being 46 miles. The pressure of the air was less than in the previous experiment, and it was gradually diminished during the experiment; consequently the pressure on the blocks was correspondingly reduced. At first the friction between blocks and wheels decreased slightly, but, when the velocity diminished, the friction increased rapidly, and the van came to rest without a jerk in 12 seconds. Thus the quicker stop was made by the revolving wheels which originally were travelling at a higher speed than in the case of the skidded wheels. This effect was exhibited in a decided form by experiment No. 3, May 28th, in which the speed was 44½ miles. The pressure applied to the blocks was sufficient to skid the wheels at once, and the diagram shows that the co-efficient of friction between the blocks and the wheels decreased immediately after the skidding, and did not rise until the end of the experiment, while the tractive force on the drawbar, at first increased by the act of skidding, largely decreased as soon as the wheels were held by the blocks. In experiment No. 3, May 29th, the engine and van were brought to rest from a speed of 39 miles an hour. The air was allowed to escape from the cylinder through a small hole after the brakes were applied, so that the pressure decreased during the whole experiment. The diagram in this case shows that the retarding force due to the pressure of the blocks was at first diminished until the reduction of velocity reached the point where the increase in the co-efficient of friction was sufficient to overcome the effect of the diminished pressure applied to the blocks. At this point the retarding effect was increased, and the wheels were skidded. The curve immediately rose in a nearly vertical line, showing that the co-efficient of friction became very great as the wheel came to rest—the time during which the wheel was partly rotating, partly slipping, being almost inappreciable. Immediately after the rise the curve fell to a point far below its original position. Thus showing that with skidded wheels there is a great diminution in the retarding effect of the brakes. As the velocity continued to decrease the curve steadily rose, thus showing that the co-efficient of friction between the rails and skidded wheels increases as the velocity diminishes. At the moment of coming to rest the co-efficient of friction became very great. The results obtained in these experiments may be taken as a fair sample of the series; from which we learn that the application of brakes to wheels does not appear to retard the rapidity of their rotation, but when it falls below that due to the speed at which the train is moving, immediate skidding is almost inevitable. The resistance resulting from the application of brakes without skidding is greater than that caused by skidded wheels. During the moment of skidding, the retarding force increases enormously, but immediately afterwards falls to less than that what it was before skidding. The pressure required to skid is much higher than necessary to hold the wheels, and appears to have a relation to the weight on the wheels themselves as well as to their adhesion and velocity. On this point Capt. Galton says:—"It would seem that the great increase in the frictional resistance of the blocks on the wheels, just before and at the moment of skidding, due to the increase in the co-efficient of friction when the relative motion of the blocks and the wheels becomes small, is what destroys the rotating momentum of the wheel so quickly." With constant pressures the friction between the blocks and the wheels increases as the velocity decreases, until, as the experiments proved, the wheels are skidded. But it was also discovered that in order to obtain the maximum retarding effect the wheels ought never to be skidded, but the pressure on the wheels should at all times be just less than is required for skidding. In order to effect the desired result, then, the pressure between the blocks and wheels ought to be very great when first applied, gradually diminishing as the train comes to rest. Such an outcome from these experiments discloses the fact that all the hand-brakes, and most of the continuous brakes, have been designed to suit conditions which do not exist in practice. The old saying—you can do no more than skid—is shown to be utterly erroneous, and the most successful brake is that one, the inventor of which has unconsciously, as it seems, grasped the true principle.

That the skidding of wheels is not the best way to stop a train has been known and urged persistently by some railway men, and the drivers and guards on most lines have orders to release the brakes when the wheels skid; but, until these experiments demonstrated the fact, not a few drivers and others, engineers amongst them, firmly believed that the skidding of wheels was the readiest method of stopping. It has been objected to mostly because of the wear of the tires—flat places being highly objectionable. So long ago as 1846 Mr. Gooch, while connected with the South-Western Railway, issued a rule to his men that wheels were not to be skidded, and if skidding did take place the brakes were to be immediately released and applied again. Mr. Tomlinson said that every practical engine-man knew that the skidding of wheels was a great mistake; but we venture to think that Mr. Tomlinson need not travel far to find plenty of practical engine-men who would argue the point with him. The gentleman who preceded him in the discussion, Mr. Haswell, expressed his surprise at the results of the experiments described by Capt. Galton, as the Newark trials had led the commissioners to form a contrary opinion as to the value of skidding. Mr. Brown, of Winterthur, speaking from practical experience on lines of heavy gradients in Switzerland, declared that if the wheels were skidded much of the retarding force was lost. Mr. Yeomans said that when the vacuum brake was first applied on the Metropolitan a vacuum of 15in. (?) was found to skid the wheels. The drivers were, therefore, ordered not to exceed 12in. He controverted the opinion that the greatest pressure ought to be applied first, and thought that a sudden application of brake-power destroyed the wheels. Unfortunately no reasons were offered for these opinions, save that Mr. Yeomans had seen wheels that had been destroyed by the sudden application of the Westinghouse brakes. He considered that Capt. Galton's experiments had only confirmed what was well known, and that, to obtain any useful information, experiments extending over many years of actual service were necessary. The companies, however, it must be remembered, have had the hand-brake in use for many years, and it has been left to persons not specially connected with railway work to point out that the hand-brake is radically wrong—for, as every one knows, it is impossible to always avoid skidding with it. In view of that fact, and of the statement that the evil effects of skidding were well known a quarter of a century ago, it does not say much for the inventive skill of the profession that hand-brakes were not long ago improved off our trains. The explanation of the diminished retarding force when the wheels are skidded is most likely that given by Prof. Kennedy, though it might be worth while to study the question experimentally by means of heavy weights resting with a small surface on a metal rail. As long as wheels revolve, says Prof. Kennedy, the surface in contact with the brake is continually changing, so the tire does not become highly polished, but directly the wheels are skidded there is theoretically only a point, and practically only a very small surface, taking all the friction between the rail and the wheel. This surface must be almost instantaneously polished, and the wheel consequently slips along with the least friction possible between it and the rail; for, as is shown by the experiment, the friction increases as the velocity decreases. The paper has now, however, drawn attention to the subject, and it is to be hoped it will be worked out in a thoroughly scientific manner. Capt. Galton deserves thanks for what he has already done, and it is not too much to expect that the companies generally should afford facilities for carrying out further experiments.

WHO INVENTED THE MICROPHONE?

DURING the past week we have received several American papers containing articles, reports, and letters referring to the disputed claim to the invention of the microphone. Some of these bear the stamp of the Edison Laboratory, Menlo Park, from which we assume that we may accept as authentic the statements reported to have been made by Mr. Edison. In one paper, the *New York Sun* of June 9, we find an account of an interview which a reporter of that journal had with Mr. Edison, to whom he showed the accounts in the London papers of Mr. Preece's lecture on the microphone. After a perusal of these accounts

r. Edison is represented to have said: "I
clare that is the coolest, cleanest steal
at I ever knew. This man talks of this
ing as though it were entirely new, and
though he believed it was the invention
Hughes, when he has the most positive
:dence that the thing is mine." In reply
a question whether Mr. Edison had
›wn Mr. Preece the microphone, the
mer is represented to have said: "Of
ırse I did, because the microphone is con-
ned in the telephone; it is nothing but a
:ly-adjusted telephone. To say that the
:rophone is a superior invention to the
:phone is absurd, because it is only a part
.he telephone. There would be no use in
usting a telephone to such a delicate
:h, because the jar of a building, the hum
l roar of the city would keep up a con-
ıal buzz." Mr. Edison, in short, claims
t the principle of the whole thing is
ed on his undisputed discovery that
:ain substances, called "semi-conduc-
s," such as carbon, several oxides and
phides, vary their resistance to the
sage of the electrical current when sub-
:ed to pressure, and in July, 1877, he
ed a patent" for an instrument which is,
en properly adjusted for transmitting the
nd of the voice, a telephone, but when
icately adjusted, which can be done by
ning a screw, a microphone. Mr. Edison
tes that Mr. Preece was shown over 200
ferent combinations of one material and
other with carbon, and also the effect of
ssure on the passage of the current. The
porter of the *Sun* gives an extract from a
:ter addressed to Mr. Edison by Mr.
:eece, in which the latter says: "Hughes's
ings border very closely upon yours, and
is quite difficult to distinguish between
at you have done." Under the circum-
ances Mr. Edison thinks it quite impos-
ble to point out the difference, for he con-
nds that the whole principle of the
covery was published by him a year ago,
d six months ago he obtained a British
tent for what Prof. Hughes "pretends to
ve discovered." Mr. Edison is repre-
nted as saying that "if you take the
illing piece and this nail business that he
lks about, it will give sound, but it will not
present the original sound. By means of
e carbon we reproduce the original sound.
. . . The discovery that I have made and
tented consists in finding some material
t would transmit waves of electric
rrent which should be proportionate to
e sound waves. That was my discovery."
the *Washington Star* of April 26, 1878,
e have a report of the proceedings at the
tional Academy of Sciences, in which we
d the following epitome of Prof. Barker's
eech when introducing Edison's telephone:
-"The peculiar point about Mr. Edison's
vention is a little plate of carbon in the
strument, on which its efficiency depends.
rbon is susceptible to a difference in con-
ctivity by a change in pressure. Mr.
ison has succeeded in discovering a kind
suitable for his purpose that pressure of
most extreme delicacy, even the slightest
eath, may be detected. He is the dis-
verer of the principle on which his tele-
one operates, and not simply an inventor."
e last sentence should help to settle the
estion in dispute; but while we have
ought it right to give Mr. Edison's version,
e must not omit the following sentence,
hich occurs in Prof. Hughes's paper (page
5, *ante*), and which has been reproduced in
e reprints of it published in America:—
Edison and others," says Prof. Hughes,
have produced variations in the strength
f a constant current by causing the dia-
hragm to press directly upon some elastic
nductor, such as carbon, spongy platinum,
c., the varying pressure upon these mate-
ials varying the resistance of the circuit,
d consequently the strength of current
owing." If Prof. Hughes has not gone
further than Edison it seems strange that he should have taken the trouble to mention what the latter had accomplished. However, both sides have now been heard, and we leave the facts to speak for themselves.

THE ORGAN: A COMPREHENSIVE TREATISE ON ITS MANUFACTURE, PROCURAL, AND LODGMENT.*

By John Watson Warman,

Associate of the College of Organists, London.

PART I.—GENERAL TREATMENT IN MANUFACTURE.

* * Hand-Blower.

o. THE Hand-blower may be divided into two orders—viz., the *Lever*, which is the form so very well known as being by far the most usual, and the *Winch* kind, which substitutes for the straight Lever a Winch or Handle similar to that of the Grindstone or the many machines in use as coffee-mills, &c.

p. *Lever Blower.* The Lever may be divided into two kinds—the Fixed and the Unfixed or Detachable—the former being simply the Lever projecting from the Organ-case or other portion, and, of course, always in position ready for use; the Unfixed is intended, as its name indicates, to withdraw or unship, either for removal entirely or in many cases to admit of re-attachment, if desired, at some other point.

q. With both kinds, *see* Counterpoising (4, t).

r. The simplest and consequently best form of the Fixed Lever Blower is that in which the Main-beam itself (*i.e.*, that to which the *Tugs* communicating with the Feeder *Lugs* are actually attached) is continued so as to be grasped, and thus form the actual Handle or Actuator; where this construction is attained it will be obvious that not only will the advantage of simplicity be secured, but that of absolute impossibility of any *slack* or looseness in the action, even by the longest wear, for the resistance or actuation being always in one direction—viz., a drag upwards—the Tugs and Centres are, of course, always kept tight to their bearings; and, provided the Centreing be correct, and the Tugs of exact length no slackness, as just said, can possibly ever result.

s. It will be obvious that this simple form is always really obtainable as far as Action itself is concerned, for all that is necessary is to have the Beam of the correct length and properly guided or otherwise treated at the grasping part, and where there exists nothing to prevent the Blowist stationing himself at any desired point along the Beam the desired result can of course always be maintained.

And thus, when the Bellows are away from the Instrument there will, as a rule, be no difficulty whatever; thus, in Bellows-room at the Crystal Palace the nine handles are all (if author's memory rightly serves) formed of the Main-beams themselves, and it will be evident that the arrangement is here of peculiar value, for the clicking of the *slack* of nine Actuators would certainly be no trifle, and might fairly render that conversation in which Blowists—notwithstanding the din around them—do, somehow or other, generally manage to carry on here, absolutely cut of question; and although this last is a matter with respect to which no builder could be expected to bestow one moment's indulgence, yet as the Bellows should never by preference be too far from the Organ, and bad as is the gossip of the Blowist, it is not so trying as the rattling of the Actuators themselves (particularly when it is remembered that although these most useful gentlemen will not talk loudly during soft passages, yet they have no hesitation at such time in strong Pumping, possibly to provide for a supply when the next Forte of the Music shall again set free their own private wind-machinery), the simple form may safely be, as a rule, laid down as desirable when practicable.

t. Where, however, the Blowing-handle projects from the Case, or other similar portion, it will be obvious that this simple form of Blower becomes often impracticable. Thus, if the Bellows come nearly or quite to the Case at that point, and be tolerably large, it will be apparent that the Handle must be extended some little distance from the Case, or other barrier, in order that the necessary *purchase* may be obtained. Supposing the requisite space obtainable, there is, of course, no objection to this, and the Blowist and grasping part of the Handle may be, if chosen, placed 6ft. or 8ft. from the Organ without the least inconvenience, but it is obvious that the Authorities will often object to spare so much space; in Pew-rented Churches every foot is often valuable, and as passing *under* the Handle is out of question, the amount of space virtually required might amount to two or three sittings, besides involving for 50 or 60 people a *détour* round the end of the Handle.

u. On the other hand, when the Bellows are far *in*—that is, when there is a considerable distance between them and the Case or other Barrier—it may easily happen that the motion of the Handle, even when projecting only a few inches through the Case, would be too great in extent for convenient Blowing, for it is of course necessary to avoid both too heavy and too light a stroke. In the former case no mere lad could supply even a puff of Wind without over-straining; in the latter the muscles will be fatigued by the mere swiftness and extent of the motion, independently of the labour of driving, notwithstanding that the latter is now light. A remedy in this latter instance is clearly furnished by simply setting-in or recessing the portion of the Case from which the handle projects, and this, in fact, is in itself an excellent plan, not only doing away or diminishing the ugly projection furnished by the Handle, but also, in many cases, veiling the Blower, and thus rendering Curtains or other Screen unnecessary. But to this treatment there are often these objections:—*a*, the space cannot be spared from the interior of the Organ; *b*, the laying or setting out, notably the Pedal Pipes, if they be at side (as is in many cases most convenient, *see* Dep. of Gen. Arr.), *may*, though it does not follow that it *must*, be injured; *c*, the addition casing will be, of course, an additional expense, and may, besides, interfere with the architectural design.

v. It will now be apparent that the shape, size, and position of the Bellows will, in many cases, exercise an important influence on the simplicity of the Hand Lever-blower, and in designing the former this point must be properly kept in view (*see* Bellows 5, m).

w. When the before-mentioned methods cannot be employed for the purpose of keeping the construction of this simple character, it is evident that a second Lever will be employed; thus, supposing the Bellows set *in* considerably, the Main beam instead of running to and through the Case, will be only long enough to carry its necessary centreings, and the Handle proper being now a short simple Lever of the 1st kind or order will operate on it by means of a Connecting Rod, itself being, of course, so centred as to *lose* the desired amount of purchase. When the Bellows, on the contrary, are too close to the Case, the main-beam will be curtailed somewhat, as before, and a Lever of the *second* order (that is, with the fulcrum at the far end) applied; the Lever will, of course, extend into the Organ, past, as it were, the end of the Main-beam, being attached to latter by rod as before.

x. It will easily be seen how that the centreings of this Lever and Connecting-rod will have to drive both ways—that is, alternately push and pull; instead, therefore, of being, as with the Main-beam, mere Pins and Points, &c., resting *against* their work, the centres of the Lever *must* be *bonâ-fide* Bolts passing through exactly-bored holes, and proper provision for tightening when wear has produced *slack* ought to be provided; the Main-beam centres of course treated in no way different from the first and simplest arrangement.

y. It is only necessary to add that care must be taken that this second Lever be not rendered necessary simply by failing to leave proper space for it to be set sufficiently *high* for proper and comfortable use; *see* more fully in Position (18, i.).

z. In all cases where the Blowing Handles are laterally at distance from Bellows, and in some instances even if directly beneath them, a second lever is *involved*; *see* more fully in Position (18, i., and on a little). When directly beneath, the Main-beam should be just as with ordinary arrangement, the Tugs being here transformed into pushing Rods. If Bellows large, have both ends of Main-beam extended and treated so as to form a Handle—thus two Blowists; this, of course, applies wherever Beam is placed.

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[18, a.] We have now briefly to consider the *Unfixed* kind. This is, of course, under precisely the same laws as the preceding. The only difference is that the Handle is removable. It is only necessary to notice two kinds—the *Cranked* or Elbowed Handle, and the *Socket* Handle. The Elbowed Handle is formed exactly like the Elbowed Pedal, except that, instead of the stem or shank spreading out to receive the foot, it is inserted into a suitable handle; the cranked portion, of course, entering some portion of the Case, and fitting on the squared end of the blowing spindle. The Cranked Handle should always be attached by a Thumb-screwing nut, the spindle, in fact, passing completely through the cranked portion, and projecting for the sake of receiving the Nut; the extreme end of the Spindle is thus turned and tapped to form a short screw. This Nut is necessary, first, to prevent wear, and guard against the Handle slipping off, both of which will be here extremely liable to happen, in consequence of its often being lifted above its proper limit, so freeing the socket portion for a moment from its bite on the spindle. In some cases, in order to avoid the necessity of a connecting rod, the Crank Handle is made to insert exactly as if it were a Crank Pedal, that is, in the Plinth, only of course projecting upwards at a slant; the Nut is equally imperative in this case. The Handle may attach to the Pedal Spindle, of course, at the back of the Organ, or it may be at side, and have a spindle of its own. For counterpoise it will be continued beyond its centre, and loaded at end.

b. The Socket Handle is simply a flat bar of iron, one end inserted into a suitable Socket-piece, the other accurately shaped, so as to slide into a socket formed in the main beam, or (where the latter is present) in the Lever actuating it. In the former case it will be either formed in the hard wood, or of an iron Channel or Runnel firmly attached thereto, so to form the socket. If in the Lever-piece it may be either as in the main-beam; or if the latter be small it may be a complete casting of Iron or Gun-metal (latter, of course, higher), the socket cast in it; the latter method, however, is not preferred by Author, for reasons which will appear in later parts of this work. A slot in some portion of the Case is now, of course, necessary. When a change of Position is desired, both ends of Beam or Lever will, of course, be provided with a socket, the Handle thus inserted in either at pleasure.

c. It only remains to add that any Handle which drives a Feeder, which, as a single Feeder, is also actuated by Foot-Pedal Blowers, should generally, if possible, be counterpoised so as not to retard the descent of the Feeder in Foot-Blowing. Thus no strict necessity for removing Hand-Blower.

d. The largest English Instrument blown by hand, so far as Author is aware, is the "Festival" Organ at the Crystal Palace, Sydenham, by Gray and Davison, 65 Sou. Stops, 9 Handles, heaviest pressure behind, 11in. (Tuba).

e. WATCH-BLOWER. This form is less known than the Lever, being far less common. It consists simply of a crank shaft—that is a long stout rod, generally of iron, on which are placed cranks, or in some cases Eccentrics, at such points as to come exactly opposite the Lugs of the Feeders, and, of course, of such a projection or throw that the diameter of the circle described by their revolution exactly corresponds with the extent of the motion or drop of the Feeder Lug; the Cranks or Eccentrics are in direct communication with the Feeder by means of a simple *Rod*, or, if the Shaft be above the Feeders, a *Tug*. Either hard wood or metal may generally be employed in either case, except with Eccentrics, which, of course, demand metal.

f. The Cranks or Eccentrics are generally three in number, demanding a corresponding number of Feeders; the Cranks are, of course, so placed as to share the circle equally between them; thus a uniform actuation is always maintained. The bearings of the Shaft will be either in metal or hard wood—the latter answers perfectly well; if wish to make the very most of the Blowist let Shaft run on Friction Rollers. The Winch is, of course, placed at one or at both ends of Shaft, and its best method of attachment will be by simple squared end of spindle and nut, as in ordinary cases. It is to be observed that there is not *strict* necessity here, provided a Fly-wheel be used, for more than two Feeders, this number both being of equal size and drop, and the Cranks or Eccentrics exactly opposite each other, will give fair results. Certain radical defects in the Winch method of Blowing are pointed out in Comparison of Methods (20, i. to l.).

g. It only remains to add that in order to further add to the steadiness a fly-wheel is generally added; this, as already said, is necessary with but *two* Feeders, but not essential with three, and in fact in such case is, in Author's opinion, best omitted, as more difficult then to vary the supply quickly (*see* 20, l.). 1½ cwt. and 3ft. 6in. diameter will be a good useful size of fly-wheel. If expense can be borne the bearings of the shaft may be formed with Friction-wheels.

h. Examples of the use of the Winch are furnished at the following places: First Bap. Church, Elizabeth, New Jersey, U.S., by Johnson, Westfield, Mass.; Carlisle Memorial Church, Belfast, by Conacher, Huddersfield; Old Hill Church, Birmingham, by Brindley and Foster; Bow and Bromley Institute, London, by the same; Beddington Church, Surrey, by Lewis. The first Organ that stood in Quebec Cathedral, Canada (by Flight) had this arrangement. It is also used by Walcker, of Ludwigsburg.

(*To be continued.*)

·RESEARCHES ON COLOUR BLINDNESS.

THIS not unfrequent physiological defect, known also as Daltonism, from the first observer of these interesting phenomena, who was blind for red, was explained by Helmholtz on the basis of the younger Helmholtz's hypothesis of colour perception, to the effect that in the individuals in question one kind of the three kinds of nerve fibres with which colours are perceived, and generally the kind that are sensitive to red, are paralysed. The consequence of this is that the red is seen only as grey, violet as blue, and in general the red part of all mixed colours is wanting, so that the person affected can never see colours like other men.

Experiments have recently been made in Belgium by M. Delbœuf (who is also red blind) in conjunction with M. Spring (who can see correctly). They are led to a different explanation of the phenomena. In order to test whether red blindness may not be as well explained by an abnormal domination of the green and violet elements of the retina M. Delbœuf looked at coloured silk bands through a fuchsine solution admitting passage of only red. He chose for this a lively red and a brown band, which appeared to him equally brown, also a violet and a blue, both of which appeared blue to him. From spectral examination of the light reflected from these bands it appeared that the spectrum of the red and brown bands, and on the other hand of the blue and violet, was not so different as the impression from the eye having normal sight might have led one to expect.

The interposition of the fuchsine solution had for result that M. Delbœuf not only could quite well distinguish colours which he generally confounded, but that the brown and blue bands appeared quite unaltered, but the violet and more especially the red band acquired a distinctness of brilliancy which had been quite unknown to him before. Scarlet, which commonly gave him the impression of a bright colour, became flamy and blinding. The same observation was made on other red-blind individuals, and evidence was obtain
case was one of real sensation, and
contrast phenomena by looking at a
by the naked eye and partly t
solution.

"This result," says M. Delbœu
dicts the young Helmholtz's hypo
least it must be understood that n
quence of an insensibility for t
because of an excessive sensitiven
violet and green rays, or more part
the complementary colour to the
fuchsine, are the peculiarities of vi
red blind to be attributed."

When a red-blind person contemp
through fuchsine he perceives an
variety. It is not thus proved, ho
he now sees all as with a normal e
vestigate this MM. Delbœuf a
endeavoured to transform a man w
sight into one red blind. After a
experiments, including the observa
red-blind person who had looked
time at a malachite-green silk ban
quite well to distinguish a cherry re
grey that he had previously confou
used for their purpose an aqueous
nickel chloride. With a certain t
the solution M. Spring now a
through it, like a red-blind person
becoming blue, the red brown,
assuming a certain moderate colour
out brightness. The same result w
with a plate of green tourmaline, w
green screens did not give this ef
whereas the fuchsine, with suitable
of layer, hardly modified for the re
colour besides the red and violet,
chloride had for the normal eye a dis
only on these two colours. On the
even very thick layers of the green s
only a slight disturbing influence
mony of the colours which the re
saw, and conversely normal eyes ha
impression of different-coloure
whether they looked at them thr
fuchsine solutions or not. Gatherin
these first results, it may be said th
blind have, as it were, nickel chlo
eye, or that the non-red blind have,
fuchsine in the eye.

The next point to determine wa
fuchsine would restore normal si
artificially red-blind person. This
the case. If any one possessing
power of sight have placed between
the silk bands so much chloride of
the red and brown bands appear to
and the violet and blue bands blue
then (having all the rest unchange
interpose fuchsine of proper thic
colours appear with their distinct p
of character.

A spectral examination of the two
showed that the fuchsine shades the
of the spectrum with greater thickne
obliterates it, and with increasing
obliterates the spectrum even furthe
the end, and at length the red. On
hand, the absorption of chloride
begins at both ends of the spectrum,
gresses towards the middle, so that
continues longest. The aspect of the
as perceived by the red-blind, who, it
get from it only two colour impressio
and a yellow—could also be produ
cially if the normal spectrum were
fall on an ordinary eye which was il
with the green light of nickel chlori
suitable thickness of chloride of ni
tion through which the light illumi
scale was passed, a normal eye percei
spectrum, like the red-blind, only
yellow. On the other hand, it was n
in the case of the red-blind, to tran
means of fuchsine solutions, the tw
spectrum into a normally seven-col
There appeared only between the
yellow which they saw without f
coloured band of a peculiar colour
normal spectrum. The authors, how
sider that no great stress must be laid
negative result, as the want of succe
attributed to the difficulty of the ex
and the inadequate arrangement e
They intend prosecuting this importan
—*Naturforscher.*

THE PHONOSCOPE.

HEN he has brought to a state of comparative perfection the inventions now ing his attention, Mr. Edison intends, it l, to make a telephonoscope, which will ful to those who are deaf as well as to whose faculties of hearing are unimpaired. inary experiments have been made by g in the tube of a "telephonoscope" a wire, when it was found to convey the much better than without. With a on paper tube Mr. Edison has heard a ewing a quarter of a mile off, and he is ined to try whether he cannot invent an ment capable of being concealed, but will render distant sounds audible even deaf. The phonoscope is a different innt altogether, for by its means vibraroducing different sounds are appreciated changes in appearance of a luminous in a Gassiot tube. The phonoscope was ed by Mr. H. Edmunds, junior, and con f a vacuum tube revolving with a n velocity, an induction coil, and a Reiss itting telephone, the membrane of which ed to make and break circuit between e and the coil. The Reiss transmitter be with a mouthpiece, the other end losed by a thin brass plate to which is d a platinum contact strip. This strip, he brass plate is set into vibration by ice or other sounds, touches a metal n connection with one of the wires lead a battery, and thus completes the circuit. lls of a Grenet battery are employed, which is connected to a coil rotating in of soft iron, in order to keep the motion n. The other cell is connected to an in coil, from which sparks are sent to the star, which is attached to the same s the rotating coil. If, while the tube makes one revolution, contact is nd broken once, a single line of light seen in the tube, but if the circuit is ted more frequently, a star will appear, mber of "rays" in which is determined number of times that contact is made a revolution. When the diaphragm of smitter is spoken or sung to, it vibrates r less rapidly, and the vacuum tube tated at a uniform speed, the appearesented by the star varies according to nd uttered at the transmitter. Two harmony produce two superimposed ne bright, the other hazy, while a disves a nebulous patch, with occasional of light. The phonoscope is a very l arrangement, but is necessarily ex, so that Mr. Taylor's phoneidoscope 71) will become the popular instrument lying the effects of sonorous vibrations.

BEE MANAGEMENT.

(*Continued from page* 306.)

Abbott's Standard Hive.

hive may be readily described by means the accompanying sketches, with the n of one part — the movable side. er appearance is given at Fig. 1; while ives a sectional view of the hive body ck to front. The inner skin of both parallel to the outer, but at front and s set as shown at Fig. 2. The frame is of e taper, and consequently on its being om the hive, the risk of crushing the tween the bottom corner of the frame inner skin is reduced to a minimum.

hape of the top bar is shown at Fig. 3 er bars are shaded to simplify matters). this shaped top bar a greater steadihe frame is gained, each bar resting on f 2in. (instead of 1½in. bare as in other), while the distance between the frames $\frac{3}{10}$ as usual.

p bar in its present form is, however, onvenient to handle as it was in its shape, but it has a decided advantage of economy of timber and labour over bar. The shape of the original top hown at Fig. 4. The top of the bar vel with the outer skin, and the crownabolished, its place being filled by a mposed of ticking and flannel. The the frame is 16½in. long at the top, ng at the bottom, and 10in. deep. All these are outside dimensions. This size of frame is much too large, in my opinion, to ever become a standard of size suitable to all parts of England, but Messrs. Abbott Bros. construct a hive in which all the improvements of their "Standard," with the exception of the taper frame (which is impracticable), is adapted to the Woodbury sized frame, and from its reasonable price and convenient arrangements is most suitable for either the bee-student or the ordinary apiarian.

FIG. 1.

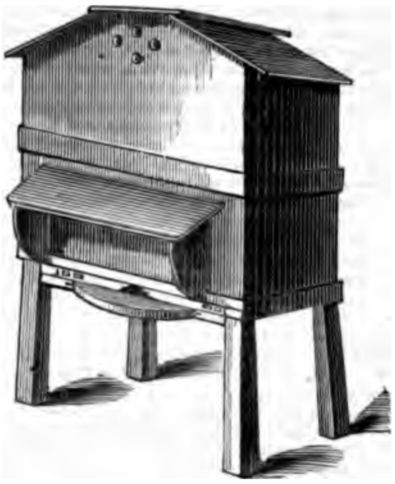
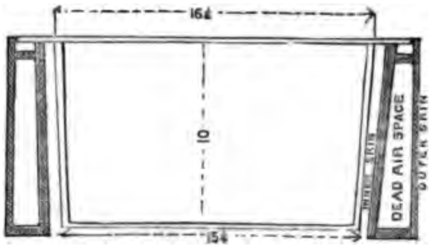


FIG. 2.



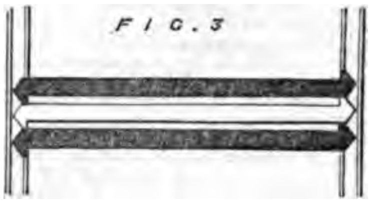
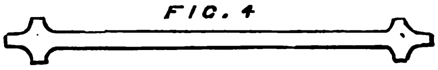


FIG. 3

FIG. 4



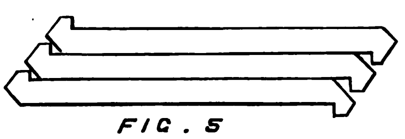


FIG. 5

The top bar of the Standard, both old and new forms, prevents the escape of heat at the frame end in winter, and does not allow the bees to get at the ends to propolise them fast. The movable side is a modification of the dummy, roughly speaking, and cannot be properly explained without the aid of drawings. The inner skin at the back of the hive is hinged at the bottom, and fastened by a sort of a hasp at the top. When room for the easy removal of the frames is desired, the inner skin is unhasped, and pushed close to the outer, when sufficient room is at once given. Of course, the ordinary dummy may also be used for contracting the space in the hive when required. At Fig. 5, the best plan of cutting out the top bars is shown by which hardly any timber is wasted. The hive as a whole is a fair sample of the ingenuity which Messrs. Abbott Bros. display in all their appliances, and it would be hardly fair to close this letter without uttering one word of commendation of the spirit of improvement which forms so marked a part of their characters.

W. S. Travis.

AMIANTHINE COAL.

THE name amianthine coal has been given to an artificial fuel, invented by M. E. L. J. Rocher, of Toulouse, and especially adapted for heating public conveyances or for use in workshops or laboratories where an open fire without a chimney is required. M. Rocher desired to produce a fuel in the combustion of which the least possible quantity of carbonic acid is disengaged, while a pleasant and healthy odour is evolved. His amianthine coal is of a cheap nature, and being dense, affords with a small volume a considerable and constant heat, burning freely, but slowly, producing no smoke, and requiring no special apparatus for effecting its combustion. The essential ingredient is green, white, or blue amianthus, or flexible asbestos, which is capable of subdivision into small particles in water, and which when intimately mixed with other substances, forms a sort of fibrous paste, possessing when dry great elasticity, whereby it is enabled to stand considerable transport without breakage, and the ashes of which after combustion retain the original conglomerate form of the fuel. Moreover, the amianthus fibres in each fuel block, while it is burning, remain unconsumed, and serve to transmit the heat to the surface of the block. As regards the development of carbonic acid, the green amianthus in particular is of great value, being composed of silicate of lime, silicate of magnesia, and protoxide of iron, which by its combustion is farther oxidised, as shown by the change of colour of the fibres from green to rusty brown, and thus its effect is much the same as that of the pieces of iron sometimes placed in brasiers for neutralising the carbonic acid. In order further to neutralise the carbonic acid as much as possible, with the amianthus is mixed fat lime, which, when formed into a paste therewith, also acts as agglutinating material, imparting great solidity to the fuel. In place of the lime may be employed other known agglutinating materials, preferably those capable of absorbing carbonic acid. To the above ingredients are added charcoal and acetate of lead, or nitrate of soda or of lime, or substances having analogous properties. Thus, for one description of the fuel 1,000 parts of charcoal, 100 parts of amianthus, 25 parts of gum, 1,500 parts of water, and 100 parts of acetate of lead are mixed; for another description, 1,000 parts of charcoal, 130 parts of amianthus, 60 parts of lime, 55 parts of nitrate of lime or of soda, and 1,500 parts of water. The above proportions may be modified according to the purposes for which the fuel is to be employed. The charcoal and amianthus are reduced to a fine state of subdivision, and are then mixed together; the nitrate of lime or analogous substance is also pulverised, and then mixed with the other two substances, and to this compound is then added the water in which the agglutinating material, gum, or lime has previously been dissolved or suspended. The compound being then stirred so as to incorporate all the ingredients as thoroughly as possible, forms a pliable paste. This paste is placed in moulds to form briquettes or blocks, which are dried either in the open air or in stoves.

EMERY WHEELS.*

By Joshua Rose, M.E.

THE uses for which emery wheels may be properly applied are for producing true cutting edges and for smoothing surfaces. Their action is abrasive and is termed grinding or polishing, according to the nature of the duty. It is indeed somewhat difficult to separate the grinding from the polishing duty, as the end to be attained rather than the nature of the duty, determines the name by which that duty is known; as a general rule, however, emery polishing wheels are distinguished from grinding wheels in that the former are composed of wooden discs covered with leather, the surface of which is covered with emery fastened thereon by glue, while the latter are composed of emery cemented together with some suitable cement. As a matter of fact, the action of emery is merely abrasive in both cases, and although in practice those composed of or covered with the finer grades of emery (that is to say, from about number 70 to number 120), are used for polishing purposes, yet, as before stated, emery polishing wheels are understood, in our workshops, to indicate wheels of wood covered with leather and coated with emery. Notwithstanding this, however, wooden wheels are sometimes coated with emery of the coarsest grades (that is to say, from about number 10 up to number 50), and the action of such wheels can scarcely be properly termed that of polishing.

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* From the *Scientific News.*

The duty of solid emery wheels, composed of even the finest grades of emery, is usually termed emery grinding, although the result attained is, in many cases, that of coarse or primary polishing. The solid emery wheel is an American invention, and has, in the smaller sizes, attained great prominence, of late years, from its capabilities of performing duties which it was formerly practically impossible to satisfactorily perform: for instance, as the grinding of hardened tools, or cutters to a true edge, or of hardened surfaces to a true conformation. The larger sizes of solid emery wheels are used for purely abrasive or grinding purposes, for which the fast running grindstone is either too unwieldly or so obstructive to the workman's operations as to render the manipulation both tedious and crude. Among this class of operations may be enumerated the grinding of ploughshares, stove-plates, wrought-iron plates, the fitting of iron castings, and the grinding of the inner surfaces of hollow iron ware. In all these latter classes of work, however, the emery wheels have displaced the grindstone, because of their handiness and greater adaptability to the size, shape, and form of the work rather than to its cutting qualifications.

Another and very successful field of operations occupied by the solid emery wheel, is that of finishing work in the lathe; thus the bearings of spindles and the surfaces of steel or chilled cast-iron rolls may be, and are finished more true and give a finer polish by emery wheels than is possible with any lathe tools of any kind whatever. In all cases of the employment of emery wheels in place of steel-cutting tools, however, the operation is considerably slower, and it may be laid down as a positive rule that, save upon metal too hard to be operated upon by steel tools, the emery wheel cannot compete with the ordinary lathe planer for milling tool duties; and, furthermore, the emery wheel cannot compete with the planer or with the file in the production of flat surfaces upon soft metals. Indeed, as a fitting tool for fine work, the emery wheel, except upon cylindrical surfaces, is out of place.

In the abrasive duties carried on in the manufacture of needles, cutlery, harness hardware, &c., the emery wheel is a most valuable tool and has assumed a very important position. This is largely due to its strength in proportion to its shape and size; for instance, vulcanite emery wheels 18in. in diameter and having 3-16in. thickness, or face as it is commonly termed, are not unfrequently used at a speed of some 5,000ft. of circumferential feet per minute, whereas it would be altogether impracticable to use a grindstone of such size and shape, because the side pressure would break it, no matter at what speed it were run. Indeed, in the superior strength of the emery wheels of the smaller sizes, lies their main advantage, because they can be made to suit narrow curvatures, sweeps, recesses, &c., and run at any requisite speed under 5,000 feet per minute, and with considerable pressure upon either their circumferential or radial faces.

The distinctive feature of the various makes of solid emery wheels lies in the material used to cement the emery together, and there is, at the present time, much thought and experiment being directed to the end of discovering some cementing substance which will more completely fulfil all the requisite qualifications than any at present known. The requirements of such a material are that it shall bind the emery together with sufficient strength to withstand the centrifugal force due to the high speeds at which these wheels must be run to work economically, and that it shall neither soften by heat or become brittle by cold. It must be capable of being mixed uniformly throughout the emery, so that the wheel may be uniform in strength, texture, and density. It must be of a nature that will not spread over the surface of the emery, or combine with the cuttings and form a glaze on the wheel. This glazing, in fact, is one of the most serious difficulties to be encountered in the use of emery wheels.

Many of the experiments to prevent glazing have been in the direction of discovering a cement which would wear away with the cuttings angles of the grains of emery, thus allowing the grains of emery to become detached from the wheel, rather than to remain upon it in a glazed condition. The cementing materials at present in use may be stated to be mainly composed as follows:—Hard rubber, chemical charcoal that is, leather cut down by acid—that is used to prevent shrinkage—and glue, oxy-chloride of zinc, shellac, linseed oil and litharge, glue, linseed oil and litharge, silicate of soda, and chloride of calcium, celluloid, oxy-chloride of magnesia, infusoria, and pure glue.

The speeds at which an emery wheel may be run without danger of bursting varies according to the thickness or breadth of face of the wheel as well as according to the quantity of cementing material and excellence of manufacture; hence, although a majority of manufacturers recommend a speed of about 5,000 circumferential feet per minute, that speed may be largely exceeded in some cases, while it would be positively dangerous in others. It is, in fact, impracticable in the operations of the workshop to maintain a stated circumferential speed, because that would entail a constant increase of revolutions to compensate for the wear in the diameter of the wheel. Suppose, for example, that a wheel, when new, is a foot in diameter, a speed of about 1,600 revolutions would equal about 5,000 circumferential feet, whereas when worn down to about two inches in diameter, the revolutions would require, to maintain the same circumferential speed, to be about 9,500 per minute, entailing so many changes of pulleys and counter-shafting as to be impracticable. In practice, therefore, a uniform circumferential speed does not exist, the usual plan adopted being to run the large sized wheels, when new, at about the speed recommended by the manufacturer of the kind of wheel used, and to make such changes in the speed of the wheel, as it wears, as can be accomplished by changing the belt upon the three stepped cone pulley, and, perhaps one, or, at most, two changes of light pulley upon the counter-shaft.

It is sometimes practicable to use wheels of certain diameters upon machines speeded to suit that diameter, and to transfer them to faster speed machines as they reduce in diameter. Even by this plan, however, only an approximation to a uniform speed can, in most cases, be obtained, because, as a rule, certain machines are adapted to certain work, and the breadth of face and form of the edge of the emery wheel is very often made to suit that particular work. Furthermore, a new wheel is generally purchased of such a size, form, and grade of emery as is demanded by the work it is intended at first to perform, nor is it, as a rule practicable to tranfser the work with the diametrically reduced wheels to the lighter and faster-speeded grinding machines. So that, while it is desirable to run all emery wheels as fast as their composition will with safety admit, yet there are practical objections to running small wheels at a rate of speed sufficient to make their circumferential velocities equal to those of large wheels. The speeds recommended for the various kinds of wheels now in use, vary from about 2,700 to 5,600 circumferential feet per minute, but the speeds obtained in workshops average between 2,000 and 4,000ft. for wheels 3in. and less in diameter, and from about 3,000 to 5,600 circumferential feet per minute for wheels above 12in. in diameter. Wheels above 15in. in diameter, and of ample breadth of face, are not, however, unfrequently run at much greater velocities. Emery wheels should be properly held upon their driving spindles or arbour, because if the latter should become heated, its expansion would tend to burst the wheel. To prevent this, and to provide for the wearing out of the wheel without excessive variation in the circumferential speed of the wheel as the wear takes place, the vulcanite wheels above 14in. in diameter are made upon a cast-iron centre.

The spindles, or arbours, for emery wheels, should have a solid shoulder for the wheel to jam against, and a washer and nut on the other side, and the thread should be such that the resistance upon the washer shall be in a direction that will tend to screw up and not unscrew the nut—otherwise the latter will be apt to become loosened. It is obvious, therefore, that where one arbour drives two wheels it will require a right hand thread upon one, and a left hand thread upon the other end.

EXPLOSIONS IN COAL-MINES.—VI.

By T. Wills, F.C.S.

Blasting Operations.

OPERATIONS of this nature are frequently employed, either to obtain the coal itself, or for the purpose of removing obstacles to the ready working of the coal. The coal is sometimes removed by loosening or cutting the sides all round, and then introducing a charge of powder behind the block, which, on its explosion, brings down the mass of coal. Rocky or hard ground is usually broken up by the use of powder. The method of conducting the blasting operation is very much the same as that employed elsewhere; a hole is drilled of a sufficient depth—into this a charge of powder or other explosive in the form of a cartridge is introduced—the drill hole is then filled up with tamping, which is rammed in tightly, and, by means of a slow fuze, the charge is ignited. In mines quite free from fire-damp, this operation is not attended with special danger; but, unfortunately, it is too common to employ blasting in mines which are by no means free from inflammable gas. In these cases it is usual for an examination of the neighbourhood to be made with a safety lamp, in order to detect the presence of gas. The shots also are only allowed to be fired by responsible persons, appointed for the duty.

There are two direct and obvious dangers arising from the employment of blasting in mines—1st. The possible ignition of gas, which is present in the mine at the time of firing, by the flame of the explosion itself, occasionally by the blowing out of the shot. 2nd. The concussion of the explosion may liberate a quantity of gas, which escapes into the mine, and is afterwards ignited at some open light. In addition to these direct dangers, there are other indirect ones, such as the risk, which must always accompany the presence of gunpowder at all in the mine; and, again, the amount of latitude which is allowed to those in charge of the blasting operations, frequently leads to carelessness. It has been attempted in the last Mines Regulation Act to surround the use of powder with so many precautions as to reduce the risk to a minimum. No powder is allowed to be stored in the mine, and no quantity greater than four pounds shall be in the charge of a workman at one time. The powder must, before being taken into the mine, be made up into cartridges, and these must be contained in a case or canister. If any fire-damp has been observed in the pit during the previous three months, the mine in the neighbourhood is required to be examined for fire-damp before the blast is fired; if any fire-damp is observed which causes a blue cap in the flame of the safety lamp no blasting shall be permitted. Unfortunately here, as in the case of the use of the safety lamp, miners appear in many cases to ignore the rules and regulations made entirely in the interest of their own safety, and to become careless and negligent to a degree. It is admitted that the above rules frequently become a dead letter, and their observance neglected. An illustration of this occurs in the case of the terrible explosion at Blantyre on 22nd October last. The following is an extract from the report of commissioners appointed to investigate the matter, and which has just been presented to Parliament:—"Powder required to be in a case or canister was allowed to be taken into the mine at times in paper parcels. Powder, where inflammable gas had been met with during the preceding three months, was allowed to be taken in paper parcels or canisters, loose, instead of in the required cartridges. The special rules made each fireman the 'competent person' to supervise the firing of shots where gas had been met with during the preceding three months, but the miners fired their own shots, except at the stoopings, without supervision. Shots, disavowed by the manager as being unsafe near accumulated gas at the stoopings, were fired with an open light by the special fireman." It is stated also, in another place in the report, that two or three days before the explosion blasting shots were fired in places in the mine in which there existed at the time a quantity of gas; one of the firemen fired the shots, opening his safety lamp to do so, and the expression is used that he did so "watching a chance." The fearful import of this state of things is seen when it is remembered that within three days afterwards 209 persons were killed in that pit.

Seeing that this, in all probability, although it is to be hoped an exceptional case, is not without its parallel, it has become a serious question whether blasting operations should not be prohibited entirely in coal mines; the loss of a useful agent would be felt, but a considerable increase of safety would ensue; before, however, this is done pressure should be put upon all persons concerned to see that the necessary rules are strictly carried out.

A third indirect danger from shot firing arises from the fact that the flame of a safety lamp may be blown through the gauze by a condensed air or sound wave, which result may occur at a considerable distance from the point of original impulse. This subject forms another of those which have been investigated by Mr. Galloway.

Many accidents have occured which have been wholly unaccounted for. Many of them have taken place immediately following the firing of a shot, especially if the shot be a blown-out one. The neighbourhood of the place has been found free from fire-damp, and after the explosion it has sometimes happened that all the safety lamps have been found locked and secure; occasionally two explosions, one immediately following the other, in different parts of a mine, have occurred. A notable case of the coincidence of firing of a shot and an explosion was recorded in the great disaster at the Oaks Colliery, in 1866, when 334 persons lost their lives. This connection between shot firing and explosions is partly traced by Mr. Galloway to the above fact, and a number of experiments tend to prove this to be the case. If an ordinary safety lamp, surrounded with an inflammable mixture, be placed at the end of a long tube, divided in its centre by some flexible diaphragm, such as indiarubber or paper, on an explosion being artificially produced at the further end of the tube, it will be found that the flame burning within the lamp will be driven through the gauze, and communicate the combustion to the outer mixture. A pistol-shot, or the explosion of soap bubbles filled with a mixture of oxygen and hydrogen, may be used. In such a case, no material substance passes to the flame of the lamp from the source of the explosion, seeing that the tube is divided by a diaphragm; an air or sound wave starts from this membrane, however, and passes to the lamp with the above effect. These experiments were repeated on a larger scale in a brick sewer 100ft. long, the same effects being observed. A amp arranged as before being placed at one end, and a pistol fired at the other (even if directed towards the roof), the flame was found to pass through the gauze. From such a sewer it is not difficult to pass by analogy to the gallery of a mine, and to see that the firing of a blasting shot may set up a sound wave which shall travel to some distance. Near the place where the shot is fired there may be no fire-damp, but at some other spot reached by the air-wave a safety lamp may be burning in a dangerous atmosphere, and an accident may result. I have repeated many of these experiments of Mr. Galloway, and it would appear that the suddenness or intensity of the wave has much more importance than its volume. Such an initial impulse as a pistol-shot I find, is by no means required. The following experiment was made:—A tin funnel; with a neck of about 1½in. diameter, has a piece of sheet indiarubber stretched on its larger end (such a funnel is frequently used for the production of smoke-rings); by uddenly tapping the indiarubber with the finger a uff of air is expelled from the funnel, and a puff of air, if directed against a flame protected by gauze, will drive it through the gauze, and may be readily made to ignite a combustible atmosphere on the outide. The volume of the air expelled is in this case ery small.

When speaking of the safety of miners' lamps, t was stated that a current travelling at the rate f from 7 to 8ft. per second might, and sometimes oes, hurry the flame through the gauze of the amp. Many calculations have been made with a iew to show that for such a current to exist normous volumes of fire-damp must escape into he ventilating current, and the conclusion has been rawn that such a state of things rarely, if ever xists, and that therefore an explosion from the assage of the flame through the gauze is almost npossible. In view of the above experiments, however, such conclusions may be fallacious, seeing that o continuous current is at all necessary, a mere uff, if sufficiently sudden, of air or gas being afficient to produce the result. A calculation of his nature is the following, by an experienced ining engineer:—

"If we take an ordinary working head, having a ectional area of (say) 30ft., or 6ft. by 5ft.—somehing like an average area—and we have (say) 6,000 ubic feet of air passing per minute, it is required hat about 700ft. of gas per minute be generated to roduce an inflammable current, but as the speed is nly 3·33ft. per second, the conditions of danger are ot present. Where, then, or when in a mine is it kely that those conditions are to arise? It will require an immense quantity of air and a great discharge of gas to produce those conditions. Taking n ordinary working head as before, we will require speed of 8ft. per second, or 14,400 cubic feet of ir per minute, and a discharge of gas equal to nearly ,000ft. per minute, and those circumstances are not t all likely to occur. They have very rarely ccurred—of that we may be assured, for we must ot lose sight of the fact that the condition ecessary to produce an explosion must be pretty losely fulfilled—otherwise there will be no xplosion."

Recently, in connection with blasting, a new ggestion as to the immediate cause of some xplosions, and the aggravation of others, has een made. This is the possible influence which he presence of a quantity of dry and fine coal ust may have in increasing the explosiveness of ome atmospheres. Coal-mines are dry or wet, ccording to the nature of the superincumbent trata. The floor of dry mines is usually covered with a considerable layer of very fine coal dust, and he air of such mines is more or less loaded with the ame dust, the fineness of which is remarkable. If, fter working in a coal-mine for some time, the skin s freely washed with soap and water two or three imes, and is then examined with a magnifying lens, articles of coal are still seen filling up its pores. The most severe explosions usually take place in dry mines.

The suggestion is, that this coal dust, if stirred p and mixed with the air of the mine by the firing f a shot, may produce in this way an explosive tmosphere. An observation made by Faraday and Lyell, in 1845, when examining into the cause of an xplosion in a coal-mine, bears upon this subject. They found that upon the sides of the props and pports facing the direction in which the explosion ad travelled, there was a quantity of coal dust hich presented the appearance of having been artially burnt or caked, and they suggested that his coal dust took some part in the explosion. The rst important contribution upon this subject is to be ound in a paper by M. Vital, in the "Annales des Mines," for 1875. This gentleman investigated an xplosion which took place in France in November, 874. A blown-out shot immediately preceded, or as the cause of the explosion; this shot was fired t the level of the floor. No fire-damp had ever een observed in the pit before, yet a serious explosion took place; the mine was dry, and the loor was covered with a layer of very fine coal dust. M. Vital conceived that the only explanation was the formation of an explosive atmosphere by the volume of dust raised by the explosion, and following up this idea, he made a number of experiments to determine the conditions of the matter. His conclusion was that the presence of large quantities of dry coal dust in a mine is a serious element of danger, and that without the presence of any fire-damp, this dust if mixed with air may form an explosive mixture. As a parallel case, the occasional explosions which occur in flour mills may be cited; fine flour dust and air may produce a mixture, which, if not explosive in the ordinary sense, becomes inflammable throughout its whole volume. Mr. Galloway has carried M. Vital's experiments further with more remarkable results. No exception can be taken to Mr. Galloway's experiments, as they were made with absolute pit gas and the coal dust occurring in the mine. For the details of the apparatus employed, reference must be made to the "Proceedings of the Royal Society," No. 168, 1876. The conclusions were as follows:—

1st. A mixture of air and coal-dust is not inflammable at ordinary pressure and temperature. (Difference from M. Vital.) 2nd. The admixture of a small amount of fire-damp makes such a mixture inflammable; ·892 per cent. of marsh gas is sufficient for the purpose, while the proportion of marsh gas required to form an explosive mixture with air alone is at least 6 or 7 per cent.

Now a safety lamp (the ordinary means used) gives positively no information of the presence of gas in any quantity less than 1 part in 60 of air, yet 1 part in 112 of air, together with coal-dust, is sufficient to produce an explosive mixture; hence an accident may take place in a mine which is usually considered to be quite free from fire-damp.

Evidence of the influence of coal dust will be looked for in future explosions, and will probably prove the truth of these important facts. In an explosion which took place at the Llan Colliery, South Wales, which was investigated by Mr. Galloway, evidence was given that the presence of coal dust aggravated very considerably the extent of the accident.

Explosions of fire-damp and coal dust are not of such great violence as those of fire-damp and air, but are likely to extend over larger areas. The means for the prevention of such accidents would be the removal of the coal dust to prevent its accumulation, or the constant watering of the roads.

Estimation of Fire-damp in Mines.

Frequent mention has been made in these lectures of the influence which the pressure of marsh gas has upon the appearance of a candle or lamp flame burning in such an atmosphere. Before the days of safety lamps the miners used to employ their candles for the examination of the air, and in the hands of an experienced man a large amount of expertness was acquired in their use; the lower part of the candle-flame was shielded from the eye by the hand, and the character and the size of the blue halo which played about the top of the flame were observed and interpreted. This empirical observation is still carried out, although more satisfactorily, by a fireman with a Davy lamp. This lamp, owing to the free passage permitted through the gauze, is the most sensitive lamp to indicate the presence of fire-damp; although, on the other hand, the gauze prevents the observation from being as accurate as it might be, from the difficulty of seeing the flame well. The blue halo or "cap" indicating the presence of fire-damp surrounds and rises above the flame; it is caused by the combustion of heated marsh gas; the marsh gas in the air burns when it comes into direct contact with the flame of the lamp, but is unable to maintain the temperature necessary for its own combustion apart from the flame. This "cap" varies in size from a practically invisible envelope to a cone of blue flame 2in. or 3in. in height. This variation appears to be directly proportianal to the amount of fire-damp in the air, and in this way the height of the "cap" can become a measure of the fire-damp. Mr. Galloway has been able to reduce this to something like definiteness by actual measurements of the "caps," obtained by introducing lamps into atmospheres containing known proportions of fire-damp

The lamp best suited for observing these "caps" is the ordinary Clanny, the glass base enabling the smaller "caps" to be seen with more distinctness. The flame of the lamp should be drawn down until it is almost extinguished, leaving a small point of blue light about one-eighth of an inch high, with a faint trace of yellow in the centre. Two Clanny lamps properly trimmed give very concordant results; no gas below the proportion of 1 part in 60 can be distinguished by these caps. The paper by Mr. Galloway containing the details of the experiments will be found in the "Proceedings of the Royal Society," No. 168, 1876. In the hands of intelligent men interested in these matters, a knowledge of these facts ought to be of considerable value, and for the examination of the amount of fire-damp in the return ventilating current they should be useful to the officials.

MALLEABLE IRON CASTINGS.

THE term malleable iron means an iron from which the carbon has been removed by the operation of puddling and boiling, and is a wrought iron. The term malleable-iron castings means an iron that has been cast into any desired shape, and then malleableised by removing the carbon by a process of annealing, which consists in burning off the whole or a part of the carbon combined with the iron from which the castings were made. In the manufacture of malleable-iron castings the first object is to get the proper kind of pig iron, for all iron is not suitable for making malleable iron by the process of annealing. From the states in which carbon exists in cast iron, this has been classified into three principal subdivisions. The first is the grey metal, or No. 1 foundry pig, in which the carbon is not combined with the iron, but is in the graphitic state, and may be seen in large flakes when the iron is broken. These flakes are sometimes called tissue and black lead. The second division is the mottled cast iron. In this iron the carbon is partly combined with iron and partly in the graphitic state, which gives the iron a spotted or mottled appearance. This iron is also called forge or mill iron. The third division is the white cast iron. In this iron the carbon is combined with the iron, and is unseen. This iron is also called forge or mill iron.

The grey iron, or No. 1 foundry iron, is the best iron for ordinary foundry castings, because it contains the most carbon, and is softer and will remain fluid longer than either the mottled or white iron, yet it is not the best iron for malleable castings, for the carbon in it is not combined with the iron, and in converting the castings into malleable iron the carbon is extracted from the iron without melting the castings, and if this class of iron is used the castings will be full of small holes after they have been malleableised, and they will not have the required strength.

The iron that will make the best malleable castings is the white cast iron, for in this iron the carbon is completely combined with the iron, and when it is abstracted from it by the annealing process, it leaves a perfectly sound and smooth casting. But in using this iron for malleable castings another trouble arises. The iron contains so little carbon that it will not retain its fluidity long enough to be run into light castings; and almost all of the malleable castings are very light, so that this class of iron cannot be used.

And as the grey iron, or No. 1 foundry iron, contains too much carbon and the white iron too little carbon, the best iron for malleable castings must be the mottled iron, which is between the two extremes. And this is the iron that is always used for malleable-iron castings, and none but the very best brands of cold-blast charcoal mottled iron will produce a good malleable casting.

Iron for malleable castings may be melted in a cupola or in either of the reverberatory furnaces. But the iron melted in a reverberatory furnace always produces by far the best castings; for the iron is not melted in contact with the fuel, as in the cupola, and it is not deteriorated by the impurities contained in the fuel. There is also the advantage that, should the iron contain too much carbon, part of it may be removed by the oxidising action of the flame.

As most all malleable castings are very small they are generally moulded in snap-flasks, with green sand, from metallic patterns or match plates. The castings, before they are annealed, are as hard and brittle as glass, and they must be handled with care to prevent breaking. These castings are put into a tumbler or rattle barrel, where they are cleaned of all adhering sand, and become polished by mutual friction, and to have them anneal properly it is very essential that they should be thoroughly cleaned. The cleaned castings intended for conversion into malleable iron are next packed into iron boxes, with alternate layers of fine iron scales from rolling mills. The boxes are then closed at the top by a mixture of sand and clay, and all the cracks are carefully closed up to prevent the admission of air. The boxes are next put into the annealing oven, where they are subjected to a white heat, not sufficiently hot, however, to melt the boxes. They are kept at this heat for a week or more, and then allowed to cool off gradually. After the castings have been properly annealed they are covered with a film of oxide of different colours, and resemble in appearance that kind of Champlain iron ore called peacock ore. These various colours of the oxide are a sign of good malleables. This adherent oxide is removed from the casting by another passage through the rattle barrel, and the process of malleable-iron making is finished.

Powdered iron ore is sometimes used in place of the iron scales, but it is not near so good as the scales, for it contains more or less silica and earth, which, at the temperature of the annealing oven, will fuse and form a slag or cinder, and prevent the oxidising action on the castings. For this reason the scales are to be preferred, and care should always be taken to keep them as free from earthy matter as possible. In every heat or annealing operation the scales part with some of their oxidising properties, and before they are again used they must be pickled and reoxidised. This is done by wetting them with a solution of sal-ammoniac and water, and mixing and drying them until they are thoroughly rusted, when they are again ready for use. The annealing boxes were formerly made of soft iron, but at the present time they are mostly made of hard iron—the same as the castings are made of. The hard iron boxes become annealed the same as the castings, and will last longer than the soft iron boxes. These boxes are generally made about 20in. long by 14 wide and 14 deep. They are set one on top of another in the annealing oven, but are never set more than two high. The lower one has a bottom cast in it, but the top one has no bottom, and is merely a frame set on the lower box. These boxes only last a few heats, and the small boxes are said to last longer than the large ones.

There are several different kinds of annealing ovens in use at the present time, and some very important improvements have been made in the construction of these ovens in the last few years. The best one in use at the present time is one with a fire on each side of it, and so arranged that the flame from the fuel does not enter the oven or strike the boxes. This oven is not allowed to cool off, but is kept hot all the time, and at one end there is a door, through which the annealing boxes are removed while at a white heat, and are replaced by cold ones. The door is then closed, and the boxes heated to the required heat. This kind of an oven is the most economical one in use, for it requires less fuel than any of the others, and is not injured by expansion and contraction in cooling, and reheating as the other ovens are. When annealing the castings in the oven care should be taken to not have the temperature of the oven too high, or the heat too prolonged, or the castings may be burned and hardened after they have been softened. After the castings have been thoroughly decarbonised by annealing in the oven they are virtually a commercially pure iron, and are the same as wrought iron without fibre, and fibre may be imparted to them by rolling or hammering. Yet these castings without fibre are sometimes equal to the best wrought iron for strength, and may be bent double when cold without breaking them. The manufacture of malleable iron by the process of annealing is older than is generally supposed. It appears to have been known in the year 1700, and malleable castings were then made upon the same principle as they now are, although it is doubtful whether the process had been brought to the same perfection in those days as at the present time.—*Iron Age.*

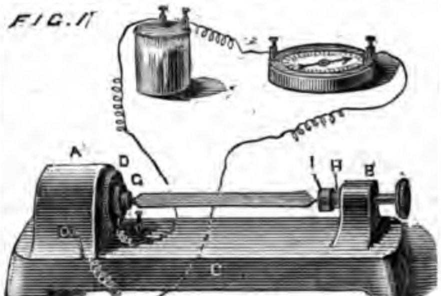
EDISON'S MICROTASIMETER.

THE following description of Mr. Edison's microtasimeter is published in the *Scientific American* for June 22. It will be seen to consist in a modification of the carbon telephone, which we illustrated on p. 381:—

The latest of Edison's inventions, and perhaps the most interesting to physicists, is his microtasimeter, or measurer of infinitesimal pressure. The thermopile, hitherto foremost among delicate indicators of changes of temperature, must now be consigned to the rear ranks, and the radiometer, which exhibits the motive power of the most subtile of forces, must retire in favour of an instrument that can weigh that force. The microtasimeter is the outcome of Professor Edison's experiments with his carbon telephone. Having experimented with diaphragms of various thicknesses he ascertained that the best results were secured by using the thicker diaphragms. At this stage he experienced a new difficulty. So sensitive was the carbon button to changes of condition, that the expansion of the rubber telephone handle rendered the instrument inarticulate, and finally inoperative. Iron handles were substituted with a similar result, but with the additional feature of musical and creaky tones distinctly audible in the receiving instrument. These sounds Professor Edison attributed to the movement of the molecules of iron among themselves during expansion. He calls them "molecular music." To avoid these disturbances in the telephone, the handle was dispensed with; but it had done a great service in revealing the extreme sensitiveness of the carbon button, and this discovery opened the way for the invention of the new and wonderful instrument. The microtasimeter is represented in perspective in Fig. 1, in section in Fig. 2, and the plan upon which it is arranged in the electric circuit is shown in Fig. 3.

The instrument consists essentially in a rigid iron frame for holding the carbon button, which is placed between two platinum surfaces, one of which is fixed and the other movable, and in a device for holding the object to be tested, so that the pressure resulting from the expansion of the object acts upon the carbon button. Two stout posts, A, B, project from the rigid base piece, C. A vulcanite disc, D, is secured to the post, A, by the platinum-headed screw, E, the head of which rests in the bottom of a shallow circular cavity in the centre of the disc. In this cavity, and in contact with the head of the screw, E, the carbon button, F, is placed. Upon the outer face of the button there is a disc of platinum foil, which is in electrical communication with the battery. A metallic cup, G, is placed in contact with the platinum disc to receive one end of the strip of whatever material is employed to operate the instrument. The post, B, is about four inches from the post, A, and contains a screw-acted follower, H, that carries a cup, I, between which and the cup, G, is placed a strip of any substance whose expansibility it is desired to exhibit. The post, A, is in electrical communication with a galvanometer, and the galvanometer is connected with the battery. The strip of the substance to be tested is put under a small initial pressure, which deflects the galvanometer needle a few degrees from the neutral point. When the needle comes to rest its position is noted. The slightest subsequent expansion or contraction of the strip will be indicated by the movement of the galvanometer needle. A thin strip of hard rubber placed in the instrument exhibits extreme sensitiveness, being expanded by heat from the hand, so as to move through several degrees the needle of a very ordinary galvanometer, which is not affected in the slightest degree by a thermopile facing and near a red-hot iron. The hand in this experiment is held a few inches from the rubber strip. A strip of mica is sensibly affected by the heat of the hand, and a strip of gelatin placed in the instrument is instantly expanded by moisture from a dampened piece of paper held two or three inches away.

FIG. 1



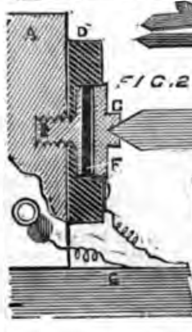
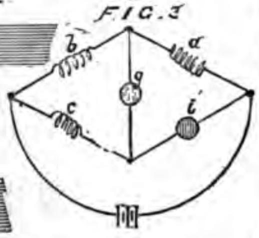


FIG. 2

FIG. 3



For these experiments the instrument is arranged as in Fig. 1, but for more delicate operations it is connected with a Thomson's reflecting galvanometer, and the current is regulated by a Wheatstone's bridge and a rheostat, so that the resistance on both sides of the galvanometer is equal, and the light-pencil from the reflector falls on 0° of the scale. This arrangement in principle is illustrated by Fig. 3. Here the galvanometer is at *g*, and the instrument which is at *i* is adjusted, say, for example, to ten ohms resistance. At *a*, *b*, and *c* the resistance is the same. An increase or diminution of the pressure on the carbon button by an infinitesimal expansion or contraction of the substance under test is indicated on the scale of the galvanometer. The carbon button may be compared to a valve, for, when it is compressed in the slightest degree, its electrical conductivity is increased, and when it is allowed to expand it partly loses its conducting power. The heat from the hand, held 6 or 8 inches from a strip of vulcanite placed in the instrument—when arranged as last described—is sufficient to deflect the galvanometer mirror so as to throw the light-beam completely off the scale. A cold body placed near the vulcanite strip will carry the light-beam in the opposite direction. Pressure that is inappreciable and undiscoverable by other means is distinctly indicated by this instrument. Professor Edison proposes to make application of the principle of this instrument to numberless purposes, among which are delicate thermometers, barometers, and hygrometers. He expects to indicate the heat of the stars and to weigh the light of the sun.

Note by Professor Edison.

The heat measurer was described and experiments shown to Professor Langley, the well known astronomer of the Allegheny Observatory, some six months ago. On his suggestion at the time, that it ought to be worked up as a very valuable boon to science, especially in the line he was investigating (that is, measuring the heat of the stellar spectra), I tried many experiments with it, and devised the form given. This apparatus was described to various members of the National Academy of Sciences, held at Washington, April 17, 18, and 19, 1878, and the Washington *Star* and *Union*, newspapers published then, gave a description of the instrument. Copies of these papers were at once mailed to William H. Preece, Professor Scheelen, Count Du Moncel, and other physicists in Europe.

A SIMPLE ELECTROSCOPE.

TO the Société des Sciences of Nancy, M. Rameaux recently introduced a very simple and sensitive electroscope. It consists of a fine fiber of white silk, fixed at one end by means of a little wax to any support, and free to oscillate in any direction under its point of attachment. A single thread would, of course, suffice for the ordinary purposes of electroscopy properly so called, but it is preferable to employ two near each other, taking care to space them so that they cannot foul each other during their swing, or influence each other reciprocally. One of the threads is charged by means of a glass rod with positive electricity. The other is charged by means of a stick of resin with negative electricity. Every body which attracts one of the threads so charged, and repels the other, is necessarily electrified. Its electricity is of the same sign as that of the thread which it repels. The sensibility of these electroscopes is greater, within certain limits, as the threads are made finer, longer, and less conducting. If the finest sewing silk of commerce be untwisted, each of the parts or strands obtained will make an excellent electroscopic pendulum, which, if about 2ft. long, is very handy, and suffices for almost all tests. White silk is preferable to coloured. The motions of these threads, if well charged, are considerable, even when the bodies presented to them contain but slight charges of electricity. When the threads are not excessively fine, disturbances of the air do not destroy the observations so much as might be supposed. M. Rameaux has found this arrangement in all cases more sensitive and sure than a carefully constructed gold leaf electroscope which he used for comparison. This system also recommends itself in several ways, for instance:—1. It is so simple that every one can construct and use it. 2. It costs nothing; no special support being necessary. The threads can be fixed to any projecting piece, as the edge of a table; the only condition being that they may hang freely. 3. It can be set up in a moment, and consequently is at once ready for any unexpected requirement; whereas a gold leaf electroscope long unused requires to be dried for hours. 4. It works perfectly, whatever the hygrometric state of the atmosphere. 5. It can be employed to show electric phenomena to a numerous auditory. With long thin fibres and highly electrified bodies, the experiments are very telling.

TRANSPARENCIES FOR WINDOW ORNAMENTATION.*

THERE are certain principles which we would lay down as a basis for this application of our art, the first of these being that the window or door-pane to be ornamented must have its transparency destroyed, by which is meant that it must be so treated as to render it impossible to be seen through. The general function of an ornamented window is to prevent an unpleasant or inartistic scene outside from being perceived by those inside; and it is well known to some of our readers that one of the largest and finest windows of the kind we are describing intercepts and blocks out by such artistic means the view of a coachhouse and stable with their accompanying stable-yard. Those whom we have captivated by this choice specimen of the united work of the photographer and the painter had no conception of the fact that as a background to this work of art, although unseen by the spectator, the unpleasant erections named stand at a distance of thirty feet. A second principle that should be recognised is that of having the picture of a vignetted, sketchy character. The tone, unless when the nature of the subject otherwise demands it, should be warm and "sunshiny."

There are three mediums which may be made use of as the bases upon which to print the transparency—namely, paper, opal, and ground glass. It is very fortunate that the first is at once the best, the easiest, the cheapest, and most convenient of these various bases. But if the image is to be formed upon it by silver printing a method quite different from that employed in ordinary practice must be made use of; for, whereas in an ordinary photograph it is essential that the image be on the surface, it is here one of the conditions of success that it be sunk into and distributed through the entire substance of the paper. The difference between these two conditions may be easily exemplified by dividing a sensitive sheet of albumenised paper into two, and printing one of them with the albumen surface, and the other with the back of the paper next to the negative, the printing being carried out in the second case until the image is clearly visible upon the albumen. Now examine the two prints as transparencies, and it will be seen more vigorous is the one than the other. To per for transparency printing it should be in and not merely floated upon the silver veral very fine window transparencies we are made upon plain salted paper.

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* From the *British Journal of Photography.*

loes not appear to be any special condition n the selection of paper for this purpose is—that it must be wove and not wire-laid lain, unalbumenised Saxe or Rives papers mirably, and the only preparation required ry immersion in a ten-grain solution of f sodium, followed, after drying, by im- n a thirty or forty-grain solution of nitrate The printing must be carried to a great depth to allow of the reduction that will n the fixing; for the gold toning will be so not to interpose any great obstacle to the tion of the hyposulphite of soda upon the which the print is composed. It will be ind that what we are now aiming at is the of a very deep, warm-coloured trans-

ving been obtained, the next step is to transparent and attach it to the window will be understood that the degree of cy to which the print will be amenable bort of that by which objects at a distance ceived through the pictorially-ornamented short, it is the transparence or, more cor- *translucence* of ground glass or of pot- s required. To such end provide a rather tion of Canada balsam in benzole, and repeatedly to the picture until the trans- quired by the first touch of the varnish which disappears upon the evaporation sole, becomes permanent. Three or four s of the varnish may be required ere this

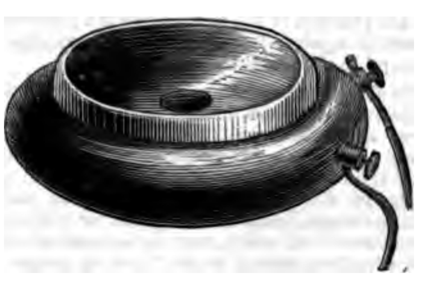
s plate having been cleaned is coated with arnish, which, for this purpose, should be ed by the addition of more balsam; and a ating having been given to that side of the is to be placed in contact with it, an t is made commencing at the foot, and e upper portion of the print curved out- s to admit of a continuous layer of the nish remaining at the point of junction e. paper and the glass, until the two are to contact up to the top. This ensures nce of air bubbles, which, although they bbed out, are yet better avoided. When as become thoroughly dry the services of may be utilised to examine the whole and complete the effect by imparting a depth here and there as may appear neces- he manner now described have been pro- ries of the finest window transparencies t seen.

of ours, having a cultivated photographic me the fortunate possessor of a yacht in e a pair of folding doors with ground panes of large dimensions, having a very border, embodying a floral design sur- ach. The centre was adorned with the previous possessor, for whom the vessel onstructed. Both the ornate border and were deeply engraved by means of fluoric , when applied as a fluid, causes the sur- upon to be of a glossy, smooth texture with the matt surface that results from e etching or engraving by fluoric acid *gas*. required was the means of removing the ng the *entourage* intact. This has been accomplished by covering the former with phic paper transparency prepared as we bed, with an additional element of colours, arent oil colours employed having been most effective in the colouring of lantern nely, Prussian blue, gamboge, burnt and , with madder and carmine for the reds. of these colours every combination of tint de. The pictures prepared in this manner ery fine appearance, no trace of the still ms being visible. It will be understood gh we have described in detail the method by silver, pigmented tissue may be made equal facility and with the further advan- manence.

CH TELEPHONES AT THE PARIS EXHIBITION.

llection of telephones in the French tele- annexe at the Exhibition is an interesting accompanying figure represents the form of Bell telephone as exhibited by . The outer case, which is of mahogany, in. in diameter, so that this form is nient for the pocket, and may also be nywhere like a watch. Its novelty lies its form; the principle, and the several being the same as in the ordinary Bell The permanent bar magnet, instead of ight, is curved round itself, after the a volute, and the small coil of insulated e is seated upon the central pole. The price of a pair in mahogany cases is 24 francs in France. The price of a pair of "mirror" telephones, which are similar to the watch telephone, but fitted with a straight side handle, like a hand-mirror is 25 francs. The ordinary hand telephones in mahogany and box are 30 francs, and those in ebonite, rosewood, or nickel-plating, from 40 to 50 francs a pair. A powerful telephone for long lines, formed of a horse-shoe magnet, with a base board and a mouthpiece, costs 100 francs a-piece. These prices are independent of the "calls" and other fittings.

An improvement effected in the construction of these telephones by M. Alfred Niaudet deserves mention. As formerly made the Bell telephone was by no means constant in its action, and required adjustment. The distinctness of the articulation depends in a high degree on the position of the diaphragm with respect to the pole of the magnet—in fact the diaphragm should be as close to the pole as possible, while leaving sufficient space for it to vibrate in without touching the latter. It was found, however, that differences of temperature affected the vocalisation of the telephone even more than they do the delicate throats of some of our most celebrated singers. The hot breath playing on the diaphragm in speaking sometimes sensibly impaired the articulation; and holding the telephone to the fire for a few moments has even rendered it dumb altogether. In certain cases heating, on the other hand, improved the speaking. This inconstancy was traced to the expansion and contraction of the diaphragm, which, being clamped all round by the wooden frame of the instrument, could only expand in the middle, so that it became more or less convex there, and, in consequence, receded from or approached the pole of the magnet. To correct this variation, it was necessary to give the magnet a slight longitudinal play, so as to move it nearer to the diaphragm, or further from it, as the case might be. M. Niaudet obviates this necessity by leaving the diaphragm free round its edge, not clamping it there between the two parts of the frame; and in order to fix it in its place and prevent its moving about, he overlays it round its edge by a circular spring made of stout brass wire. This holds the disc down all round, but leaves it free to expand at the edges without buckling in the centre. A telephone of this kind, therefore, requires no adjustment—a point greatly in its favour with the public at large.



M. Niaudet has also effected improvements in Edison's singing call for telephones. This consists essentially in connecting up a small local battery with the telephone, so that on singing against the diaphragm the latter is made to rapidly interrupt the circuit of the battery, and a singing note is heard on the receiving telephone loud enough to call attention. The local battery is connected up for calling by pressing a button in the back of the telephone. This carries a small platinum contact pin forward, within vibrating range of another contact attached to the diaphragm itself. When the call has been responded to, the press button is released, the contact pin springs back, the local circuit is withdrawn, and speaking can be carried on in the telephone in the ordinary way. M. Niaudet gets a considerable improvement in the sound of the call by making the frame of brass instead of wood. A speaking tube covering the diaphragm, with holes in it for the escape of the breadth, is also an advantage. The merit of this alarm is that with the exception of the battery it is all comprised within the ordinary telephone itself. The singing note given out by the receiver may be easily heard a distance of 20 yards, with a battery of from two to four cells.—*Engineering*.

The Microphone.—Mr. Williamson has forwarded one of his microphones, which is the simplest and lowest-priced one we have yet seen. It consists merely of the base board, a block, and a stick of carbon, two binding screws, and a brass weight to adjust the instrument to the sounds. The price is so low that no one would go to the trouble of making a microphone of this pattern—viz., that shown in Fig. 4, p. 256. No one seems to have tried the carbon employed by Mr. Edison—made of compressed lamp-black prepared from the lighter hydrocarbons.

SCIENTIFIC NEWS.

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THE publication of the names of the officers of the British Association is an evidence that the session has closed, and that the scientific world is looking forward to its annual holiday. Ireland is well worth visiting, and Dublin is itself a seat of learning, so that despite the counter attractions of Paris, a large attendance of members and associates may be expected—the well-known hospitality of the Irish being an additional inducement to pay a visit to the sister isle. The popular lectures or discourses will be by Mr. G. J. Romanes, on "Animal Intelligence," and by Prof. Dewar on "Dissociation; or, Modern Ideas of Chemical Action." Dr. W. Spottiswoode is the president elect, and will deliver his address on Wednesday evening, August 14th. Efforts will be made, we believe, to give a very full and complete exhibition of the wonderful phenomena of the microphone, the telephone, and the phonograph. Contributors of memoirs are reminded that in order to obtain a hearing they should send an abstract of their papers, together with the papers themselves, addressed to the general secretaries, 22, Albemarle-street, on or before August 1, indicating on the wrapper the section for which the memoir is intended.

Mr. A. C. Ranyard, hon. sec. of the Royal Astronomical Society, is about to proceed to Colorado to observe the coming solar eclipse. In order to photograph the corona on a much larger scale than has hitherto been accomplished he takes with him a camera of 13 aperture. He will camp in the company of Prof. Young and Dr. Henry Draper, at a station some 20 miles south of Denver, whence he has promised to forward us an account of the eclipse.

At the Sorbonne on Thursday week the gold medal of the French Geographical Society was presented to Mr. H. M. Stanley. The Royal Geographical Society is asking for funds to despatch a small expedition to explore the country between the east coast and the northern end of Lake Nyassa. The expeditionary party will be commanded by Mr. Keith Johnston, and will leave England in the autumn.

The telephone has been successfully utilised at the Midland Railway Works, Derby, where it connects the engineer's and the telegraph departments.

Baron von Ettinghausen, until lately director of the Physical Institute of Vienna, and the most popular scientific lecturer in that city, died recently. He was born at Heidelberg in 1796. Baron von Bibra died at Nuremberg on June 5, in his seventy-second year. He was a nobleman of culture, who carried out a series of chemical researches at his castle in Franconia, which attracted the attention of the physiological world. Besides his scientific work, Von Bibra wrote many novels and tales. Prof. C. Stäl died at Stockholm on the 14th of June in his 46th year. He was known as the Swedish entomologist.

The successor to M. Leverrier, as director of the Paris Observatory, has at last been appointed in the person of Capt. Mouchez. His functions are, however, purely administrative, the scientific direction being intrusted to M. Tisserand, an astronomer of great promise, formerly attached to the Toulouse Observatory.

In his Harveian oration, delivered before the Royal College of Physicians, Dr. Burdon Sanderson, after alluding to the fact that the countrymen of Harvey, Bacon, Hunter, Bell, while lavishing money on some object supposed to be scientific (the Loan Collection, for instance), made no provision whatever for the prosecution of experimental research in pathology and therapeutics, said that "twenty years hence it would certainly be recognised that the scientific investigation of the essential nature and origin of disease, and the mode of action of remedies, was a matter of no less importance to the public welfare than the application of the sciences of physics and chemistry to the invention of new methods of destroying human life."

An explosion of gas from coal took place on board the Caduceus at Cardiff last week, through a trimmer lowering a naked light into a portion of the hold which had been loaded a day or two before. The vessel, a steamship, was uninjured, and has left for Aden with over 2,000 tons of coal on board. Six of the trimmers were severely burnt. An explosion of a mixture of air and gas from coal was the cause of the serious disaster on board the Sardinian, but in spite of many warnings the authorities do not interfere. They endeavour to enforce compulsory ventilation where it is not wanted (in the body of the coal), but neglect to insist on the provision of a means for removing the gas given off by the coal.

An exhibition of tin-plate and wire work was opened at the Crystal Palace on Saturday, by the Lord Mayor. It is under the patronage of the Tin-plate and Wireworkers' Company.

It is stated that the accident to the German ironclad in the channel was partly occasioned by the roaring of the steam from the König Wilhelm, which prevented the helmsman hearing the command. Orders should, of course, be given by telegraph, in such cases, but a Mr. Justice has devised a means of preventing the roaring by attaching to the steam outlet a chamber containing a number of loose spherical particles—annealed glass beads of about ⅜in. diameter are preferred. Experiments have been made at Portsmouth, which prove that the method is successful. A large area for the escape of steam must, however, be provided. The balls break up the wave-lines of sound, and so prevent the "roar."

The "duplex" method of telegraphy has been successfully applied to the Wheatstone automatic instruments, and on a recent occasion as many as 358 messages were sent in an hour by its means—219 in one direction, and 139 in the other. More than 139 could have been sent, but they were not received.

It is known that the European observers of the recent transit of Mercury had rather poor success. Happily it has been otherwise in the other hemisphere. A letter from Admiral Serres to the Paris Academy states that the operations at Païta have succeeded admirably. The conditions allowed of determining the hour of the four successive contacts with the greatest precision. During the transit a number of micrometric measurements were obtained, also 600 daguerreotypes, representing all the phases of the phenomenon. This result is in great measure due to Commandant Fleuriais, who was connected with one of the expeditions for the transit of Venus. The observers had carefully rehearsed their parts over and over again, and were complete masters of their instruments. Each observer was required to make a separate report, independent of all the others. A chronograph tracing furnishes a record of all the indications made at the same moment with the phenomenon. The photographs have been sent to Paris in two sets (by separate couriers)—the one containing the even numbers, the other the odd.

The prevalence of shortsightedness in Germany, and its augmentation in the course of school studies are sadly illustrated by some facts which an eminent oculist has published, regarding an examination which he made in January this year, of all the scholars in an advanced girls' school in Dortmund, Westphalia. Of 214 scholars 106 were shortsighted. In the fifth class (the youngest of the girls), 40·7 per cent. were shortsighted; in the fourth, 41·8 per cent.; in the third, 46·8; in the second, 76·6 (!); and in the first, 57·1. In the second class the proportion is so great that it may be considered as exceptional; but in the other classes it will be seen how there is a regular progression upwards.

In a recent communication to the St. Petersburg Academy, M. Nyren states that on the 10th of May last year, at 4.16 a.m., he observed in a fine level in Pulkowa, several small and regularly repeated oscillations indicating a slight earthquake. Now, on the same day, at 3.2 a.m., Pulkowa time, there occurred the violent earthquake of Iquique in South America. M. Nyren considers it possible, therefore, that the earthquake observed at Pulkowa 1h. 14min. later may have been propagated from the one place to the other; not, however, through the rigid crust of the earth, but probably through the earth's interior. He thinks this view the more reasonable because the rigid crust would soon bring the movement to disappearance, and because the seat of the great earthquake was deep. Supposing the two earthquakes, then, to be thus connected, the velocity of propagation would be about 2·4 km. in a second.

A prize of about £118 is offered on the Lamey foundation by the Kaiser Wilhelm University at Strasburg for treatment of the following theme: What influence have the modern forms of industry, and the dissolution of the old industrial union (Gewerbeverfassung), on general and technical education in the middle and lower classes, and, in connection with the latter, on the moulding of society; and what requirements arise out of this for the settlement of the conflict between technical interests, on the one hand, and human and social-political, on the other? The date fixed is January 1, 1880.

A subterranean telegraph line is now being laid between Frankfort and Strasburg. The cable is formed of seven insulated wires; it is covered by a layer of bricks and an iron guard. It was made in Siemens and Halske's works in Berlin, and its transport was effected by means of large specially-constructed rollers. As the rollers advance (when the cable is being laid) the wires are unwound of their own accord, and guided into the subterranean channel by workmen. After the channel is covered in certain marks are arranged exteriorly at equal intervals, corresponding to certain divisions of the cable, to facilitate discovery of the part to be repaired in case of derangement.

It is proposed (we learn from *Les Mondes*) to erect foot-bridges at the most frequented parts of the boulevards in Paris, where the passage of foot passengers is always difficult, and sometimes dangerous. Two circular bridges are to be placed, crossing diagonally, so that passengers going from one of the four angles may reach any of the other angles without walking in the street. The height will be sufficient to allow the highest conveyances to pass below. At the junction of the two bridges is a platform, 6 metres square, from which spiral staircases descend to the footpath.

To show the vibrations of one of Chladni's plates, M. Terquen brings over it Koenig's flame apparatus, constructed for the study of vowel sounds. So long as this is over the node lines the flame remains at rest, but over other parts it vibrates considerably. Two such arrangements, placed over similar or contrary segments of vibration, may be connected and the vibrations united in one flame by means of a V-tube, a telescopic tube being inserted in the path of one set of vibrations.

It is inconvenient to make a horse carry its forage even for one day. With a view to cases in which rations must be provided in advance for several days, an Italian colonel, M. Ravelli, has invented a biscuit forage, easily carried, which each horseman may conveniently pack (in quantity sufficient for two or three days) on his saddle. The Italian and French Commissions charged to examine M. Ravelli's biscuit are unanimous in formulating these conclusions:—The biscuit, suitably given, was consumed with appetite; it was easily digested; it produced no disorder in the system (the derangements noted in the case of two horses are not thought worthy of much consideration, as they may have arisen from other causes); and not only does the biscuit form a perfect nutrition for the horse, but it increases the vigour of the animal. It is recommended, however, to give the biscuit a more convenient form.

The action of the currents of electricity that pass round the earth may be conveniently exhibited to a large audience by the following arrangement, devised by Prof. W. Le Roy Broun:—A rectangular frame of light poplar wood is suspended horizontally by wires attached to the frame of a hydrostatic balance, its longer sides in the magnetic east and west line, and at right angles with the beam of the balance. About the perimeter of the frame are previously wrapped a number of coils of insulated copper wire, each extremity of the wire being made to terminate near the centre of one of the shorter sides; it is there passed through the wood, fastened, and cut off about 3 ctm. from the frame. The index of the balance being brought to zero point, the ends of the short terminal wires are immersed in two mercury cups for electrical connection. When the battery current is sent round the rectangle from east to west on the northern side, and from west to east on the southern, the northern side is attracted and the southern is repelled, and the corresponding deflection of the balance renders this plainly visible. When the current is reversed, the deflection is in the opposite direction. By breaking and closing the circuit at proper intervals, to augment the oscillations, Prof. Broun easily made the large frame oscillate through an arc of 5°. When the sides of the rectangle were placed N.E. and S.W. the current produced no sensible effect.

A popular drink among the Chinese consists of a solution in water of a powder obtained by pulverisation of hay, barley, or rye, or of all three together, with or without the addition of aromatic or medicinal herbs, after having undergone a certain amount of fermentation. The powder thus obtained is known under the name of "kin-tsee," and when properly prepared may be preserved two or three years.

In further researches on the temperature of flames M. Rosetti finds that while, with increasing pressure, flames grow larger, yet, even with considerable variations of pressure, they have, at corresponding points, nearly the same temperature. He examined Bunsen burners with the lower apertures stopped or open, fish-tail burners, and Wisnegg lamps; the maximum temperature was always about 1,340°. The large and the small flame in Bunsen's apparatus showed for reversal of the sodium line 1,200° and 940° respectively. In the flame of a stearine candle the temperatures of the separate layers were between 640° and 940°; in that of the Locatelli lamp, between 575° and 920°; of the petroleum lamp, between 780° and 1,030°. The maximum temperature of the alcohol flame was 1,180°. Variations of the specific gravity of the alcohol from 0·912 to 0·8225 had very little influence. Mixtures of ordinary coal gas and other gases were examined.

Erratum in "Astronomical Notes for July."—Page 386, paragraph 1, line 6, "Captain Jupman" should be Captain Tupman.

Expansion of Rails by Heat.—The high temperature on Wednesday week, which was about 130 in the sun at Wigan, produced an illustration on a large scale of the mechanical force of expansion by heat. On the London and North-Western Railway, between Wigan and Manchester, near Platt Bridge Station, the up-line to Manchester was found bulging for eight lengths in the shape of an S at one point, the metals and sleepers having been bodily moved nearly 2ft. The rails appear to have been set too closely, and on expansion under the sun's heat they were pushed out of place.

Feed Water Boilers.—A Memphis paper has the following:—"A clause ought to be added to the laws governing the running of steamboats on the Western rivers, and it should require them to be cooled down and carefully cleaned out at least once in five days during the season of high water. It is known to be a fact that the mud in boilers sometimes becomes so thick in a run from New Orleans to this point, that when the boilers cool down a stick will stand straight up in the mixture of mud and water therein; also that at times engineers are compelled to run a pole or rod up through the mud valve before the mud and water will run out after the valves are opened. Is it any wonder, then, that steamboat boilers explode? A strain such as is placed on a boiler required to generate steam to propel a heavy tow of barges up the Mississippi river against a four-mile current is very great, even when the water is comparatively free from the thick sediment and vegetable matter that settles in them after running so long a time without cleaning out. Half a dozen or more of the explosions that have happened in this vicinity during the past ten years may be safely attributed, not to a lack of water in the boilers, but to a surplus of mud. Require engineers to lie by after a proper time to clean out, and few disasters of this kind will be recorded." While the facts stated expose a frightfully bad engineering practice, the remedy is by no means to be found in a law, which directs certain things to be done. The blow should be struck at the root of the evil. Make it a crime to allow a boiler to explode, giving damages to those injured, punishing owners or engineers with imprisonment, and boilers will not explode; for engineers, firemen, and owners, know how to take care of boilers, and if they were to suffer personally for the results of their carelessness they would not be long in finding means for preventing explosions.—*The Iron Age.*

TERS TO THE EDITOR.

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not hold ourselves responsible for the opinions of pondents. The Editor respectfully requests that all ations should be drawn up as briefly as possible.]

munications should be addressed to the Editor of the MECHANIC, *31, Tavistock-street, Covent-garden,*

ques and Post-office Orders to be made Payable to ORE EDWARDS.

order to facilitate reference, Correspondents, when of any Letter previously inserted, will oblige by g the number of the Letter, as well as the page on ppears.

ld have everyone write what he knows, and as he knows, but no more; and that not in this in all other subjects: For such a person may e particular knowledge and experience of the such a person or such a fountain, that as to gs, knows no more than what everybody does, o keep a clutter with this little pittance of his, rtake to write the whole body of physicks: a vice nce great inconveniences derive their original." *yne's Essays.*

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RACULOUS APERTURE — THE LAST THING (THAT SHOULD BEEN ADMITTED) ON SUN-S — EYE-CUPS — FINDING A 'S LATITUDE AND LONGITUDE ITS R.A. AND DEC.: AND THE JLAR DISTANCE BETWEEN STARS, THEIR CO-ORDINATES G GIVEN—DIAPHRAGMS, WHICH ME—THE SUN AT A HEIGHT 5° — PSEUDOSCOPIC VISION — LING—THE GEOLOGY OF TUN-GE WELLS—DURATION OF SUN-E.

]—THERE is (what I can only presume to t wonderful misprint in the first paragraph zod's letter (14458) on p. 342, where he r is made to speak—of a microscope ob- having "an angular aperture of 230°!" king the lenses that an object should be in *n stuck on to the anterior one*, an angular of 180° *might* (theoretically) be obtained; oor Artemus Ward said, 230° is "too

at purpose letter 14479 (p. 367), with its g diagrams, was ever either written or I am wholly at a loss to conceive; as neither it nor they possess the htest scientific interest of any sort or n. As for the sketches, they are eless monstrosities; representing nothing seen in the heavens above, the earth r the waters under the earth. Amorphous ches on a black ground, put in almost at y eye estimation with a terrestrial tele- e really worse than useless; and in the the Astronomical subscribers to the MECHANIC, I protest against its precious g so utterly wasted as it is by these most gravings.

surely some error in reply 33127 (p. 377). it arises from the convexity of the cornea great already. To apply, then, an eye- ny other contrivance for increasing such —would simply be to aggravate the defect nded to cure.

epeatedly expressed my disinclination to ms; and were it not that a considerable lapsed since I replied in these columns to identical with those put by "Minn" (in 2, p. 379), I should certainly have con- self with referring your correspondent to volumes for the information which he it is, however, now some years since I ough a similar pretty little mass of figures, e for all recompute examples of the prob- hich he requires the solution, and hope nd others, will take good note of the d page in which my communicaion appears. y 1, 1879, then, the R.A. of *α* Arietis will 22·58s. (= 30° 5′ 38·7″), and its Declina- ′ 35·1″; the Obliquity of the Ecliptic on being 23° 27′ 22·88″—What will be the and Latitude of the Star? The actual is:—

R.A.	30° 5′ 38″·7	sin.	9·7002028
Dec.	22 53 35·1	cot.	0·3744054
	49 53 50·78	tan.	0·0746082
e add	23 27 22·88		
	73 21 13·66		

30° 5′ 38″·7	tan.	9·7630783
73 21 13·66	sin.	9·9814072
49 53 50·78	cosec.	0·1163096
35° 58′ 35″·1	tan.	9·8608851

Again—

	73° 21′ 13″·66	cot.	9·4756585
	35 58 35·10	sin.	9·7689725
Latitude	9 57 43·18	tan.	9·2446310

Now let us reverse the operation. Given the Longitude of *α* Arietis = 35° 58′ 35·1″; its Latitude = 9° 57′ 43·18″; and the Obliquity of the Ecliptic = 23° 27′ 22·88″, what are the Star's R.A. and Dec.?

	35° 58′ 35″·1	sin.	9·7689725
	9 57 43·18	cot.	0·7553690
	73 21 13·66	tan.	0·5243415
subtract	23 27 22·88		
	49 53 50·78		

	35° 58′ 35″·1	tan.	9·8608851
	49 53 50·78	sin.	9·8836005
	73 21 13·66	cosec.	0·0185928
R.A.	30 5 38·7	tan.	9·7630784

	49° 53′ 50″·78	cot.	9·9253918
	30 5 38·7	sin.	9·7002028
Dec.	22 53 35·1	tan.	9·6255946

If "Minn" will carefully study the preceding operations, he will be able to gather from what formulæ the methods of forming them are derived; and will see that the fact of an object being situated between the Equator and the Ecliptic can make no difference either in the details of the calculations, or in their ultimate results.

We will next find the distance between *α* Coronæ, R.A. 15h. 29m. 34·37s. and N.P.D. 62° 52′ 29·6″, and *μ* Sagittarii, R.A. 18h. 6m. 32·14s., its N.P.D. being 111° 5′ 25·4″.

The difference between the R.A. of the two Stars is 2h. 36m. 57·77s. = 39° 14′ 26·55″.

	39° 14′ 26″·55	cos.	9·8890187
	111 5 25·4	tan.	0·413[illegible]303
	116 28 28·39	tan.	0·[illegible]7470
subtract	62 52 29·60		
	53 35 58·79	cos.	9·7733649
	111 5 25·4	cos.	9·5561098
	116 28 28·39	sec.	0·3508597
	61 22 47·89	cos.	9·6803344

Therefore the stars in question are 61° 22′ 47.89″ apart. Your correspondent will see that, as N.P.D. is used throughout, the signs of the Stars' Declinations do not enter an element into the calculation at all.

I have read query 33257 (p. 379) over two or three times; but find it no more intelligible after the third perusal than it was upon the first. The object of putting diaphragms into a telescope is to prevent the internal reflections in the tube from reaching the eye end of it. In a properly-constructed eye-piece the whole of the field lens receives light from the object-glass, and the emergent pencil is smaller than the pupil of the eye. In what way these additional diaphragms can be supposed to improve the performance of such an eye-piece, I am entirely at a loss to imagine. I can only trust that Mr. Lancaster may be more successful in apprehending "Observer's" difficulty.

I may answer Mr. Shore (query 33269, p. 379) by telling him that the Sun is 45° high in London at Noon on the 6th of April and the 6th of September. Between these dates he is twice every day at an elevation of 45° above the horizon; but between April and June he gets further and further from the Meridian, as this particular elevation is attained. On the other hand, between June and September he begins to approach the Meridian again, and is finally, as I have just said, *on* it at a height of 45° on the 6th of that month.

There is an old, but interesting experiment, to which I have, I fancy, previously adverted in these columns, and which I would commend to "Mac" (letter 14509, p. 394) in connection with his pseudoscopic views of Lunar Craters. It is simply to take an ordinary signet ring, illuminate it by a side light, and view the crest, or coat of arms engraved on it, through a lens of an inch—or less—focus. At first sight the device will appear as it should do, in intaglio; but after a very short time will apparently rise above the surface of the stone, and stand out boldly in cameo. Probably, moreover, after a little watching, it will again appear to be sunk; only, however, after another interval again to rise into relief—and so on. The explanation of this curious effect lies deeper, I am convinced, than in the result of mere ocular fatigue.

I do not know whether it is necessary to caution "Argent Sable" (reply 33112, p. 400) that, presuming his dial to have been originally constructed for Latitude 52° 55′, it is useless for him to set it up in any other one. The edge of the gnomon must be rigidly parallel to the axis of the earth; and this obviously would not be the case were a gnomon forming an angle of 52° 55′ with the horizontal plane of the dial to be erected in, for example, Latitude 54° 20′. The thickness of the old gnomon may be determined by the interval between the two 12 o'clock hour lines; they being separated by a space precisely equal to it.

In reply to "A Tyro in Geology" (query 33307, p. 404) the rocks about Tunbridge Wells belong to the upper part of the Wealden Series. The Weald, as "A Tyro" may probably have heard or read, is the delta of an enormous river which debouched in (what is now) the South Eastern part of England. Fresh water shells and the remains of enormous reptiles are found in different beds of this formation; but fossils are very rare, or entirely absent from the series represented by the Tunbridge Wells rocks. Subsequently to the Wealden period, the entire series of deposits subsided, and was covered by the Chalk Ocean. Again, after a stupendous interval, some internal action forced the whole series of Wealden beds up through the chalk, a great deal of which was removed by denudation. Hence the physical geography of Kent and Sussex, with the Wealden sands and clays bounded by the North and South Downs of Chalk. There is a minor repetition of this structure in the Isle of Wight.

The method of determining the duration of sunshine, concerning which "Cl. Sy." puts query 33345 (p. 405), is exceedingly simple. An accurately ground and polished glass sphere forms, of course, an image of the Sun in its focus. Such a sphere, then, is placed inside of a basin turned to the radius of its focal length, and to the North interior of this basin is attached a strip of black ribbon divided into hours (*i.e.*, intervals of 15°) and their subdivisions. The action of this simple apparatus must be obvious. Whenever the Sun is shining it burns a minute hole in the silk ribbon, such hole becoming a line as the Sun travels in his diurnal path. When he is concealed by clouds, the burning ceases; and at the end of the day the ribbon is taken out and the burnt space measured: the time of sunshine being thus immediately deduced.

A Fellow of the Royal Astronomical Society

CASSEGRAIN REFLECTORS.

[14527.]—MR. FENNESSY, in his letter (14502) in your last number alludes to glass specula silvered at the back. Now, the celebrated optician, James Short, made several, but notwithstanding his consummate skill as an optician found great difficulty in figuring the two curves. There is one important point that Mr. F. appears not to notice—that it is absolutely necessary that the glass should be of the finest optical crown, which would greatly increase the cost of these specula, for, as the light has to be refracted through the glass and back again, any striæ or defects in the glass would be fatal to good performance. Another difficulty is the production of the double image caused by reflection from the front curve, and also the production of colour caused by refraction through the glass, but I have read somewhere that our present Astronomer Royal devised a plan by which these two last difficulties might be obviated, as well as the spherical aberration, but I am not aware whether this plan ever went beyond theory. Perhaps our obliging correspondent, "A Fellow of the Astronomical Society," could give some information upon this point. I happen to possess a disc of Chance's best 1in. hard white crown, 5in. in diameter, and am strongly tempted to try this winter when I have leisure, and attempt a speculum upon this plan, if I could obtain some information upon the subject. **T. Godfrey.**

DI-METHYL AND ETHYL HYDRIDE.

[14528.]—SOME of your readers do not appear to be convinced of the identity of di-methyl and ethyl hydride, but regard them as isomeric. If the production from di-methyl of ethyl chloride, from this ethyl acetate, from this ethyl alcohol, from this acetic acid, and from this silver acetate, be sufficient proof, such proof will be found in a paper of mine in the *Journal* of the Chemical Society, November, 1868.

With regard to the passage quoted from "Frankland's Researches," wherein he disputes the identity, a later opinion of his will be found in *Nature*, 1876, Vol. XIV., page 76. He there states that he "was mistaken," and the identity is established. Specimens of the products I obtained were sent from the Owens College to the Loan Exhibition of Scientific Apparatus. It was when speaking of them that Frankland admitted the identity.

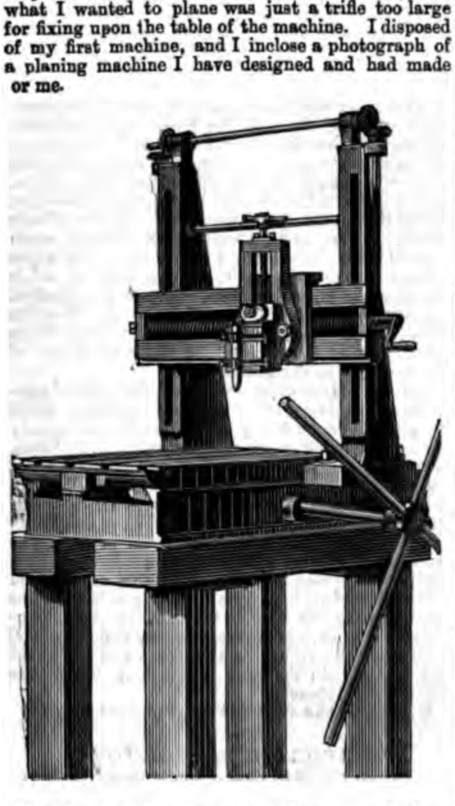
Wm. H. Darling

SUTLEJ BRIDGE.

[14529.]—COL. PEILE, R.E., writes from Murree: "I have just returned from testing the Sutlej Bridge. Sixteen spans erected in 6 months, two of them over 40ft. of water running 3 miles an hour." In a previous letter he says, "such a job is without precedent in India. The spans are, I think, 240ft. each, and were built, eight of them, by Westwood and Baillie, of Poplar, where I had the pleasure of seeing them in progress several times, and the remaining eight by a firm in the north, whose name I do not remember." **J. K. P.**

A PLANING MACHINE.

[14530.]—Some time ago I constructed a planing machine, but, like most amateurs, I made the mistake of making it too small. Although it did its work very well I was constantly bothered by finding that what I wanted to plane was just a trifle too large for fixing upon the table of the machine. I disposed of my first machine, and I inclose a photograph of a planing machine I have designed and had made for me.

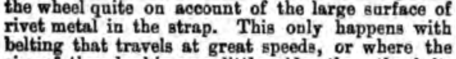


I find it to be very convenient for use, quite large enough, and yet not clumsy. It will plane 24in. long by 18in. square. I can take a cut in cast iron 3-16in. deep with 1·50in. feed. Until I had a planing machine I never appreciated its advantage, but found it at once helped me out of the difficulty all amateurs (and professionals, too) experience—that of filing work square, making a perfect fit, and producing a true surface. Many amateurs are really first-class turners, but they are almost always disappointed with their work when completed, as it is faulty from their inability to produce a correct surface by filing, but a planing machine overcomes this difficulty, and enables them to produce work surpassing anything that can be done by means of a file. I have a friend, who lives some twelve miles away, and although skilled in the use of the file he generally brings his work over to my house to do, finding that the time taken in travelling is more than made up by the amount and quality of work done by planing. Should any of your readers desire to see the machine I shall have great pleasure in showing it them, or will furnish any particulars they may require if they choose to advertise their addresses.

W. T. C.

THE PROPER WAY TO LACE A BELT.

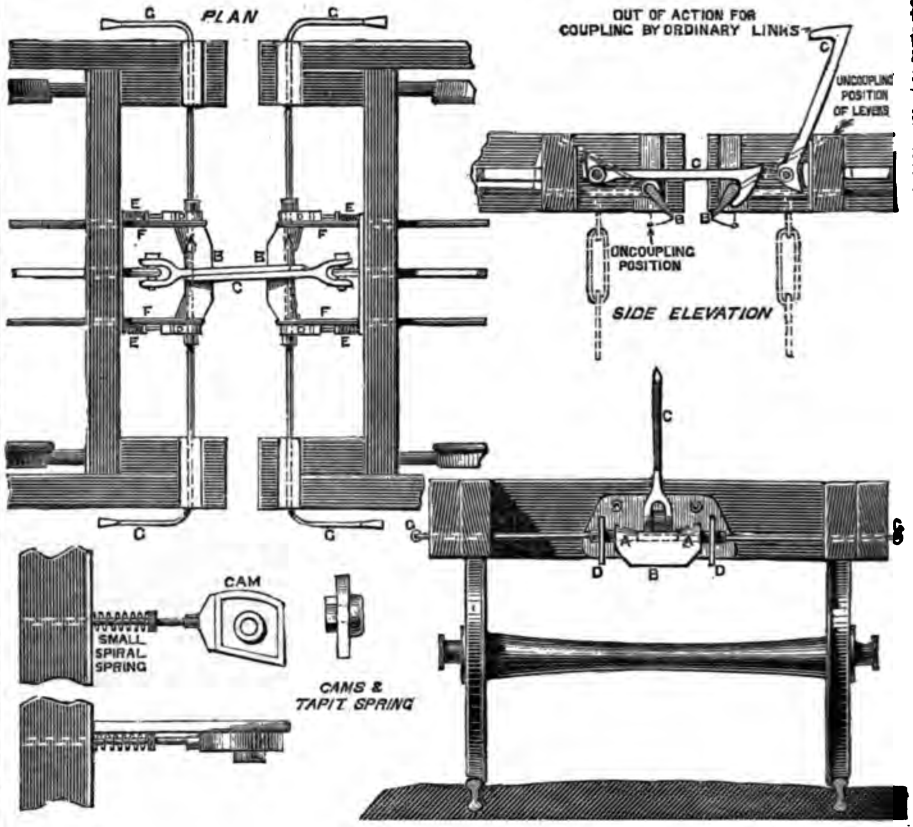
[14531.]—I was pleased to see the letter (14410) from "B.," p. 295, and, for many purposes I should prefer the mode therein described to using copper rivets or small bolts. My reason for so doing is, that when using rivets or bolts in any number the large heads of the rivets or bolts cause the belt to slip, and in many cases I have seen the belt fly from the wheel quite on account of the large surface of rivet metal in the strap. This only happens with belting that travels at great speeds, or where the rim of the wheel is very little wider than the belt. Now, if we use the plan "B." advised, it will be seen that the points of the nails clench into the belt; thus, very little, if any, of the metal will touch the wheel. For my own part I have not the least faith in using anything harder than leather for mending a belt. I will describe the best way I have ever seen, and I will warrant it will never give at the joint for years if done as follows:—Suppose the belt is 4in. wide, thin the ends, screw two pieces of the belt firm in the vice; take hold of one side of the belt in the vice at a time. Take a saddler's large awl, make a hole through the belt 2in. from the joint through the single leather, get a thin pigskin lace, draw it through, as per sketch. This is called single lacing. The stitches must be very close together—three or *four to the inch. In all cases the finer the better.* Pull the stitches tight, sew 2in. beyond the joint, put four rows of stitches in the join in the belt, and it will be there for years. A good bootlace would do to sew a strap for a small lathe. This plan differs from the old-fashioned one. Formerly was used a thick lace, long stitches, double sewing, and a punch to take the piece out with; in this case is used a thin lace, short stitches, single sewing, and an awl to make a hole with. This takes a long time to do, and the reason it should be adopted in all shops is, that it runs over a very small pulley as smooth as over a large one; the single stitches allow it to bend at the joint almost as easily as in any other part. Now, if the belt be riveted or bolted or double sewn with wax ends or anything else, it goes over a small pulley with a jump, as there is always a hard place at a joint when a strap is pieced like this: besides, every time it goes over a small pulley it strains the joint, and does the belt more harm than hours of hard work. By single sewing, as advised, machinery and belts will last much longer and run with much less noise.



Chelt.

HITCHINER'S RAILWAY COUPLING.

[14532.]—On Friday, the 22nd of February last, a most interesting trial took place at the Great Northern goods yard, King's-cross, of Walker's, Douglas's, and Harrison's railway couplings. They are designed to enable railway waggons to be coupled and uncoupled without a man having to go between them. At the trial the danger of uncoupling waggons in the ordinary way was clearly demonstrated to those present. I have lately had the opportunity of seeing another coupling in use. It is the invention of Mr. Hitchiner, and is simple in construction. I have found it to work well in practice, and not to get easily out of order.



A, horizontal shaft, on which are placed an angle plate, draw bars, tappet springs, and cams; to this shaft is also fastened the levers for coupling or uncoupling. B, malleable iron plate, set at an angle of 60°, so as to form a face for the hook to slide upon on coming into contact with it. On either side of this plate there are shoulders tapering down to the same facing as the centre part of the plate. In the event of the coupling hooks falling on these shoulders, they slide down till they come side by side. C is the hook, or coupling, the face of which is set at an angle of about 50°, so that it easily mounts the inclined plate. The jaw part of the hook is allowed considerable play, in order that when two hooks come in contact they fall side by side, and also to allow transverse movement on curves. The same part is also provided with a nib, or brought to a taper point on both sides of the jaw, so that when it is necessary to couple a waggon by the ordinary links the hook is lifted up till this nib, with the action of the draw-bar spring, keeps the hook from coming in contact with the chains. D is a cam, with a [illegible] fastened on the shaft, A [illegible] plate is in a coupling position or not, these faces are in their respective positions. Against these faces a tappet spring, marked E, acts, which is also supplied with a facing, so that in any position of the lever the plate is held firmly, thereby making it very useful for shunting. F is a draw bar on each side of angle plate, fitting on the shaft, A. GG are levers for coupling or uncoupling.

It will be seen that the carriages or trucks will couple themselves on contact without assistance, and can be coupled from the side with facility. By turning the plate, B, waggons can also be driven together without coupling, as required for shunting, thus accomplishing some of the work most dangerous with the common link coupling. Much injury to goods, cattle, and rolling stock, results from the slackness of the coupling, and though some of this is purposely left to facilitate starting, the injury can be reduced with the coupling illustrated, as the space between dead buffers is only sufficient to allow for curves, and in spring buffers the springs are slightly compressed in the act of coupling, thus making a connection approaching that of a passenger train.

I understand that six waggons are to be fitted with the apparatus for the purpose of being tested in actual practice, and to ascertain the cost of maintenance.

June 18th. C. E. S.

MIDLAND ENGINES—MIDLAND v. M.S. AND L.

[14533.]—I am obliged to "C. E. S.," page 290 (14393) for his information respecting the Midland express bogie engine. I must apologise for not acknowledging it before, but this is my first opportunity. I agree with "C. E. S." that Mr. Johnston's style of chimney is a great improvement in the appearance of the engines. During the last few years there has been quite a revolution in the designs of locomotive chimneys. The tendency has been to make them appear too stiff, with but little ornamentation about them. My idea is that a chimney looks far better with graceful curves both at the top and bottom.

"W. J. S.," page 315 (14433), states (under the heading of "Single v. Coupled Engines," that the L. and N.W. would have continued running at their own rate of speed between Manchester and Liverpool, "but for the Midland coming forward and running trains in 45 minutes." Allow me, sir, to supplement what was said by your correspondent, "Finem Respice" last week, p. 341, and say it is not the Midland, but the Manchester, Sheffield, and Lincolnshire Co. that is running the service of hourly express trains between Manchester and Liverpool, over the Cheshire lines route viâ Warrington, and have done so since the line was opened on July 7th, 1877. The distance by this route is 35 miles, while the L. and N.W. route, viâ Newton, is 31½, and although the L. and N.W. professed to run the distance in 50 minutes, the trains could not get in to time, I suppose owing to the crowded state of the line. On the other hand the Cheshire lines trains are frequently in before time.

As many of your readers are no doubt aware, this is only a portion of the C. L. C. line. They also run to Chester viâ Knutsford and Northwich, as well as the local traffic of Stockport and Altrincham, &c.

I am pleased to see the remarks of "L. L." on this subject in No. 691.

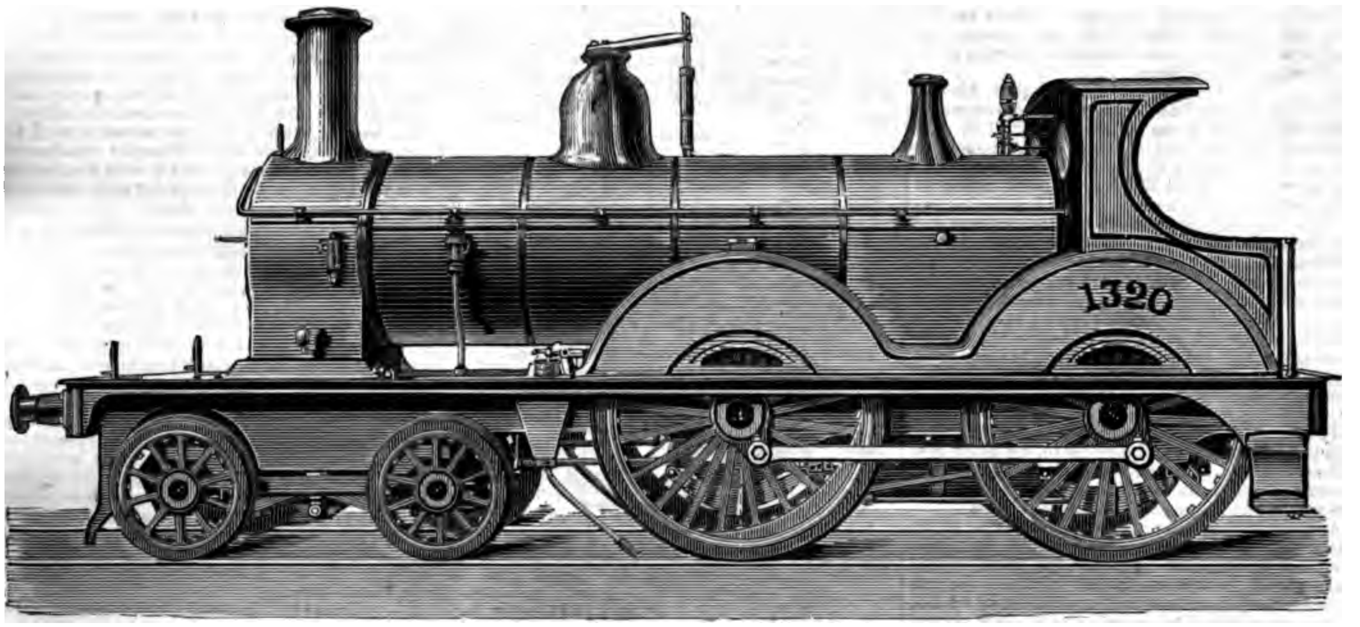
For the sake of clearness, it may be as well to say the Midland Company do run trains from Liverpool over the new route as far as Glazebrook, where they turn off to join their own line at New Mills, viâ Stockport and Marple. Probably this is how "W. J. S." got the idea of the Midland running to Manchester.

All the C.L.C. trains are worked by M.S. and L. engines, just as the Manchester, South Junction and Altrincham line is worked; but with this difference: instead of the M.S. and L. having a share in the working they simply supply the locomotive power. The engines are four coupled tanks, with outside framing, and small leading wheels. The tank is at the back. The engines (which have a short wheel base) are turned at the end of each trip—viz., at Bowdon and Oxford-road on a table the size of an ordinary carriage turn-table, placed at the end of the platform line for the purpose.

June 21. R. N. H.

MIDLAND BOGIE ENGINES.

[14534.]—I HAVE great pleasure in sending a photograph of one of the Midland bogie engines which the Editor has kindly promised to have engraved for the ENGLISH MECHANIC. The cylinders are 17½in. in diameter, and the stroke is 26in. The boiler, which is 4ft. 2in. in diameter and 10ft. 5¾in. in length, contains 223 tubes, whose external diameter is 1¾in. Heating surface of tubes, 1,115 sq. ft.; fire-box, 110 sq. ft.; total, 1,225. The driving and trailing wheels are 6ft. 6in., and the bogie wheels 3ft. 3in. in diameter. Total wheel base, 21ft. 6in.; length over buffer beams, 29ft. 4in.; weight on bogie wheels, 13 tons 10cwt.; on driving wheels, 14 tons 10cwt.; on trailers, 12 tons 7cwt.; total 40 tons 7cwt.



I should be much obliged to "C. E. S." if he would tell me where Midland engines, Nos. 1288, 1297, 1298 are stationed, and what section of the Midland line they run over mostly.

In my letter (14493, p. 372), M. and L.R. Co., should read M.S. and L.R. Co.

I forgot to mention that 1320 is now fitted with the vacuum brake.

June 21. L. L.

SINGLE v. COUPLED ENGINES.

[14535.]—THE letter of "L. L." seems very fully to confirm my own observations on this head (letter 14483, p. 315). I am obliged for the emendation pointed out as to the ownership of the line from Central Station, Liverpool to Manchester. The Midland and Great Northern, both running trains therefrom, the line is currently adverted to by either name owing to their joint interest with the Cheshire lines, "C.;" but the facts still bear out my statement about the London and North-Western. Granted there were one or two trains daily doing the distance in 50 minutes, or 39 miles per hour, that was nothing remarkable by the side of the Cheshire lines, "C.," doing it hourly—not 31½, but *36 miles* by their route in 45 minutes, so that the London and North-Western could still, if they chose, take the lead in time by their shorter route.

Apropos of this matter, the fares were considerably reduced on the opening by the—what shall I say?—Cheshire lines, "C.," and, so reluctantly on that matter, also caused a similar concession of the London and North-Western. "L. L." thinks I am hard on the London and North-Western directorate, but I am glad his own letter corroborates my opinion, where he says "all the London and North-Western trains between Manchester and London" (and, for the matter of that, London and Liverpool, &c.) "could be accelerated without taking off any of the stoppages"—*e.g.*, the 10 a.m. from Euston gets to Crewe at 1.36, and allowing, as with some other trains, one hour for the run from there, *viâ* Runcorn to Liverpool, might easily be timed to reach Liverpool at 2.45—35½ miles—instead of as at present 3 p.m., which even then would not be as good as the timed speed to one of their minor trains, the 3.5 p.m. from Crewe, running to Warrington, 24½ miles, in 31 minutes, or 47 miles average per hour, and I do not think it is generally noticed that none of the London and North-Western "crack" trains surpass the speed of their 5.15, or newspaper train, which, though having frequent stops, runs between stations (*e g.*, to Blisworth) over 47 miles per hour. My trip with Penrith Beacon was about 19th or 20th July last; I only caught the train through it being 12 minutes late at Crewe, and I noted the following times: Crewe, departure 4.48 p.m., arrival 6.7; Nuneaton, 61 miles, departure 6.9, arrival 7.46; Willesden Junction, 152½ miles, arrival 8.1; Euston, 158 miles.

I observe the engine selected for running the Royal train to and from Balmoral is Candidate, one of the Precursor class, 5ft. 6in. coupled wheels; the speed is not high—at most 42 miles per hour. Hardstaffe, the driver, tells me they are preferred for the North road and its heavy gradients, for their uniformity of speed up and down banks.

In letter 12422 "C. E. S." says the only London and North-Western engines which can do the "15-coach test" are these Precursor class, "giving a tractive force of 105·091b." I should feel obliged by learning whether Webb's Precedent, or 6ft. 6in. class, do not also come up to this standard. Several of the drivers have related to me runs which would show they had done this, and the only complaint was that in several the blast pipe was too narrow, and they did not make steam freely, but in the most recent this had been remedied.

June 21. Wm. J. S.

[14536.]—I HAVE read with interest the letter of "L. L." (14493, p. 372), and agree with much that he says respecting the Manchester express trains on L. and N. W., G. N., and Midland lines; but when he states broadly not only that "the L. and N. W., having the direct route, have no need to attain such high speeds as the G. N.," and that they average 4¾ hours, with several stops between London and Manchester, but that "they do not run nearly so fast between stations as the G. N.," I must ask is not this rather too strong a statement? To show reason for the question, I give the running (*a*) of the 4 p.m. express Euston from Willesden to Rugby, 77½ miles, and (*b*) that of the 2.45 express King's Cross from London to Peterborough, 76¼ miles, in each case without stop, omitting some of the small *stations* near London on the G. N., to bring out a better comparison of the trains on the distances traversed:—

(*a*) 1876, September 8
Engine 667, L. and N. W.

		p. m.		speed.
	Willesden	4 $14^{1}/_{2}$	leave	
2¼	Sudbury	4 19	pass	33·333
5¼	Harrow	4 $23^{1}/_{2}$	,,	43·333
7¾	Pinner	4 $26^{1}/_{12}$	,,	46·451
10½	Bushey	4 $29^{1}/_{2}$	,,	48·292
12	Watford	4 $31^{1}/_{12}$	,,	56·842
15½	King's Langley	4 $35^{1}/_{4}$	,,	50·4
19	Boxmoor	4 $39^{5}/_{12}$	,,	50·4
22½	Berkhampstead	4 $43^{3}/_{4}$	,,	48·461
26½	Tring	4 $48^{7}/_{12}$	,,	46·551
30¾	Cheddington	4 $53^{7}/_{12}$	,,	54
34¾	Leighton	4 $57^{1}/_{2}$	,,	61·276
41½	Bletchley	5 $4^{1}/_{4}$	,,	57·777
46¾	Wolverton	5 $10^{5}/_{12}$	,,	53·513
54¼	Roade	5 $20^{1}/_{2}$	,,	46·115
57½	Blisworth	5 $24^{1}/_{3}$	,,	46·956
64	Weedon	5 $32^{1}/_{12}$	,,	50·322
69¾	Crick	5 $39^{2}/_{3}$	,,	45·494
77¼	Rugby	5 50	arrive	43·548

(*b*) 1877, April 12.
Engine 7, G.N.

		p. m.		speed.
	London	2 45	leave	
2½	Finsbury Park	2 51	pass	25
5	Wood Green	2 $54^{1}/_{2}$	,,	42·857
6½	Southgate	2 $56^{5}/_{12}$	,,	46·956
9¼	Barnet	3 $0^{3}/_{4}$	,,	38·076
12¾	Potter's Bar	3 $6^{1}/_{4}$	,,	38·590
17¾	Hatfield	3 $12^{1}/_{6}$	,,	50·704
22	Welwyn	3 $17^{7}/_{12}$	,,	47 076
28½	Stevenage	3 $25^{1}/_{3}$	,,	50 32
32	Hitchin	3 $28^{3}/_{4}$	,,	60
37	Arlsey	3 $33^{5}/_{6}$	,,	60
41	Biggleswade	3 $38^{1}/_{4}$	,,	54·339
44	Sandy	3 $41^{1}/_{2}$	,,	55·384
47½	Tempsford	3 $45^{1}/_{12}$	,,	58·604
51¾	St. Neot's	3 50	,,	51·864
55¾	Offord	3 55	,,	48
58¾	Huntingdon	3 $58^{1}/_{4}$	,,	55·384
69¼	Holme	4 $9^{3}/_{4}$	,,	54·782
76¼	Peterborough	4 19	arrive	45·405

Thus, I think, we see that, though the advantage be on the whole with the G. N., both must, where they have the ground in their favour, get over it as quickly as may be, that speeds of upwards of 50 miles per hour are to be found between stations as well on one as the other, and therefore that "L. L.'s" statement is a little too strong.

The 861-871 class, working the Manchester newspaper train, are stationed at Rugby. They do not return sooner owing to one of the London return engines having to bring up the train preceding theirs—at least, this was the case recently. Itzaex.

CONTINUOUS BRAKES.

[14537.]—I NOTICE in many of the letters on continuous brakes an inclination to point out imaginary defects in the Westinghouse brake. I can well understand that my countrymen are chagrined at being beaten by an American; but I think it would be better to beat him fair and square than to pick holes, which serve only to let the picker through. Will not some of the companies place at the disposal of the rival inventors a few miles of double line, so that the brakes can be tried side by side and under the same conditions? I note that in the experiments which Mr. Sanders has sent you, he has taken as a comparison, trials of the Westinghouse made in December, while his were made in July ; but he does not say in what manner the times and distances were taken. On p. 575 of your XXVth volume, speaking of these two experiments made with Sanders's brake, you say, pointedly, that "on the journey in question two stops were made in a very effective manner, but the figures given are of course beyond comparison with the authentic records of the competitive trials of some of the rival brakes." No one, I presume, would charge any engineer or official with intentional understating of the figures, but mere estimates (pace Messrs. Barker) are not quite so accurate as actual records. On the page quoted I find that the stop from a speed of 53 miles in 223 yards was on a rising gradient, and also that there was "nothing remarkable in the stop, as a stop, compared with the performances of others." I should like to see Mr. Sanders beat Mr. Westinghouse, but I am afraid the vacuum principle is out of the running when compared with the pressure. I should like to hear of a good trial between the Sanders and the Westinghouse brake. Surely there ought to be no difficulty in arranging one. Will Mr. Sanders challenge?

Nun. Dor.

[14538.]—It would seem from "C. E. S.'s" last letter, p. 371, that he still refuses to acknowledge his error in describing our hydraulic brake as now in use on the Midland to be the same as the one tried at Newark. He has evidently made up his mind that it is the same, and refuses to accept our statement that it is not, as worth anything.

His proof is, he says, that the carriages fitted with the brake are numbered the same. This is not the case; but, even if it were, it is, we suppose, just possible to change the arrangement of a brake without changing the carriages.

Again, says "C. E. S.," Mr. Barker himself pointed out to myself and others the improvements in the train since it ran at Newark. "C. E. S.," therefore, has seen the improvements, though he still persists in saying the brake is the same. But now we come to "C. E. S.'s" great point, which we quote verbatim :—"The only excuse for the contradiction of my facts is that one of these engines and two carriages have gone away from Bedford to be repaired, but they will have returned before this letter is in print." We thought somehow that the question between us was whether Barker's brake is the same now as at the Newark trials ; but when we read this sentence first we experienced a doubt as to whether we had not been writing quite away from the point, and laying ourselves open to "C. E. S.'s" close and persistent logic. But we can only conclude "C. E. S." is joking.

To "C. E. S.'s" statement that one of our firm was present at the trial he refers to, we must give a distinct denial. The only official trial ever held, to our knowledge, on the Midland Railway, was the one whose results we published in the *Times*.

Apropos of the discussion on Capt. Tyler's paper, "C. E. S." may perhaps remember that the chairman first of all ruled that only the Westinghouse brake should be mentioned, and the discussion was to be confined to the abstract qualities of all brakes. It was after Mr. Harris had spoken that several gentlemen treated the society to a "puff direct" of the inventions they were connected with.

Perhaps it would end this controversy if "C. E. S." were to make a personal examination of our train. We shall be happy to afford him the opportunity of a run with it, and will estimate the speed and distance for him with an indicator designed for the purpose.

A public trial we cannot bring about, but our brake is open to the inspection of the public, and as one of the public, and an impartial person, we invite "C. E. S." to observe its working. In a short time our automatic arrangement, which complies with all the Board of Trade conditions, will be at work on the Great Eastern Railway. We shall be equally ready to assist "C. E. S." in informing himself of the working of this invention.

45, Bedford-row. **Barker, Harris, and Co.**

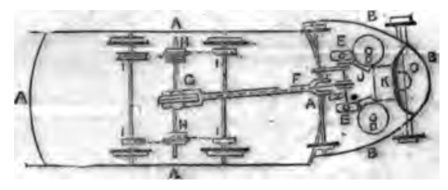
INTERFERENCE OF SOUND IN TRAINS.

[14539.]—Mr. W. John Grey need not fear that he labours under an illusion regarding the noise he perceived. I am almost sure the noises in a train are more in number and greater in intensity than those which Börne heard 40 years ago in a Frankfort postchaise, in which he counted about a dozen distinct different noises. These noises, I venture to say, can entirely be avoided except the clapping of the wheels on the uneven rails, and that of the engine. It is a fact that the noise is greater on the tail, and through the engine on the front also. But it is not interference with the sound-waves which would keep the middle part comparatively quiet. Beside these noises the vibration and knocking are different in each carriage, which is due to its relative position in the train, or its construction, or whether we sit in a neutral segment or a node. A train when in motion differs in nothing from a vibrating string, on which at certain intervals weights are fastened. Therefore a wave created at any part of the train must of necessity run along to the end, and, this being free, the amplitude of the wave increases : hence the greater noise on the ends. Trains, especially fast trains, ought to be arranged in length and weight so that harmony in vibration or swinging is impossible, to prevent a part of the train leaving the rails, to prevent it from vibrating or swinging in such a manner as to impede its speed, to prevent great wear, and for the greater comfort of the passengers. Look at the carriages. They are built like an ordinary stationary building ; nothing meets the eye which would imply a meaning that it had been done to avoid noise—not even the wheels are in the position where they ought to be. But that is no wonder. Acoustics are not an essential part of the study of a railway engineer or that of a station-master. A carriage-builder ought to study acoustics as much as a musical-instrument maker—the former for decreasing, and the latter for increasing the vibration. The only consolation I have is the hope that my ideal institution will soon spring up, wherein all will diligently study the law of vibration. **J. H. Schucht.**

[14540.]—I think the phenomenon that Mr. W. J. Grey mentions, in letter 14478, page 367, about the noise of the passing train diminishing at the middle and increasing in intensity at the end, is due simply to the fact that the guard's brake van being a somewhat heavier carriage necessarily makes more noise, in conjunction with its being a hollower carriage than those for passengers. I have frequently noticed in passing a good long passenger train, where there are often one or more brake vans in different parts of the train besides at the end, that the noise grows louder as many times as there are brake vans ; hence my reasons for supposing this to be the cause of the phenomenon for which Mr. Grey seeks an explanation. **Wiseaf.**

MECHANICAL POWER ON STREET TRAMWAYS.

[14541.]—In answer to letter 14469 of "A. W. E., if he will refer to the following sketch he will perhaps find something new, and that I do not adhere to the type of combined engine and car. But having taken particular notes of what was required, have thought it out thus :—A A A A being the outline of body of car ; B B B, outline of bogie, with, C, receptacle for coke ; D D, boilers ; E E, engines ; F, splinter bar, or pole, hinged upon bogie, and hinged upon an articulating wheel for a pitch-chain mounted on a counter shaft to centre of car ; H H being four smaller pitch-chain wheels, from which the dotted line to I I I I being four more pitch-chain wheels ; J J, fire-holes to the way to fuel ; L, toothed wheels for moving bogie and engines about when disconnected, not used when coupled up to the car. Now the power is upon the car the engines are coupled upon one shaft-crank at right angles driving a pitch-chain wheel, either cast upon it solid or keyed upon it, driving a pitch-chain up, G, and the power transferred from H H on the counter-shaft to I I I I, coupled up double or single, which will be in a line under the seats. This can be disconnected by taking the pin out of fork, F, connecting it with the bogie and a pin out of pitch-chain, and the engines are detached ; throw it into gear at L, and your engine can move itself off. The power I reckon required, or rather more—the idea I have in this thick head of mine—is two boilers 16in. dia., 5ft. 6in. high, worked up to 200lb. ; two cylinders 4in. dia., 10in. stroke ; pitch-chain wheel upon crank-shaft, 6in. dia. ; driving one upon counter-shaft, 12in., that is the articulating wheel ; small ones upon counter-shaft, H H, 6in , those for the traction of car upon car-wheel axles, 12in. Perhaps you can see the advantage of this arrangement in all its bearings. The car, you see, actually propels the engine, and with lightness, the traction power always equal to your load upon car, easily applied to all the existing cars if one should become a cripple, easily detached, easily coupled up, able to turn any curve or cross points. Pitch chain I had forgot for size, outside links ¼in., centre links ⅜in., pins ½in., pitch 2¼in. Front wheels of bogie upon a lock, steered with tangent wheel and screw. The pitch line is given for the wheels. **Beaver.**



[14542.]—I am very glad to see that the subject of "tramways" has been brought before the readers of the English Mechanic by your able correspondents. "A Tr ," and "A. W. E. ;" also by your very interesting article upon page 355. I have for a long time past watched the progress of tramway engineering, and there cannot be a doubt that tramways will, in a few years' time, be laid down in all large towns, and also that they will be extended to hundreds of suburban villages which at the present time are very inadequately supplied with means of communication with the adjacent town or railway station.

We frequently hear it remarked that "tramways are nothing but small railways, and that the tramway engineer has only to copy what has already been done upon railways." To a certain extent this is true. Tramways are small railways, but there is a great difference in the permanent way, the mode of working, the speed, and a number of other minor details.

It is these differences which at the present time require the most careful attention and study. And the most important part of the subject is the question of mechanical power for propelling tram cars. I have repeatedly found that the first question the directors of a tramway company ask is, "will it pay," to use steam or other engines in place of horses. Mechanical power upon tramways being comparatively new, the necessary data has not yet been conclusively proved from which the exact cost can be ascertained. What is now required is that a series of comparative experiments should be made, in order to show the total cost of working a tram car for a certain number of miles—by horses, and by an engine. Of course, taking into account the first cost—working expenses, and the cost of maintenance and renewals. As soon as this data has been obtained it will be a very easy matter to determine whether tramway engines will pay.

Speaking from my own experience, I am of opinion that, where a tramway is nearly level, an engine will never be able to supersede a small tram car drawn by one horse. Where the gradients are severe and necessitate the use of two or more horses, there is no doubt that engines can, and ultimately will, be used with very great advantage. I have been present at trials and experiments with tramway engines, at all of which it was clearly demonstrated that there is a great difference between the *animal* and the *mechanical* horse power.

A person unacquainted with the subject would very likely imagine that, as one horse can start and run with a car, a small engine of two-horse power would easily do the same work. In practice this would be found to be a most erroneous idea. The select committee appointed to inquire into the subject of mechanical power on tramways gave special attention to this fact. Experiments were made, and evidence given to explain the reason why one horse will do more work than an engine of the same horse power. These experiments prove that, at starting, a horse can exert for a few seconds a power of about 440lb., or even more, but in ordinary work about 160lb. to 165lb. is the power exerted. It will therefore be at once seen that, if an engine is constructed to exert the ordinary power of a horse, it will entirely fail to exert the extraordinary power of 440lb. This makes the fact clear, that if an engine is to do the actual work done by a horse, it must be powerful enough to overcome as great a maximum resistance as the horse.

The want of attention to this fact has caused several engines to fail to perform the duties required of them. It, of course, must always be remembered that the engine has to propel itself in addition to the car. There is also another part of the subject which I will mention before concluding my letter—it is that of the "resistance per ton." In last volume, page 121, I explained the resistance of trains upon a railway. The constant resistance in ordinary working is 12lb. per ton upon a railway. I have lately made some experiments with a view to ascertain the constant resistance upon a tramway. A railway carriage runs upon a clean rail, has coned wheels, and the necessary lateral play ; whereas, a tram car runs upon a grooved rail, which is frequently nearly full of mud and dirt. If coned wheels are used their action is nullified, as the narrow grooves do not allow the necessary lateral play. I have found that the constant resistance which on a railway is 12lb. per ton, on a tramway is often 24lb. per ton ; and on curves, and at a speed of six miles an hour, I have known the total resistance to be as great as 50lb. per ton.

There are numbers of other details which require consideration, but the length of my letter will compel me to postpone them until a future time. In conclusion, I may mention that I consider steam is the best mechanical power for tramways, and also that the engine should be separate from the car. There is no doubt, whatever, that as soon as an Act is passed permitting the use of mechanical power on tramways, engines will be constructed capable of performing all that is required, and also of fulfilling all the necessary conditions and restrictions. The Select Committee has made its report, and the following cutting from the *Times*, of Friday, June the 14th, gives a very good epitome of it. And it is quite expected that next session an Act will be passed in accordance with the recommendations contained in this report :—

'STEAM ON TRAMWAYS.—At the commence- ntof the session a select committee was appointed consider under what conditions (if at all) the use steam or other mechanical power may be thorised upon tramways, and to draw up regula- ns which should govern the use of steam or other chanical power upon such tramways. All tram- y bills introduced this session were referred to m, and after hearing evidence on the matter,)pting the principle that steam might advanta- ously be used on tramways, the committee inserted uses and regulations in such bills, whereby the of such mechanical power should be regulated. committee have made their report, which has t been printed. Therein they show (1) that it is expedient to throw impediments in the way of use of other than animal power on tramways; (2) that it is necessary to take such securities ire warranted by the novelty of the undertaking; that the local authorities are the best judges as rhether the use of steam should be allowed, and ; they should have power to make contracts and eements with promoters, but that (4) power ild be given to the Board of Trade to intervene)ehalf of the public to prevent undue pressure g put by local authorities upon promoters, and revent bargains being made injurious to the lic as residents or ratepayers. They also suggest the contracts should be renewable every seven s, and that provisions should be made for a)dical revision of tolls. All differences between local authorities and the promoters are to be ect to an appeal to the Board of Trade, and it commended that pending such appeal the Board ild have power to order the discontinuance of m on such tramway as is the subject of dispute. the purpose of securing interchange of traffic of preventing undue preference, it is recom- ded that the Railway Commissioners should have same jurisdiction for those purposes over tram- s as they now exercise over railways. They think that the Board of Trade might well be isted with the power to grant licenses for the rimental use of steam. The committee also prepared suggestions to govern the use of n, to provide for the safety of passengers and for ecurity of the general public, which they recom- d should be framed into bye-laws by the Board, to be of general application. The suggestions led to, however, are not set forth in their re- , but they embrace, among other matters, ral speed, speed at facing points, use of bells or tles, stoppage at intersection of streets, emis- of smoke, and protection of passengers from hinery."

ıne 26. **C. E. S.**

(*To be continued.*)

GNESIUM--REFRACTION OF SOUND ADULTERATED WHITE LEAD — RSENICAL VIOLET POWDER, &c.

1543.]—The only way in which "Ignoramus" ry 33297, page 404) could succeed in storing up nesium in a vaporous state would be by keeping a white-hot, air-tight vessel.

. H. Davies (query 33275, page 403) will find a concave sound lens can be made by securing pieces of bladder or thin indiarubber to rings d parallel to each other, and joined round the , so as to make a cylindrical vessel. This must lled with carbonic acid gas, and slightly ex- ted, when the surface will become concave. A a simpler plan is to use a balloon of hydrogen. uis case you have practically a concave lens of uch a lens will cause sound-waves to diverge. answering a question on "Adulterated car- e of lead" (query 33228, p. 403), A. E. Menke s great nonsense. He seems, first of all, to be are that oxalate of barium is insoluble in ; and, secondly, that sulphate of barium (the in which that metal is certain to occur in white is insoluble in hydrochloric acid. The querist nd the method given by A. E. Menke suitable e detection of calcium compound such as chalk plaster of Paris. Any sulphate of barium es, or Spanish white) will be left behind on dis- g the sample in dilute nitric acid.

. P. G.," of Harcourt House, Anerley, also rubbish in his reply on page 402 to a query on tection of "Arsenic in Violet Powder" (No.). He might gently heat water containing powder in a tube open at both ends (if it were impossibility) until it was dried up, and he l get none of the arsenic to sublime. The best are given by "J. M. W." in the previous reply. P. G." also goes out of his way to praise the of oxide of iron as an antidote for arsenic. ry well when the arsenic has been swallowed in ity; but that is not the usual way of employ- iolet powder. There can be little doubt that rsenic got into the violet powder purely by ent, and there is little cause for future alarm. he other hand there is a good deal of violet ler sold containing a considerable proportion of tallised sulphate of calcium, which I can under- d would be very irritating to the skin.

I hardly understand what the discussion headed "Chromium" is about, or what proof the facts mentioned are of the decomposition of bichromate of potassium on solution. I should consider that the very fact that $K_2Cr_2O_7$ crystallises out again is against the theory of decomposition. When anhydro-sulphate of potassium ($K_2S_2O_7$) is dissolved in much water and evaporated, it cannot be recovered, being converted into $KHSO_4$; but no such reaction occurs with the anhydro-chromate. As I pointed out on previous occasions, there is absolutely no evidence of the existence of H_2CrO_4. Other acids, when not obtainable in a free state, form acid-salts containing basic hydrogen; but there is no such chromate known. All the acid chromates are anhydro-chromates, containing the elements of a neutral chromate, plus CrO_3.

In letter 14315, page 220, Mr. Albert Smith wrote: "For the determination of water in lard, 100 grains should be taken and gently warmed until it ceases to lose weight." Asked why he supposes gentle warming would suffice, it appears that he employs a temperature above that of boiling water, and stirs with a thermometer all the time. His last described process is satisfactory. Another plan is to weigh out 500 or 1,000 of the lard, introduce it into a long graduated tube, which is then immersed for a short time in hot water. The lard melts, and any contained water settles to the bottom, and may at once be measured, and its weight thus ascertained. This plan was described by me in the ENGLISH MECHANIC for Oct. 11th, 1872. Mr. Albert Smith should be obliged to me for calling attention to the error by which the oil in mustard was stated in his article at 25 per cent. The amount he now gives—*i.e.*, 35 per cent., is strictly in accordance with my experience—indeed, I have published a method of determining the proportion of admixture in mustard based directly on that fact.

"Daghbert" (query 32768, p. 175) will find "chloride of manganese" is best purified by taking a portion of the crude liquid (say, 1·10), and precipitating it by boiling with carbonate of sodium. The precipitate of carbonate of manganese is washed and added to the main solution of $MnCl_2$. On boiling the $MnCO_3$ precipitates the iron, alumina, &c., and thus pure $MnCl_2$ is left in solution. It will retain any calcium originally present, and this is not readily removed. If the solution was very acid, a larger proportion must be treated with sodium carbonate. From the solution of the pure chloride, MnO_2 may be precipitated by diluting, adding ammonium acetate and excess of bromine, and then gradually heating nearly to boiling. If sodium acetate be used instead, the precipitate is contaminated with alkali. From the solution of pure manganese chloride, the solid salt can be obtained by mere evaporation to dryness. No ignition is required.

For "Making Pure HCl" (query 33087, p. 302) there is no occasion to purify the salt. Take 4lb. of table-salt in lumps (not powder); make a mixture in earthenware of 70 fluid ounces of sulphuric acid (free from arsenic) and 42 fluid ounces of water. Let the mixture become quite cold, and then pour it on the salt previously placed in a glass flask. Little gas comes off in the cold. You cannot get Na_2SO_4 in glass apparatus. The absorption in water occurs very readily. None passes until the liquid is almost completely saturated. But acid of 1·11 sp. gr. is the most convenient for use, as it does not fume. The saturated liquid is but rarely required.

For the detection of the "Adulterations of Coffee" (query 33239, p. 379) the microscope is invaluable. A high power is not requisite. Chicory may be detected pretty certainly by strewing some of the sample on some cold water. The coffee does not readily become wetted owing to the oil in it, but the chicory sinks to the bottom, colouring the water on its way. The sunken portion should be removed, boiled in water, and examined under the microscope. The solution in water should be cooled thoroughly, dilute sulphuric acid added, and then permanganate, until the brown colour is destroyed. Addition of iodine solution will then show starch, the presence of which may be due to cereals, beans, acorns, &c.

"A Very Old Subscriber," query 33241, p. 379, will find full information about tea in the articles I recommended to Mr. Clemcats on p. 369. A reliable method for the detection and determination of glycerine in complex organic liquids is still a desideratum. I have tried several very carefully, but without much success. A method recently published, and of which I have no experience, is the following:—Evaporate 300 cc. of the beer down to 100 cc., and shake with 200 cc. of petroleum ether. The upper layer is removed and the aqueous liquid again shaken with petroleum ether. It is next made alkaline with baryta water, and shaken with twice its volume of a mixture of two parts of alcohol and three parts ether. The etherial layer is separated and the treatment repeated. The etherial liquid is heated in a water bath till the ether is evaporated, and the residual alcohol extract concentrated and heated in a water-bath for two days, when the glycerine left is weighed.

Glycerine may be separated from sugar by treating the sample with a mixture of equal volumes of absolute alcohol and ether, in which sugar is insoluble. In the case of honey it would be necessary to drain off the water as completely as possible first. A little sugar may be dissolved but would be left behind on evaporating to dryness, and re-treating with a mixture of one volume of alcohol and two of ether. This solution on evaporation would leave the glycerine. When extracted the glycerine is best recognised by its physical properties.

I should proceed in a similar manner to detect glycerine in water, after evaporating the sample to dryness at a gentle heat. I much doubt if traces could be discovered.

"Cameron," query 33247, will find the logwood test the simplest he can use for seeing if there is anything wrong with his bread. Only, if not carefully applied it is liable not to give the blue colour. This is well known to chemists of experience.

Query 32313 (page 636 of last volume), entitled "Microscopical," asks for a suitable book for a beginner to use with the microscope when employed for examining starches. I am sorry that I do not know one that can be thoroughly recommended. Hassall's "Adulteration of Food" contains many good plates, but little information on microscopic manipulation. The best way of observing starches and powdered articles of food is usually to place a little on a glass slide, add a drop of water, and cover with a thin glass circle; then use transmitted light. In some cases equal parts of glycerine and water form a useful medium. George Sims, on page 396, gives some useful hints. First study the appearance of pure substances, and you will soon learn to detect them in admixture. Do not trouble to mount the starches permanently, as they are better kept in a solid state, and a slide extemporised when needed. To secure the genuine articles it is well to powder them oneself. Thus get the corns in the ear if possible, beans and peas in the seed, coffee in the bean, &c. In examining starches note the size, shape, rings if any, position and shape of hilum, influence of polarised light, &c. A very high power is rarely required.

"F. W. S." (query 33277, p. 380) will find blast furnace slags are most possible when the lime and alumina are in the proportion of $6CaO$ to Al_2O_3. They still melt well with half this proportion of lime—that is, with 16·8 of lime for every 9·3 of alumina. To find the proportions of oxygen in the silica and bases "F. W. S." must adopt the following plan:—

The percentage of silica $\times \frac{8}{15}$ gives the oxygen in the SiO_2. The percentage of alumina $\times \frac{15}{29}$ gives the oxygen in the Al_2O_3. The percentage of lime $\times \frac{2}{7}$ gives the oxygen in the CaO.

In the example given by the querist the alumina (37 per cent.) is greatly in excess. A slag to be readily fusible should contain from one-half to twice as much oxygen in the silica as in the lime and alumina together.

Sheffield, June 29th. **Alfred H. Allen.**

FINDING THE INITIAL VELOCITIES IN CASES OF CIRCULAR MOTIONS.

[14544.]—KINDLY allow me to correct some errors in my letter, page 395. There are some printers' errors, but only one of importance—that is the statement in the heading of the table of four cases of circular motion that velocity $= \frac{2\sqrt{r^2 \times 2}}{f.}$ Instead of *f* please read *t.*, or time of fall to centre.

I find also that a mistake has crept into the paragraph in which I show the results of dividing the squares of circumferences by squares of times to obtain the squares of velocities, and this portion of the letter should read as follows:—Even admitting for the present that velocity is to be a measure of motion in a circular path in a certain time, then, as the table is to be made out to suit the law that "the squares of the times of revolutions are as the cubes of the distances," the periodic time at distance 1 must equal 1, V will equal 6·2832, and $\frac{V^2}{1} = 39{\cdot}4786$, or centrifugal force and gravity; and allowing the correct formula for centrifugal force $\frac{V^2}{2} = 19{\cdot}7393$.

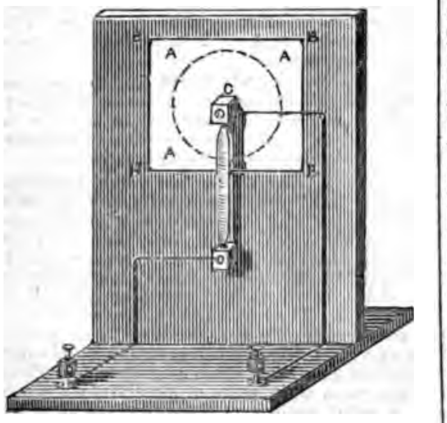
We would consequently have to allow gravity at a distance of 1 from a centre to be equal to 19·7393! The tabular statement given by the present writer agrees with Kepler's 3rd law, and gives gravity at distance 1 as equal to 1. **G. Pinnington.**

A CURIOUS BIBLICAL ERRATUM.

[14545.]—I HAVE just had pointed out to me a curious erratum in a modern Bible. It occurs in a Pearl Ref., 16mo., 1850, of the British and Foreign Bible Society, 20th chap. Rev., last verse, "Cast into the lake of *life*" for lake of *fire*. **J. K. P.**

ANOTHER MICROPHONE.

[14546.]—I send herewith a sketch of a microphone I have constructed, and which gives excellent results in transmitting the human voice, musical notes—in fact, is better in this respect than any other kind I have tried. The description is as follows:—The upright board has a circular hole, A A A, cut through it about 2½in. in diameter. Over this is gummed some vegetable parchment, B B B B, which, when the gum has well dried, is wetted and dried several times till quite taut. To the centre of this is fixed the upper carbon block, C, by means of a screw and a small wooden nut, and the wires connected with battery and telephone in usual manner. I have only tried a 2½in. hole, but I am inclined to think that an improvement may be made by varying the size of the hole and the position of the carbon block on it, but have not time at present to experiment myself. Perhaps some of your other readers have, and I should be glad to hear with what result.



Coventry, June 22nd. T. J. Mercer.

AN ARTICULATING MICROPHONE.

[14547.]—A microphone, which will transmit distinctly the loudest voice or the lowest whisper when such are spoken 10ft. or 12ft. distant, without the smallest jar, and in the same tone as the speaker's voice, is, I apprehend, rather more than the generality of microphones can be said to accomplish, and yet it is quite possible that such a microphone can be easily constructed.

Take a piece of very thin deal, 5in. by 2½in., smoothly planed, fix to it the sides 1½in. deep, equally thin, now add ends ⅛in. thick. You will then have a lidless box whose bottom and sides are very thin and smooth, but with ends much thicker. Now hold a stick of cask-wax in the flame of a spirit lamp, and run it in the seams where the sides and ends join—of course having previously glued them; screw this firmly through its end, to a stout base-board 3in. by 7in. In this box fix an ordinary microphone, as in Fig. 1; to the centre of the vibrator cement a piece of iron wire. It is only necessary, now, to make a stand upon which to place a horse-shoe magnet; the stand, with the magnet upon it, must be in height so that when placed upon the base board the feet of the magnet will stand parallel to the iron wire. The magnet may be fixed to the stand, but the stand must be free, so that it can be moved backwards or forwards on the base board, nearer or further from the vibrator. Having connected your batteries and telephones, bring the feet of the magnet within ⅛in. of the iron wire (the wire must not touch the magnet). Now speak, standing three or four feet away—your friend will then report to you through the telephone the result; if not satisfactory remove the magnet further away, until the voice is clearly heard, and in its natural tone. Further information I shall be most happy to give. I would remark the results have been equally as satisfactory as they have been wonderful, the magnet merely acting as an easily adjustable spring in controlling superfluous vibration, which is the cause of that peculiar and annoying jarring sound.

FIG. 2

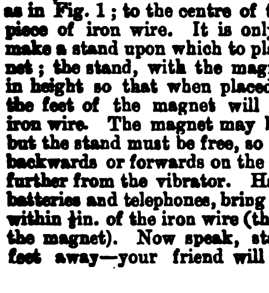
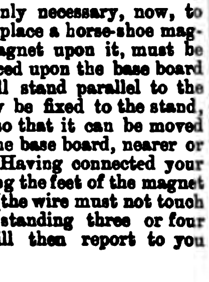


FIG. 1



B. Blakeborough, F.G.S., F.M.S., &c.

A SINGING MICROPHONE.

[14548.]—To wile away some hours of indisposition I have made various microphones. The most sensitive I have made was one in the form described by Prof. Hughes, with a sounding-board at right angles to the base-board, two blocks of gas carbon, ¾in. square and ¼in. thick, and the pencil of gas carbon 1½in. long, ⅜in. broad, and ¼in. thick, tapered to a fine point at the bottom—not so fine a point at the top. The holes at top and bottom are about the size of a large gimlet, and gradually slope to a point made with a small drill. There was one Léclanché battery in circuit. I put a blue-bottle fly under a wine-glass on the base-board, and could hear it patter pretty well, and its buzz was loud enough. But presently, while showing my wonderful work to admiring friends, the creature began to sing. At first I thought I must have secured the veritable fly that the *Daily Telegraph* told us "trumpeted through its proboscis like an elephant in an Indian jungle." But, alas! later on I found myself again disappointed, for the microphone gave me the benefit of its song again in the evening, when the fly was no longer there, and there was nothing at all on the board. The song was upon one note, and resembled the note produced by rubbing a wine-glass round its edge with a wet finger. It lasted for about 15 or 20 seconds, and was almost unendurable when close to the ear, and so loud in the room that any one could hear it quite plainly. It issued from the telephone I held in my hand, and there was no sound in the room or out of it which could account for the phenomenon. The microphone was resting on a writing-table, and the connecting wires went round me and over the top of a bookcase above my head. The wires were insulated with double white cotton, and not a thing was stirring in the room or near the microphone. Though so large and heavy, the microphone is a very sensitive one (at least to me), and I could hear the tick of my small Geneva watch quite plainly when I only put the very edge of it down on any part of the writing-table, and also the tick of a small 10s. brass clock on the mantel-piece, some 8 or 9ft. off, though it does not tick loud. Has this singing phenomenon been observed before, and how can it be accounted for? There were three witnesses to its first performance besides myself. The sound in the first instance gradually died away, but the second time it ceased somewhat suddenly.

Since writing the above I have found out how to produce the noise at will. Directly I touch the wires at the back of the microphone, close to the brass binding screws which connect them with the carbon blocks, the telephone begins to sing, and even now, as I write, is going on singing for a minute and a half. A breeze coming in at the window will make it sing, and it goes on singing when there is no visible vibration. These wires which are double covered, I twisted round a pencil to coil them for convenience. One of them goes close round the sealed top of the Léclanché to the zinc, where it is wound round a brass screw, screwed into the zinc. The other, the lower one of the two, touches the American cloth of the table top, and is joined on to the line wire, which runs straight to the telephone. There are 18 coils in the upper one, which is about 9in. or a foot long, and 9 coils in the lower, which is about 6in. long. The line wires are only 12 or 14ft. long. The noise coming from the telephone, when held off the mantel-piece, is loud enough to be distinctly heard like the hum of a water tap through the room, along a passage 20ft. long or more, and in any part of another room at the end of it. It would therefore act perfectly for a call-bell.

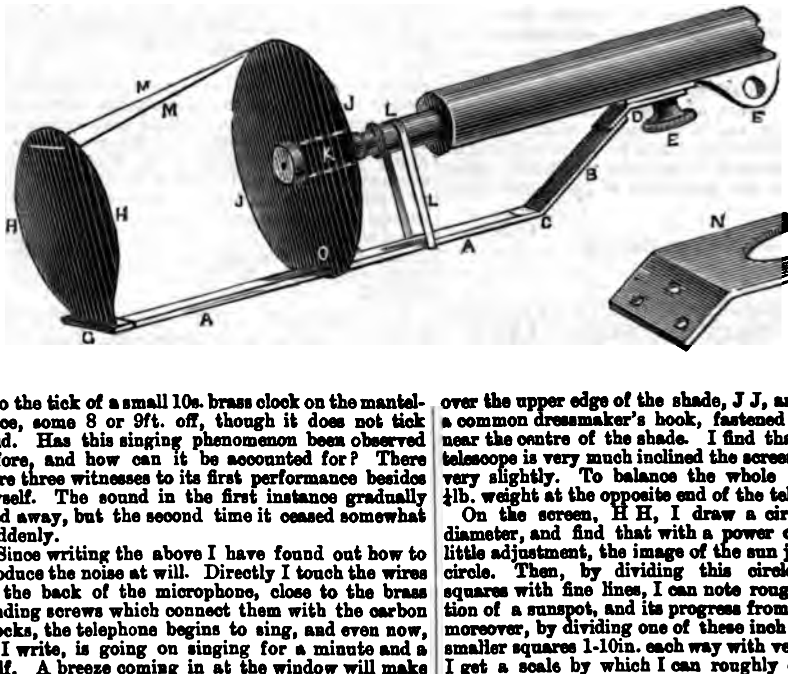
If others have observed this phenomenon I should be glad to be informed of the reason of it. I imagine it must proceed from the rapid variation of the first point of contact of the bare wire on the binding screw, and yet the last turn of the wire in each case, before it leaves the screw, is of the covered wire, and if it is the vibrations which cause the noise they must be infinitesimally small, for the covered coils rest against the battery jar and table, in either case within 1½in. from the screw. The song is varied from a higher to a lower note, just like a singing water tap sometimes varies its note with variations of the rush of water through it. If such an astonishing sound can be caused by such small vibrations, surely the resources of the microphone for magnifying purposes have not yet been fully developed.

L. B. B.

SUNSPOT SCREEN FOR SMALL TELESCOPES.

[14549.]—I send you a drawing and description of a simple, light, yet very useful addition to a telescope for viewing sunspots, faculæ, &c. The whole apparatus is attached to the telescope in less than a minute, and weighs under 6oz. I find it far more useful than the cone which is sometimes made to slip on over the eyepiece, because several persons can see the sun's image at once, and it is also infinitely less trouble than having to darken a room.

A B are two narrow strips of light deal, 1in. wide and ¼in. thick, hinged together by a small light hinge at C; the longer strip, A, is 30in. long, and B is 6in. D is a piece of thin brass, shown on a larger scale at N; this slips under the screw, E, which fastens the body of the telescope to the central bearing, F, to which the claw stand is fastened. Tightening up the screen, E, makes the carrier, A A B, very firm. G is a cross-piece 4in. long, with a saw "kerf" or slit along its centre, into which a thin piece of white cardboard or thick piece of cartridge paper, H H, is slipped. This piece, H H, is 12in. in diameter, and receives the sun's image. J J is a circular piece of black cardboard, with a tube, K, of the same material, which slips on to the draw tube, and is, of course, behind the shade, J J. This shade I make 15in. in diameter, so that its shadow shall well cover the screen, H H. The shade, J J, has a notch on the lower edge at O, to clip the strip, A A, and help to steady it. L is a strap forming a kind of stirrup for the support of the carrier, and which does better on the rack tube than on the draw tube. M M are two black threads, which pass through the screen, H H, over the upper edge of the shade, J J, and then over a common dressmaker's hook, fastened lower down near the centre of the shade. I find that unless the telescope is very much inclined the screen curves but very slightly. To balance the whole I suspend a ¼lb. weight at the opposite end of the telescope.



On the screen, H H, I draw a circle 10in. in diameter, and find that with a power of 70, and a little adjustment, the image of the sun just fills the circle. Then, by dividing this circle into inch squares with fine lines, I can note roughly the position of a sunspot, and its progress from day to day; moreover, by dividing one of these inch squares into smaller squares 1-10in. each way with very fine lines, I get a scale by which I can roughly estimate the diameter of a spot or group, for each of these squares would represent a diameter on the sun of very nearly 8,500 miles.

An eighteen months' use of this contrivance has proved it to possess the following advantages: (1) It is simple, light, inexpensive, and can be made by any one; (2) it is easily fitted to the instrument, and is quickly taken away; (3) it enables several persons to observe solar phenomena at the same time; (4) it saves the trouble of darkening the room, can be packed up with the instrument, and can be used at any open door or window; (5) being moved with the instrument the screen is always at the same distance from the eyepiece and always at right angles to the axis of the telescope. In using it myself I generally use the 70 power to note the approximate position and size of a sunspot, and then change the eyepiece for one of 120, with which I have been able to get very good definition of details, and have made some (to me) very interesting drawings of maculæ. The lines on the screen seldom prove any disadvantage with the higher power, but when friends think them so I just place a piece of plain white paper on the screen. The only thing I find necessary is to get rid of the reflection of side lights, which, of course, lessens the brightness of the sun's image; in the absence of these the contrivance fully answers one's expectations. Some time after I had made the contrivance I have here described at my friend Mr. Dancer, of Manchester, a similar one, which he was good enough ne some time ago. The principle is the ; I find that though mine gives a much ize of the sun it is a lighter apparatus. I some of your readers will try this arrange- report any improvements they make in it

B. Templar, F.R.A.S.

rt, June 28.

COMPOUND PULLEY BLOCK.

—I UNDERSTOOD Mr. Jewsbury to be : a real live block. Surely, however, he is ating a fancy. If he knows, will he please ; number of rotations of B will be t" to move A at all, let alone produce a rotation of A? It will be quite time enough Mr. Jewsbury into his figures when he has it his block is a block in the now proper he word. I asked him particularly as to of his block, but am as far off as ever. ective and circular-face views of it, see ly ENGLISH MECHANIC, 3rd May, 1878, May, 1878.

Aliquando.

NEW METHOD OF RESOLVING HIPLEURA PELLUCIDA, &c.

—HAVING seen Mr. Williams's and P.'s" method, I thought I should benefit s of the ENGLISH MECHANIC by sending ; the bottom of the stage of the microscope iaphragm fitted with a plano-convex lens, xposed to parallel rays from a lamp which pass a meniscus with spherical surfaces. top I place one of Abrahams lenticular he rays falling upon this are directed upon , and the pencil of light being very oblique ng upon the striæ, the markings are ut with wonderful projecting ridges. Now not require any special apparatus. I have mphipleura pellucida, and resolved M. test with ease, using a 2in. power—300

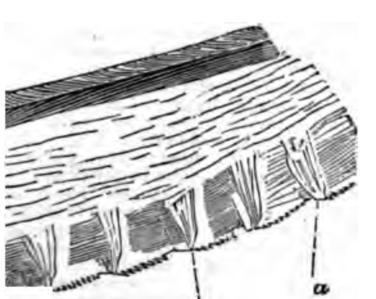
lra-villas, Wood Green. J. Berrows.

MICROSCOPICAL.

]—IN the use of the ordinary binocular bisecting the pencil from the highest Essex" (letter 14439) is on the right track ting the illumination, or directing it from ons at a greater angle, but my own opinion ocular microscope in any form where the btained from half the object-glass is that higher than one-fifth it ceases to be of ity, as the combined images cannot com- r the loss of definition in each eye. In the ism by means of which the full aperture l in each eye, with equal illumination in s, the effect is much superior, and in l observations, with either high or low affords great relief to be enabled to use continuously without regard to any special lumination.

F. H. Wenham.

]—I HAVE lately been examining the ovi- the saw-fly. It does not quite correspond pecies described in Clarke's "Objects for scope," and the construction of the saw different to the specimen figured on page Hogg on the Microscope." The fly is similar to a small wasp; colour is gene- k, with one yellow spot on top of the d three or four yellow stripes on each side lomen.



ached figure represents a portion of one ified 200 diameters. I am unable to make ructure and use of ribs, *a a*, which separate ns of teeth. Can any reader inform me int has been determined? They may be ds, or deposits of material to give rigidity, fancied that I could detect tubular open- they terminate, at the edge of the saw. sted to my mind that they might be tubes some lubricating substance to the teeth, s unable to trace these vessels, if such they are, to any glands, I am not at all certain on the matter. My inability to trace the vessels farther than here shown may arise from the transparency of the object, which is mounted in glycerine jelly. A large trachea, running the whole length of saw, is now quite invisible, though very distinct before mounting. I hope some friends with better appliances than mine will investigate this point, and let us know the result. I would call attention to the striking resemblance between this insect's saw and the long American band saws. I do hope we shall have a little more on minute insect structure and histology in general. There must surely be many readers of the E. M. who have good opportunities and apparatus for this fascinating study. If they would come forward with the results of their observations there can be little doubt that a considerable addition would be speedily made to our knowledge, and much good to science would probably result from the discussions raised. One word more, do not soak insects in potash—use turpentine and glycerine, and mount in glycerine jelly or Canada balsam. I prefer the former.

Humble Bee.

AN EASILY-CONSTRUCTED CAMERA LUCIDA.

[14554.]—FOR the benefit of those with whom, as with myself, expense is a consideration, I send the following description of an easily-constructed camera lucida, which I made in about ten minutes. I first procured a pill-box lid which just fitted on to the eyepiece of my microscope, and in the centre of it made a circular aperture about the size of the top lens of the eyepiece. I then cut a piece of card to the shape of Fig. 2, in which the angles, A E B and C F D are both 45°, just nicked with a penknife along the lines A E, B E C F, and D F, and with a little gum affixed to the lid, as in Fig. 1. A piece of thin covering glass attached to B E C F, and therefore inclined at an angle of 45°, completed the apparatus, which answered remarkably well.

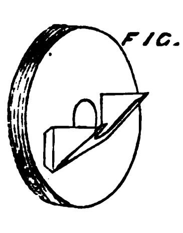


FIG. 1

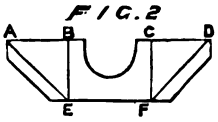


FIG. 2

C. G.

AMERICAN OYSTERS.

[14555.]—CAN any one who has tasted American oysters say if the following is true? I cut it from the *Scientific American*, which is an out-and-out believer in everything American:—"It is a well-known fact that the edible oyster (*Ostrea edulis*) attains its full growth and proper flavour only in the waters of the American coast; and that its representative in Great Britain, owing perhaps to some trouble in its 'environments,' has dwindled down to a minute coppery-flavoured bivalve, which affords to the evolutionist a melancholy example of 'reversion,' and to the American gastronome an object of aversion. It is no wonder, then, that when one of our American oysters is seen for the first time by an inhabitant of the British Isles, it should call forth expressions of great surprise."

The "native" a "minute coppery-flavoured bivalve!" Good gracious, has this gentleman ever tasted a real "native," which costs, nowadays, 3d. in the City, while his wonderful "blue points" can be had 14 for a shilling, done up in a bag? According to Lieutenant Broca, the Chesapeake oyster is sometimes 15in. long and 3½in. wide, large enough, goodness knows. But he also says that he has eaten oysters from the most celebrated localities, and always found them somewhat insipid in taste, a "marked characteristic of the species" (American). As a matter of fact, the oyster from Virginia is found in the fossil state in the neighbourhood of Bordeaux, so that American oysters have not yet been developed. Blue points may be better in the States than they are here, but I can't imagine any one preferring them to "natives." I believe American oysters are excellent when cooked, but as the real epicure eats them, they cannot compare with our natives or the bivalves of Arcachon. Will any of your readers resident in the States tell us if either of the three American species, Virginiana, Borealis, or Canadensis, is equal in flavour to our native or even our common oyster, which some years ago was sold at about two a penny? The "canned oysters" sent here are, in my experience, tough morsels, fit only for the stew-pan, and a good deal of it they require. I have not ventured on "blue points," though I like the Anglo-Portugo; but if they are so much superior to our "minute coppery-flavoured bivalves," it's really a wonder they sell them at a third the price.

Hematopus.

COHESION OF ATOMS.

[14556.]—PROFESSOR TAIT devotes a chapter or two of his work on "Recent Advances in Physical Science" to the consideration of the absolute diameter of an atom; and from three or four methods of calculation arrives at a mean result, that the said diameter is about one five hundred millionth part of an inch. This gives us data for estimating the cohesion between two atoms. Take, for instance, iron. A bar of this metal one square inch in area will support a weight of 30 tons (Arnott, page 25). The atoms of iron are, of course, not in absolute contact, so we must make allowance for this, and instead of 25×10^{1}, we will take 20×10^{16} as the number of atoms in a surface 1in. square. Dividing 30 tons by this number we obtain ·000000002352 grains as the cohesive power between two atoms of iron. To put this result in another form, it may be said that a wire of iron one five hundred millionth part of an inch in diameter would support a weight of ·000000002352 grains. I would be glad to have the opinion of any reader interested in this kind of calculation as to whether I have made too much or too little allowance for the interstices between the atoms of iron.

Newcastle-upon-Tyne. Wm. John Grey.

MUSICAL TONES.

[14557.]—"G. P." is informed, I see, by Mr. Jackson that the relative values of all notes in the diatonic scale are determined by "the simple continuous procession or evolution of the two kinds of concord—that is to say, the accretion of concords to the constituent notes of concords already determined." Whatever that may mean, I trust that "G. P." will be the wiser for the information. Would it not have been more satisfactory if Mr. Jackson could have informed him that the relative value of a note has been determined from a scale in which that note occurs, having been tuned by ear to the greatest nicety on some instrument—an organ or harmonium—and the vibrations of the notes in question accurately ascertained therefrom by means of a siren or tonometer?

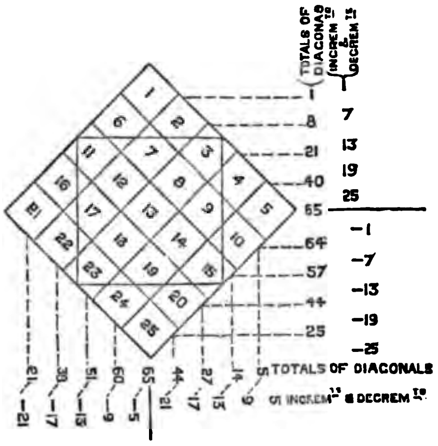
But, strange to say, this seemingly obvious, simple, and safe course of proceeding has never been taken; the *mere reputed scale ratios* have been accepted and assumed even by scientific writers of authority, as equally applicable to all the keys; and their worthless conclusions are reproduced by Mr. Jackson with the result we see in letter 14497. I repeat the question which I asked on page 344:—"Is the A♯ in the phrase (there printed) higher or lower in pitch than B♮?" Will no one venture upon an answer?

H. C. K.

PROPERTIES OF NUMBERS.

[14558.]—THE following remarks have reference to letters 14375 and 14441, by R. Miles and "P. G.," on the subject of curious figure squares, in Nos. 687 and 689 of the ENGLISH MECHANIC of the 24th May and the 7th June respectively.

R. Miles may find a clue to the solution of the mystery which he propounds by summing the rows of figures taken diagonally in his square, and noting how the increments and decrements of these totals compensate one another, as shown here below.



The problem has probably come down to our times from antiquity, and may have been among those derived by the early Greek mathematicians from Egypt. It is preserved as an heir-loom, and shown by a farmer—a sort of rustic genius of Whitstone, in Cornwall—as the wonder of his village, "the wonder of Whitstone," and may be similarly known in other places.

"P. G." (14441) will find a ready method of constructing his "curious figure squares (they are associated in my early recollections with the title of "magic squares") by regarding them as cor-squares, so to speak, resulting from the combination of simpler, or, as they may be termed, primitive squares, constructed as follows:—Calling the number of terms on one side of the contemplated square, *r*, or the radical number, the first of the primitive squares should consist of the cardinal numbers from 1 to *r*, ranged in any order, and repeated up to *r* times in successive horizontal lines, in the same order as at first adopted, but with a change in the initial term for every line, so that the same term shall not occur more than once in any of the perpendicular columns—as in the following examples:

(*a*)

1	2	3	4	5
3	4	5	1	2
5	1	2	3	4
2	3	4	5	1
4	5	1	2	3

(*b*)

2	4	1	3	5
3	5	2	4	1
4	1	3	5	2
5	2	4	1	3
1	3	5	2	4

It will be evident from inspection of the squares so framed that all the lines of figures, whether read horizontally or perpendicularly, will add up to the same sum; and if, as in the examples above given, the arrangement provides for the non-recurrence of the same term in the diagonals, then the diagonals also will add up to the same sum. Like results, it should be noted, are also obtainable by a special arrangement of the terms, whether as regards the diagonals or the whole square, notwithstanding the recurrence of the same term in some of the rows or diagonals—as in the following examples:—

(*c*)

3	1	4	2	5
5	3	1	4	2
2	5	3	1	4
4	2	5	3	1
1	4	2	5	3

(*d*)

3	4	1	2	5
5	3	2	4	1
1	2	3	4	5
5	2	4	3	1
1	4	5	2	3

The second primitive square should be constructed similarly to the first, but with the multiples of *r*, from *o* to $(r - 1)\,r$, instead of the cardinal numbers—as in the following examples:—

(*e*)

0	5	10	15	20
15	20	0	5	10
5	10	15	20	0
20	0	5	10	15
10	15	20	0	5

(*f*)

0	20	0	20	10
15	5	5	0	15
20	15	10	5	0
5	10	15	15	5
10	0	20	0	20

It will be readily perceived that these squares also fulfil the conditions of the first squares, as regards the equal summation of their several rows or columns and diagonals; and so also must any compound squares that may be formed by the combination of any two or more of them. And if in combining a square of the first kind with one of the second, it is so arranged that the similar terms in the one shall meet in succession with the several different terms in the other, then the resultant compound square will also contain the cardinal numbers from 1 to r^2, and will so fulfil all the conditions of a perfect "magic square."

Reverting to "P. G.'s" letter (14441), it may be seen that the squares there exhibited No. I. results from the combination of (*d*) and (*f*) here given; and Nos. II. and III. from the combination of (*b*) and (*d*) respectively with squares akin to, but not quite identical with (*e*). And it will be readily apparent that several more such squares may be constructed from combinations of the primitive squares above given, and of others not here shown. Here follow two new examples—combinations of (*a*) with (*e*) and (*f*) respectively:—

1	7	13	19	25
18	24	5	6	12
10	11	17	23	4
22	3	9	15	16
14	20	21	2	8

1	22	3	24	15
18	9	10	11	17
25	16	12	8	4
7	13	19	20	6
14	5	21	2	23

"P. G." may thus perceive that the possible combinations forming magic squares are considerably more numerous than might appear at first sight. And he will also readily conceive how the number of such combinations is likely to increase with the number of terms composing the square.

The difficulties in the construction of squares of even numbers will appear more clearly on trial of the application to them of the principles above enumerated. One word as regards the square of 3, alluded to by "P. G." Though there would appear to be but one combination of nine figures fulfilling the required conditions, yet the same combination may be presented in different aspects—as, for instance, by changing the perpendicular into horizontal columns, and vice versâ. It may be to some such varied phases of this square that "P. G.'s" recollection reverts when he thinks to have once found a second. I do not know of any systematic treatise on the subject, though doubtless such exists. The above remarks are based on recollections of readings in juvenile books of scientific recreations some forty years ago, and I have not since given a thought to the subject till I saw "P. G.'s" letter the other day

E. C. C.

DISTANT SIGNALS.

[14559.]—Now that the holiday season has come again, and many of us are looking forward to spending a portion of the summer in out-of-door expeditions of one kind or another, by land or sea, the want of some ready means of communication with companions at a distance too great for the voice to reach, will be felt by many. By the following method, after a little practice, three or more words per minute can be signalled to any distance at which a pocket-handkerchief can be distinguished. The signals are derived from the Morse code, and are made by waving a handkerchief or cap over the head; a wave to the right corresponding to a "dot" of the code, and a wave to the left a "dash." The letter A is thus once to the right and once to the left of the sender, and the motion appears to the receiver of the message quite similar to that of the needle in the needle code. He acknowledges the receipt of each letter by a vertical wave, or if he do not understand holds up his handkerchief till the signal be repeated. The sender signals the end of each word by a horizontal wave left and right at the level of the waist. If he make a mistake nine dots signify rub out and begin again.

A copy of the Morse code may be had from the nearest telegraph clerk, or in the ENGLISH MECHANIC, Vol. XXVI., p. 149. At sea the distance is sometimes too great to distinguish a cap or handkerchief without a glass, and for yachting purposes I find it convenient to carry on board a red flag about 2ft. by 3ft., hung by brass rings on a light flag-staff, so that it turns on the staff without rolling up on it. This can be seen at a distance of one or two miles, and the return signals made with a handkerchief can be seen with the glass. At night the signals are made by a lantern eclipsed at long and short intervals, with a screen (cap or other opaque object). The long eclipse being the dash, and the short the dot. They may also be made by long and short blasts of a horn or whistle, or in other ways which will suggest themselves.

Belfast. **J. Brown.**

The "Marvel" Meter.—A much wanted instrument has been invented by our well-known correspondent, Mr. F. L. Striffler, to supply a deficiency in the bicyclist's requisites. The usual price of these indicators is from £1 1s. upwards. The price of the "Marvel" is 10s. 6d., and Mr. Striffler assures us it will not only do as much as its dearer brethren, but more, inasmuch as the distance indicated can be easily read whilst the rider is mounted on the bicycle. This latter qualification should be a special recommendation to bicyclists. The size of the "Marvel" is 2¼in. in diameter by ¾in. thick, weight 3 ounces. It is fixed on the axle or spokes, preferably the former. It can be made to register miles by forwarding the size of wheel it is intended for. It is best to have it register revolutions, as these are more rigidly correct, and the distance can be ascertained to 1 revolution, whereas if miles are recorded the distance cannot be relied on for less than a quarter of a mile. The outer or top wheel rotates once in 100 revolutions, or moves one tooth for every revolution of the wheel to which it is attached. The "Marvel" is hermetically closed, and therefore no dust or damp can penetrate. It will last as long as a bicycle, barring accidents. In case of a spill it will not be injured, the parts being so few and simple. Mr. Striffler has also invented a "Telemeter," or adjustable distance indicator. All the existing mileage indicators (with the sole exception of the "Telemeter") can only register a certain distance for a given size of wheel. If applied to a wheel of different diameter than to that it was originally made for, the measurement is incorrect in a corresponding ratio to the difference in the diameters of the wheel. This has been felt to be a disadvantage by many bicyclists, and also among those who prefer taking their pleasure in vehicles drawn by horses. For one reason, it is very rarely a wheel is made exactly of the diameter it is ordered, or stated to be. It may be called 55in. in diameter, and be 54⅞in. or 55 1-16th; this error will be increased in proportion of 3·14159 to 1in. in the circumferential measurement, and in a 100 miles will amount to a serious discrepancy between the actual and indicated distance travelled. To supply this deficiency Mr. Striffler has invented the "Telemeter," or adjustable distance indicator, for bicycles or other travelling machinery (dog-carts, carriages, &c.). The "Telemeter" for bicycles is made to fit on the axle inside the driving wheel, this being the best and safest place for such an instrument. In case the axle is taken up with a lamp or circular valise, it can be attached to the spokes: this must be specified on order. The size of the instrument is 3in. in diameter, 1¼in. thick, and weighs about 6oz. The ordinary "Telemeter" will register 50 miles of distance for any size of wheel generally used. For 5s. extra this value can be increased to 500. The outer wheel of the instrument rotates once in half a mile, and the value of every tooth in it is 8 yards and 4-5ths, thus an accurate measurement can be taken with ordinary care. A run of 5 miles should be taken to regulate it to the size of wheel.

REPLIES TO QUERIE

**** In their answers, Correspondents*
spectfully requested to mention, in each
the title and number of the query asked.

[30178.]—**Emery Wheels.**—No man
nation should lose his life in the foolish way
to. Let "Grinder" get a practical whe
maker to put his wheels together for him
following way:—Choose seasoned mahog
teak, or any seasoned wood, and let him d
wheel together in quarters, using marine
good liquid glue for the wheels used in wa
best Scotch glue for those that are used dry
crocus or fine emery, like the grinders of
do. Have 3 dowels in each joint, proper
together, the wheel properly turned after
the lathe, and the emery put on properly
will never fly to pieces.—J. P. H.

[32269.]—**Systematic Memory.**—It
curious that, in almost every instance of t
artificial memory given by its exponents, th
is applied to remember things of but little
well-known professor of mnemonics devote
his method to remembering a lot of date
accession of kings and queens, the phre
organs, and a poem about water coming do
where; while Mr. Iron (p. 374) illustrates
by mnemonics for the Sermon on the Mou
cui bono? Dates are about the most useles
knowledge; the phrenological organs are
better; the poem above alluded to is chief
able for the fuss it makes about a simpl
fact; and the Sermon on the Mount is not
a subject to which artificial memory
applied in practice. What is wanted is a
tion of the use of mnemonics in science or
as suggested by Mr. Temple: and to th
call Mr. Iron's attention.—WM. JOHN G

[32260.]—**Systematic Memory.**—
allowed to suggest to any one copying my
cal table, or copying one for themselves,
be more convenient, after writing the firs
0 words as printed, to make one large sq
remaining 90 words, consisting of 9 sm
(similar to the first one) in 3 rows? The
each word can then be more easily car
mind's eye. But in learning the table by
better to repeat the words in batches
making a slight pause after "Jew." "boo
&c. The word representing 53 should
instead of "goal." Picturing a "cow,"
be: Picturing a "cow" (the second word
lump of salt would recall to the mind, &
kind of process is required for dates, as ill
"Theo. Izod," April 26.—W. P. IRON.

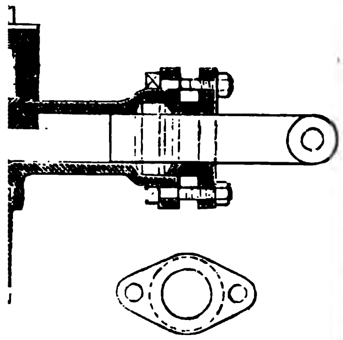
[32609.]—**L. and N.W. "Cornwall"**
I have lately seen an engraving of this en
answer this query myself. The "Corn
on six wheels; the leading and trailing h
bearings, and the driving wheels inside
of course, outside; boiler of the L.
standard, with a "cab" over the foot
engine is No. 173.—R. N. H.

[32670.]—**Whitening Bells.**—The w
ing" is quite sufficient. Why not have
first? Here is the recipe:—Take 6lb. c
tartar, 4 gallons of water (rain or distil
ference), and 8lb. of grain tin, or tin sha
them together, and then put in the bells,
been previously cleansed by dipping in
rinsing. The operations may be varied
the articles in the solution at the time
only, then, it is advisable to add the ing
layers between the articles. Several r
been given in back volumes, and I now se
Coating metals with tin: Messrs. N
Co., of Vienna, use a zinc and carbon bat
inner cell containing the carbon is half
chromic acid, and the outer cell containi
is filled with dilute sulphuric acid. The
be coated with tin are put into a bath c
protochloride of tin and cream of tart
without chloride of tin. The proportio
ingredients are: 8 parts of protochlorid
parts of cream of tartar, and 2 parts of t
if the latter is used. When it is pres
coating is effected more rapidly, wherea
bath is composed of protochloride of tin
of tartar only, the tin coating is very w
not produced so rapidly as when the chlo
These ingredients should be dissolved i
gallons of distilled water. The black pla
"pickled" in any suitable manner.
immersed in the above-described bath
and are allowed to remain in the same
or shorter time, according to the thick
deposit or coating of tin required on
While in this bath the plates or other
coated are connected by a wire with the
of the battery, while the negative end of
is connected with a piece of tin hung
bath. When the plates or other piece
have been sufficiently coated with tin, t
over a fire in order to give the tin a lust
ance.—UNCERTAIN.

[32835.]—**Three-Cylinder Engine**
chanic" hints a complaint that my r
weeks after his query. I cannot help t
it in, early enough, but, as it is merely

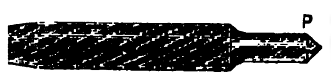
ıry was not sufficiently definite, I pre-
ı kept back in the hope of something
ıg up. Now to answer the additional
would say "yes," the "virtue" of three-
ines is fully established. There is a good
pressure, of course, where the steam
one piston to another, but that is
pared with the fact that these engines
very highest speeds without knocking
to pieces. Mr. Willan's engine was
n p. 61, Vol XX., and there is a letter
ntleman on p. 224. A trial was made
team launch No. 80, fitted with twin
ed by Willan's non-compound type of
r engine. The mean number of revo-
Thorneycroft propellers was over 500
and the speed realised was 8½ knots, the
wn with that class of boat. I have no
cquaintance" with these engines in the
ing them or superintending their work-
neither directly or indirectly interested
nercial success.—J. M.

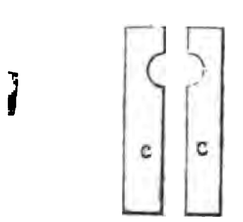
'orce Pump.—I herewith send full-size
rce-pump which will be suitable for



ineer's" boiler. I cannot give him the
e for fixing to the bed-plate, but have
s own discretion.—BLACK WITCH.

'ooks and Eyes for Catgut Band.—
ree answers to this query on p. 250.
ject was pretty well exhausted, I think,
k in correspondence between the late
Blacksmith" and myself, particu-
ape and depth of thread of internal
g the last of the three answers first, I
at I never met with directions worse
a few instances long ago, when some
empts wilfully to deceive. "Os" is
he goes, but does not say what sized
t; and, as he says the gut only wants
"nothing else," it is clear he chooses
The hooks and eyes are usually taper:
iameter with callipers just below the
and that is the right size for the gut;
select hooks of the size of the gut at
r part. Next reduce the gut either by
penknife, or by filing on a notch in a
as a support, taking care to leave it
o screw in hard, and particularly to
rminate in a blunt cone or pyramid.
Now seize the gut in the vice in a





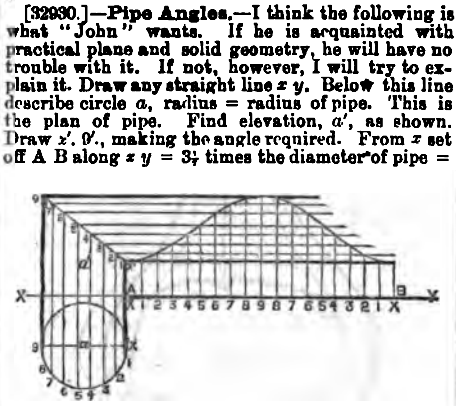
'ormed of two bits of hard wood, *c c*,
groove filed in each, to avoid bruising
rew the hook hard on with plenty of
ther the hand-vice or a stiff piece of
to force it on with. If the tip of the
nside the eye, cut it off, and screw on
ent tells you to stop, as, of course,
avoid stripping the thread. Do not
ng if you can avoid it, as, if you do,
reat difficulty in starting it again.
ur own hooks and eyes use a piece of
arge size, to avoid splitting in tap-
it off afterwards to size. Mouth out
hin edge with a cone-countersink;
edge, in the act of screwing on to
throw up any fibres, pare them down
to lead properly into the hole. In
ve as much substance as I can at
s that is where they break. Eyes
. As they are hardened and blazed
nper there is little fear of softening
them off the gut when necessary;
ake them too hot, plunging them in water would most certainly not restore the temper, as Mr. Wiesendanger says it would. Hot iron, too, which is to be applied till the "fatty matter melts and fills the interstices," would ruin the gut, leaving little for the subsequent plunging in water to spoil. Water should never be allowed to touch the gut. My sketch shows the hook and eye amply long enough: they are commonly much too long. See that the hook has free play (not loose) in the eye, or it will break in going over a small pulley. A small, coarse square file is most suitable for filing the hollow curve of the end of gut, as a square file is for filing hollows generally—a fact that I have found very commonly unknown even among workmen. Tapping the hole too far in, particularly in the hook, is nearly certain to make it give way.—J. K. P.

[Every reader of the ENGLISH MECHANIC will welcome the re-appearance of "J. K. P." in its columns. It is quite true that this matter was ably discussed by himself many volumes back, but so many fresh subscribers read the ENGLISH MECHANIC by this time that the recapitulation of information on this and kindred subjects by a veteran like himself is most welcome.—ED.]

[32881.]—**Gas-Holder.**—The last few numbers of the ENGLISH MECHANIC have just come to hand, and on looking through them I perceive several answers to my query from correspondents to whom I owe many thanks. There being a little misunderstanding as to what purpose the gas-holder is for (my query being, perhaps, rather vague), I write to say that it is merely for storing gases such as oxygen, hydrogen, marsh gas, air, carbonic, anhydride, &c., previous to passing them over substances heated in tubes in a furnace. I have found "Os's" plan of a gas-holder made of zinc to succeed very well, but I want to dispense with weights, and use water as the pressure, in the same manner as in a "Pepys." Mr. Lancaster's method, described on p. 298, I tried some time ago on a small scale, with a Winchester quart, and the only inconvenience I found from it was that in generating a gas, say hydrogen, in the ordinary way, it had in passing into the Winchester to overcome such a column of water that it either blows the cork out of the generating flask, or else a piece out of the Winchester quart.—F. A. B. J.

[32883.]—**Railway Grease.**—This is made as described on page 298 by "H. B. F.," with the addition of common washing soda. It takes a long time to make it; but, as regards the quantity of each article used, I cannot with any certainty speak at present.—CHELT.

[32930.]—**Pipe Angles.**—I think the following is what "John" wants. If he is acquainted with practical plane and solid geometry, he will have no trouble with it. If not, however, I will try to explain it. Draw any straight line *x y*. Below this line describe circle *a*, radius = radius of pipe. This is the plan of pipe. Find elevation, *a'*, as shown. Draw *x'*. 9'., making the angle required. From *x* set off A B along *x y* = 3⅐ times the diameter of pipe = circumference. Bisect A B in 9. Through the centre of *a*. plan draw *x* 9 parallel to *x y*. From *x* and 9 set off any number of equal distances, *x*. 1. being = 9. 8., &c. From these points (*x*. 1. 2., &c.), draw lines at right angles to *x y* to meet *x.'* 9'. From these points in elevation draw lines parallel to *x y*. From *a*. 9. and *b*. set off distances, 1. 2. 3., &c., 9. 8. 7., &c., equal to the same distances in the plan, *a*. From these points raise perpendiculars to meet the corresponding horizontal lines. The intersection will be points in the required curve. Draw this in by free hand, and cut out to it, and when turned you will find it to come correct. If you do not understand, write again, and I will try to be plainer.—D. M. L.



[32930.]—**Pipe Angles.**—Let "John," from a point on a plane surface, draw two indefinite straight lines to the angle at which the two lengths of pipe are to be jointed together; from said point, with any working radius, describe an arc between the two lines, bisect the arc, and from the point of bisection to the point where the two lines meet draw a line, the which line will be equally inclined to each of the two lines previously drawn. Set a bevel to the acute angle formed by either of the two lines and the bisecting line. Next determine, from the width of the parallel strips of zinc, the core of the finished pipes. In a lathe turn up a piece of hard wood cylindrically with the finished diameter equal to the bore of the proposed pipes, then cut one end of the cylindrical piece of wood to fit the bevel as previously set. Lastly, bend and stamp the strips of zinc around the wooden cylinder a little beyond the extremity of the oblique base one piece at a time, take a bent scriber, and mark off on the insides of the strips lines even with the face of said oblique end, and cut the strips by the lines so drawn, when no misfitting ought to occur at the joints.—S. J.

[32931.]—**Dried Apples.**—The apples to be dried should be sour, or what are known in England as "cooking apples." Pare them carefully, then quarter and core; after which thread the pieces on to thin twine, and hang up from ceiling of kitchen. When perfectly dry they may be packed in a flour barrel; will keep good for 12 months, if properly prepared. I am receiving your valuable paper regularly, and shall be happy to answer queries that I may be able to.—A. T. BARRAUD, Quebec.

[32945.]—**Reducing Aperture of ¼in. O.-G.**—I apprehend that I cannot help H. R. Herbert out of his difficulty. A very small stop placed close behind the posterior lens of a ¼in. will certainly give greater depth of focus; but, in such a case, to my eyes the loss of light and definition is worse than the evil. H. R. H. must accustom himself to object-glasses of longer focus, or low powers, in which differences in depth of the object are not so appreciable. Having been away on the Continent I have got somewhat in arrears in the perusal of the ENGLISH MECHANIC. I have an impression that some one asked whether a low power as usually made, if set behind a higher one, would not act as a combination in lieu of a high power? I think that there would be but very little chance of a good result this way. The correction of the lenses separately is not such as to enable them to work well in combination, and the field of view would be much distorted. A far better plan is to use an amplifier, consisting of a double concave lens of crown glass, set about 3in. more or less behind the object-glass; this sometimes even improves the defining quality of some objectives.—F. H. WENHAM.

[32969.]—**Bronze Tea-Urn.**—"Coppersmith" will find a method of bronzing on copper on p. 200, Vol. XX.; see also p. 645, Vol. XXV., and p. 97, Vol. XXVI. There are other methods of bronzing described in the ENGLISH MECHANIC. Would advise a search through the indices.—J. F. M.

[32972.]—**Grafting Stockings.**—I think directions will be found in a little work published by Chapman and Hall; but surely some of the lady readers of the ENGLISH MECHANIC can supply the required information.—LUCY.

[32976.]—**Grindstone for Razors.**—If "from Greenwich" they are probably Ransome's artificial stones.—T. K.

[33005.]—**Intermittent Downward Filtration of Sewage.**—"St. Mar" should read Prof. Corfield's Reports to the British Association in his "Treatise on the Treatment of Sewage," published by Macmillan.—BARKING.

[33008.]—**Photo Varnish.**—No varnish at all.—M. S.

[33013.]—**Wood-Cutting Machinery.**—The best book is Richards's "Treatise on the Construction and Operation of Wood-working Machines," which is profusely illustrated with plates of the best varieties of machines (Spons). The same author's "Operator's Handbook" is also a useful work.—T. K.

[33019.]—**Spectroscope.**—May I suggest that an "Ignoramus" should get Proctor's little book on the spectroscope, or Roscoe's work?—M. S.

[33029.]—**Gilding on 15 or 18 Carat Gold.**—I think if "Os," who replied on page 324, looks at my query again he will find that he has misread it, as the query asks for information on electrotyping with 15 or 18 carat gold, and not gilding on 15 or 18 carat gold.—R. N. C.

[33054.]—**Hydric Sulphide.**—Both L. Briant (p. 340) and F. W. Muncey (p. 324) omit to state that the Sb_2S_3 and HCl must be heated to evolve H_2S; or, in the technical jargon of W. J. Grey, that they will not yield it "in the cold." By the way, will L. Briant give his reasons for saying that this method yields H_2S "in a far purer state" than the FeS method? He follows several text-books in that assertion, I am aware, but neither of them gives any reason for it. As to W. J. Grey's remark "that the poisonous properties of the gas seem somewhat overrated," I take the first book that comes to hand (the Irish Education Commissioners' "Chemistry"), and find—"A horse has been killed by an atmosphere containing $\frac{1}{250}$ of H_2S; $\frac{1}{800}$ is poisonous to man; a cubic inch introduced into the lungs will cause instant death; it will destroy life by acting on only the surface of the body." From personal experience, I can say, I never prepare it even in the open air without suffering from its effects for days afterwards. It is most culpable negligence on the part of book-makers to omit stringent injunctions of caution (to young students) in dealing with H_2S, Cl, Br, I, CN, HCN, &c.—DAGHBERT.

[33057.]—**Henry Andrews, Almanac Maker, &c.**—Perhaps the following may be of some use to your correspondent, "E. C. H.," and also of some interest to other readers of the ENGLISH MECHANIC: Henry Andrews, the celebrated calculator, was born at Frieston, near Grantham, of poor parents. By his own industry, from a limited education he made great progress in the liberal arts, and was justly esteemed one of the best astronomers of the age. When only six years old he would frequently stand in his shirt looking at the moon out of the chamber window at midnight; and when about ten years of age he used to fix a table on Frieston-green on clear frosty nights, and set a telescope thereon to view the stars. Soon after this he would sit whole nights together by the fireside with a table books making astronomical calculations. At a suitable age he was sent from home to earn his own living, and the first situation he filled was at Sleaford as servant to a shopkeeper; after this he went to Lincoln to wait upon a lady, and during this servitude used at every opportunity to make weather-glasses and weather-houses. His last situation of this kind was in the service of J. Verinum, Esq., and his master finding him so intent on study allowed him two or three hours every day for that purpose. On the 1st of April, 1764, he went to Aswerby Hall, the seat of Sir Christopher Whichcote, to view the great eclipse of the sun which was visible on that day, where a number of ladies and gentlemen had assembled for the purpose; and as he had previously calculated a type of this ecclipse, he presented the same to the company, showing them the manner of its appearance in a dark room upon a board, and after it was over they unanimously declared that his calculations came nearer than any given in the almanacs. A short time after this period he opened a school at Basingthorpe, near Grantham, and afterwards engaged as an usher in a clergyman's boarding-school, at Stilton. He then settled in Cambridge, where he proposed to reside, in the expectation that he might derive some advantage in prosecuting his studies from the men of science in the University; but the noise and bustle of the town not being agreeable to him he left Cambridge, and came to reside at Royston, Hertfordshire, where he opened a school, at the age of 23 years, and at this place continued until the day of his death, which happened, after a short illness, on 26th January, 1820, at the age of seventy-six, having enjoyed an uninterrupted state of good health till his last illness, when the greatness of his mind was more particularly conspicuous. On his death-bed not a murmur escaped his lips, but serenity of mind, resignation, and patience were constantly depicted on his countenance, in which amiable situation he continued until the vital spark had fled. He was for more than forty years the author of that far-famed production, "Moore's Almanac," published by the Stationers' Company. The "Vox Stellarum" of Henry Andrews was the most successful of the predicting almanacs, its sale being about 500,000 copies annually. This prodigious circulation of Chaldean mysteries was owing to the astrological predictions with which the worthy calculator was required to fill it, and with which it was allowed to be filled, though printed for a public company and revised and sanctioned at Lambeth Palace by the Archbishop of Canterbury! Andrews was greatly esteemed for his integrity, talents, and modesty. His profound knowledge of astronomy and mathematics was acknowledged by every scientific man who was personally acquainted with him, or with whom he had been connected, particularly by the late Astronomer Royal (Dr. Maskelyne), who valued him much, and who, in relation to the *Nautical Ephemeris*, was in constant correspondence with him for nearly half a century. On retiring from the situation of computor of the *Nautical Ephemeris* he received the thanks of the Board of Longitude, accompanied by a handsome present, as a just tribute for his long and arduous services, for which he would never receive more than a nominal remuneration.—See *Gentleman's Magazine* and *Monthly Magazine* for the year 1820.—GLOWWORM.

[33059.] — **Phosphate of Alumina.** — In the answer given by "X. Y. Z.," p. 376, what does he mean by AlO_3, PO_5, and HO (query, hydroxyl)?—F. W. WOODMAN.

[33062.]—**Zincography.**—There is a difference between zincography and anastaty, although in many shops they are known by one name. The distinction is this:—In zincography the work is drawn direct on the plate or grained paper used, and the plate being properly manipulated, it may be worked with letter-press—similar, in fact, to an electro block; anastaty being principally used for reproduction of print, &c., or drawings done on plain paper with brush and pen. The plate is polished and the work treated similarly to a stone; but, at the same time, I do not pretend to say it would not be possible to use a polished plate in connection with zincography. "D'Evyln" and others will see that there being no composition on the paper to be transferred, there is nothing to adhere to the plate; therefore, it would be next to impossible to pull it underneath a scraper, so that some other process must be used; hence the rollers.—PAPER CUTTER.

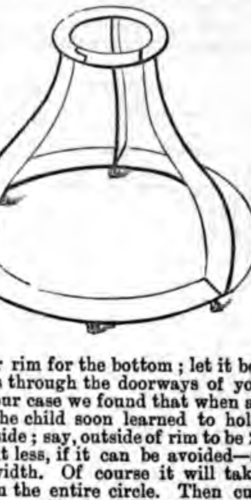
[33117.]—**Chamber Organ.**—A soundboard of 4ft. 6in. would rather crowd the pipes; but as some of your stops are short (that is to tenor C) they might be got in, and 2ft. would be wide enough. As to pedal pipes I am greatly exercised as to these just now. I have not heard a pyramidon, but from what I know of it I don't think it is suitable for a small organ. I intend having a bourdon, and can confidently recommend it to you. As for such a small organ it might be small scale. I wish myself to know, and should be obliged if you or any other correspondent could tell me what length the C C C bourdon pipe might be cut to at first, as, I think, it must be great waste to cut it really 8ft. long, and saw the surplus off. By no means omit the pedal pipes—they add greatly to the dignity of the organ tone. As to the best flute: I have made a suabe flute with inverted lips, which has a very sweet tone, and is not difficult to make. About 2¼in. inside *width, and 3in.* ditto depth, would be a very good *scale for the C C pipe, I think.—E. K.* ELLIOTT.

[33140.]—**Decimals.**—Your example is not printed quite accurately; however, the value of the correct series may be found by multiplying the numerators in the brackets by 16, and dividing by the denominators; the operation standing thus:—

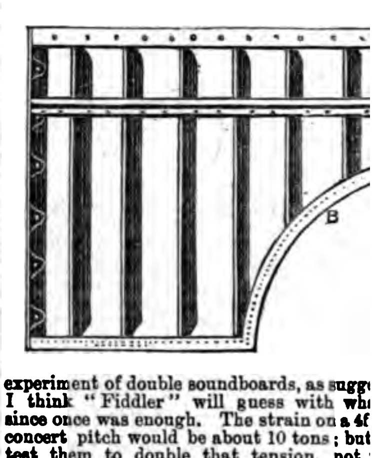
$$\begin{array}{r|llrr}
5 & 16 & & & \\
25 & 3{\cdot}2 & \div\ +1 = & 3{\cdot}2 & \\
25 & {\cdot}128 & \div\ -3 = & & -\ {\cdot}042667 \\
25 & {\cdot}00512 & \div\ +5 = & {\cdot}001024 & \\
 & {\cdot}0002048 & \div\ -7 = & & -\ {\cdot}000029 \\
\hline
 & & & 3{\cdot}201024 & -\ {\cdot}042696 \\
 & & - & {\cdot}042696 & \\
\hline
 & & & 3{\cdot}158328 & \\
 & & -\dfrac{4}{239} = - & {\cdot}016736 & \\
\hline
 & & \text{Ans.} & 3{\cdot}141592 &
\end{array}$$

—L. HARNOR.

[33153.]—**Hobby Horse for Crippled Child.**—When I read the above query I very anxiously awaited replies, because some fourteen years ago I required a similar contrivance for my son, who at that time was a very weak child, particularly in his loins and legs; and, believing it was quite necessary that he should have help to learn him to walk, and that help, if possible, to be applied by himself, I set about how best to obtain it, and, remembering hearing old people speak of the "go-cart" or hobby horse, I determined to make one. But here commenced a difficulty, for I do not think "here at least" that there was one in existence; so I had to be content with learning that it was a something that a child could be placed in, and push itself about, and, being tolerably well versed in the use of carpenters' tools, I set about in earnest to make one, which I soon accomplished, and the child took to it readily, and had not had it in use for more than a week or so before the little thing would run in it as hard as its little legs could patter, and very soon it had the desired effect of teaching him to walk or run without it. I need hardly add that we used it for our other children, and also lent it to friends who had seen it. I have somewhat digressed from the commencement; but I waited to see if anything better would be advanced, and up to this there has only been the reply of "E. B. F., whose plan, although commendable, is not so useful, for, whilst it acts in one direction only, this will act in all directions alike, so that, whichever way the child may lean, there is a corresponding move in the go-cart, causing the child to follow, and so giving the impetus to walk or run. Directions for making are as follows:—Whilst some person holds the child perfectly upright upon the floor, carefully take the height to under the arm-pits for the height of go-cart. Procure an 11in. by ⅝in. board, and strike out a circular rim for the bottom; let it be of a size that will pass through the doorways of your house, although in our case we found that when a doorway was narrow the child soon learned to hold it up a little on one side; say, outside of rim to be 2ft. 6in.—do not have it less, if it can be avoided—and let it be 3in. in width. Of course it will take several pieces to form the entire circle. Then cut another rim of 2ft. 5in., or ½in. less all round than the other, which must be securely screwed to the first, letting the top joints fall well into the middles of the first rim, so that, when screwed together, it will be stronger than a solid piece of a greater thickness, owing to the grain of the wood having been crossed. For the upper rim, take the measure of the child round the waist under the arm-pits, and cut a circular rim in one piece from a 2in. piece of board, which in my case was, outside measure, say 10in., inside 8in., making a solid rim 2in. thick. Do not have the inside much larger than the measure of child's waist, or it will, if not strong, when holding up its arms, drop through. With a sharp spokeshave carefully work this rim to a round, or at least take off all sharp edges sufficiently to take the pressure of the child without hurting it. With a dovetail saw make one clean cut through, then at a sufficient distance to admit the child's body, and also between two uprights, make another cut from the top side, half-way through, then turn it up, and from the under side, and half an inch nearer to the top cut, make another cut half-way through; then, with a frame saw, extend this cut laterally to the first cut, so that a good rabbet and bearing has been formed for the piece when closed. This will require hanging with a brass butt, and fastening with a small brass bolt placed underneath. Then procure eight castors, with flat screw plates, and fix the
distances on the under side of bottom
three pieces for uprights, say, cut as in sk
tenoned in both top and bottom rim. The
these must be such as to give the heigh
when all is together, giving a finished a
somewhat like sketch appended. Should "
think the plan worth while to try, I will
further by letter, or, if unable to make
riences a difficulty in getting one made,
objection, if he writes me to that effect, to
for him at a reasonable cost.—W. HORLE
House, Toddington, Beds.



[33193.]—**Iron Pianoforte.**—A "so
back is so named in contradistinction to t
article made of angle iron, and riveted
whereas the former is cast in one piece, a
no rivets to give way, will stand much
the breaking tension of the strings.
advantage is the facility with which the
curves can be formed, as at B, which grea
the quality of the tone. The plan of
strung back includes a shelf, A, on which
plank beds, and five or six parallel bars b
end pieces. These bars are 1in. wide at
tapering to ⅜in. at the back, and are about
at the middle, lessening gradually to 1¼i
juncture of the pin rims and top. "Fidd
of a double soundboard is very good in t
it lacks one essential—that is, posts, si
violin, to conduct the vibrations. If they
so connected, one would not affect the oth
effect, you might as well place two pian
back. I may as well mention that I have



experiment of double soundboards, as sugg
I think "Fiddler" will guess with wh
since once was enough. The strain on a 4f
concert pitch would be about 10 tons; but
test them to double that tension, not
doubts of the back, but for the purpos
stretching the wires. I know so little of
bilities of cast iron that I should have
"well hammering" would be the very
induce disaster. "Fiddler's" notion of
pin-piece needs no further commendation
say it has been adopted by all our leading
their "iron horizontal grands," but, fro
yielding character of the gun metal, it
necessary to encase the wrest-pins in a fel
they would either be too tight or turn too
believe, however, this arrangement is not
by tuners, since so much allowance has t
for the back turn that it is rather sug
Albert Smith's celebrated clock, which,
pointed to twenty minutes past three, a
eleven, was proved, by a series of ingenio
tions, to mean exactly nine o'clock. In sp
the merits of an iron over a wooden back
I was (like "Stringplate") for a long ti
prejudiced against them, and, when I w
convinced of their superiority, it was v
against my interest, for it so happened I
laid in a very large stock of seasoned wo
was thus rendered useless. I should n
"Fiddler" to go to the trouble and e
making a pattern, and having a casting fr
since these backs are becoming general the
at little more than the price it would
amateur to get the large number of holes
pinned; and I have every reason to believe
manufacturer is getting sufficiently awa
interests to advertise his list of prices
columns.—W. H. DAVIES.

[33195.] — **Dying Intestate.** — 1. L
administration ought to be taken out.
absence of any reason to the contrary th
granted to the widow. 2. The estate of the
will belong as to one-third to the widow
thirds to the child. The widow may, of c
and do what she likes with her one-third s
share of the child should be sold and in
Government securities. However advant
may seem to deal with it in business,
widow (even by unavoidable misfortune)
part of it she would be liable to make it g
her own property. 3. They cannot claim
of the deceased's estate. 4. They are not.
clusion the widow had better put the mat
hands of a respectable lawyer, as I do not
can arrange matters without legal help.—

33212.] — **Prussiate of** [illegible]. — I
Smith's answer to this [illegible] he m
and 2KFe3Cy?—F. W. W[illegible]

—**Improvements in Bicycles.**—I was the very same objections, but, being con- ıt my theory was correct, I replied, "Make ıtion, and I will run the risk." The result satisfactory, and it will turn sharp corners ıter safety than a bicycle. It is, I confess, avier to drive, but not so much as was an- —ALDERLEY EDGE.

]—**Green Pavement.**—Wash with water a little carbolic acid has been added. ufficient for a small pailful. The green robably a "conferva."—TRESSILIAN.

] — **Green Pavement.** — A solution of of lime (about a pound to half bucket of ıid on with an old brush, left on for a few ıen washed off with plenty of water, will rid ıe green for some months.—J. A. P.

]—**Green Pavement.**—Get some well- ıme shells, as burned limestone is usually Scotland, reduce them to fine powder with nouthed hammer, strew some of the powder ıvement during a shower of rain, or sprinkle with water from a watering-can, let this or 10 or 12 hours, sweep it all clean off; if ı mass has not disappeared repeat the opera- will clean it effectually.—AN OLD ME- No. 1.

.]—**Adulterated Carbonate of Lead.**— as much as possible in nitric acid. If any- soluble is left, it will be sulphate of barium tes). The solution must be divided into two and *b*. To *a* add a strong solution of of lime; a precipitation will take place. oes not completely dissolve in caustic soda, (as carbonate) was present in the original To *b* add excess of acetic acid, and then of oxalate of ammonia. If a precipitate indicates lime, most probably as carbonate. WOODMAN.

.]—**Adulterated Carbonate of Lead.**— owing substances are used to adulterate this ıd besides chalk:—Sulphate of barium, of lead, sulphate of lime, or carbonate of I have rarely found more than one sub- resent as an adulterant in samples I have l. The process I give underneath will do for ction of any or all the above, supposing them esent. If your sample is mixed with oil re- by means of benzine before testing. Car- of lead is readily soluble in dilute nitric acid. an insoluble residue remain your sample is e. The residue may be sulphate of lead, of barium, or sulphate of lime—perhaps a of all three. Well wash the residue, and with a little ammoniac sulphide. If you have washed away all traces of lead nitrate and lue turns black, sulphate of lead is present. solve in hydrochloric acid and boiling water, ıd prove the presence of lead in the solution usual methods. After washing the residue aining dry it, and fuse it with four times its of a mixture of carbonate of potash and soda. cool, and dissolve in hot water, filter, add ıt hydrochloric acid to the filtrate to drive onic acid, and then add a solution of barium A white precipitate, insoluble in acid, s the presence of sulphuric acid. The insoluble in water, must now be dissolved in ic acid, evaporated to dryness, and the s digested with alcohol. If calcium is pre- will be dissolved by the alcohol; if barium present, being insoluble, or, only soluble to a ght extent in alcohol, it will be left. Warm c solution and add to it ammonia and ic oxalate in excess—a precipitate of oxalate will make its appearance if lime is present. the barium chloride in water, and add to tion dilute sulphuric acid; a white precipi- ows that barium is present. Having proved ence or presence of lead, calcium, and barium es, proceed to examine the nitrate of lead for calcium and barium since if these sub- are present as carbonates they will pass into with the carbonate of lead. Evaporate the f acid, dilute and pass sulphuretted hydrogen the warm solution till all lead is precipi- s sulphide), and filter. The filtrate will con- adulterants, if present. Boil to expel sul- ed hydrogen, filter if necessary, and to the add excess of ammonia and ammonic car- Filter, wash precipitate, dissolve in HCl, ıte to dryness, and treat with alcohol, &c., as ed above.—T. J. H., Bury.

9.]—**Cobalt Oxide.**—If by "prepared oxide" an zaffre, it is "an impure oxide prepared by g cobalt ores with sand;" if smalt, that is a of potash coloured by cobalt oxide. Cobaltous CoO, is "a grey powder formed by igniting drate out of contact with air." Cobaltic or sesquioxide, Co_2O_3, is "a black powder when ignited, yields Co_3O_4, corresponding to magnetic oxide of iron)."—DAGHBERT.

2.]—**Boot and Shoemaking.**—Perhaps the ıg works may suit "B. W. W.," which are obtained from the office of *St. Crispin*, 50, ller's-row, Strand. The "Man's Man; a al Treatise on Making of Men's Boots and 1s. 6d.; "The Woman's, Man," a similar to above, in making women's boots and 1s. 6d.; "The Shoemender," containing in- ons how to proceed to make good any break ture in soles or uppers, 1s. 6d.; "Art of Cutting Out Modern Boots and Shoes," with numerous diagrams, illustrative of the proper mode of laying down patterns of all kinds on skins and fabrics, complete, in four parts, at 1s. each.—T. H. A.

[33233.]—**Cooking by Gas.** — "Gastronomy" will find that it is a much better, cleaner, and cheaper way of cooking by gas than by an ordinary fire. The stove which I recommened is one called by the makers, "The Wonder, No. A 55." It is made of sheet iron inside, and polished outside; size, 25½in. high, 14in. wide, 12½in. back to front. It has three compartments for roasting, stewing, baking, &c., also fitted with an apparatus for boiling on the top, on which three pans can be placed. It is very neat, taking up little room, cooking by reflection; price 50s., complete, with pan and grid-iron. I think this stove is fitted in every respect for "Gastronomy." It also can be purchased from any gas company.—STUDY QUIET.

[33233.]—**Cooking by Gas.**—We have a stove capable of cooking everything for a dozen people, and it works most satisfactorily. The gas jets are inside the lower part of stove, not above the meat, but at the bottom there are jets all round. I like this arrangement because the heat given off by burners circulates entirely around a joint of meat, and does not overdo any portion. This would not be the case with the jets above the joint. Personally, I object to having a boiler fixed to the stove, because it is an impossibility to clean such a boiler, whereas a saucepan or pot can readily be cleaned. And, again, unless the boiler is well supplied with water the iron would be cracked directly. I also do not care for the fire-clay; anything that tends to accumulate dirt should be objected to, and, again, anything using up heat should be discarded.—W. J. LANCASTER.

[33234.]—**Flute.**—I should advise "J. C." to try one of Rudall Carte's, 1867, patent flutes, in wood. They are fine instruments. The fingering is much different, but a few days would set all right.—G. O.

[33236.]—**Slide Rule.**—If "Cotswold" would purchase "Instructions for Using the Routledge's Engineer's Slide Rule," which may be had from any rule-maker, price 6d., he will find all the information he requires.—J. POLLITT.

[33236.]—**Slide Rule.**—On pages 568, 569 of the ENGLISH MECHANIC, for August 17th last, is the information asked for by "Cotswold" respecting the words "Square, cylinder, globe, over various figures and names of materials, &c.," and when those figures (which are called gauge-points) are correct, and correctly decimal pointed, "the lines marked C and D can be used to get the cubic contents of round timber" by setting the length on slide $\frac{B}{C}$ opposite the proper gauge-point on A, the answer being on line C opposite the diameter on D. Thus taking a simple example of round timber, say, 24in., or 2ft. long, and 7in. dia. = 22in. = 1·833ft. girt or circumference throughout. 1st. The gauge-point for dimensions of length and diameter being properly = circular inch per square foot × 12in. long = 2,200 (instead of 22, as shown on line of rule marked cubic feet under the word cylinder and letters I I)—

24 (ins. length) on slide $\frac{B}{C}$ set opp. g.-pt. 2,200 on A

Or, ·24 do: do. $\frac{B}{C}$ opposite 22 on A,

Opp. 7 (ins. diam.) on D is ans. on $\frac{B}{C}$ very nearly ·535 cubic ft. Or, 2nd. The proper G.-Pt. for length given in feet and diameter in inches being = $\frac{2.200}{12}$ = 183·3 (instead of 1,833 on rule); then—

2 (ft. length) on $\frac{B}{C}$ set opposite G.-Pt. 183·3 on A,

opp. 7 (ins. diam.) on D is ans. on $\frac{B}{C}$ = nearly . . ·535 cub. ft., as before. Or, 3rd. The proper G.-Pt. when length given in ft. and girt or circumference in inches being = 12·6. 2 (ft. long) on $\frac{B}{C}$ set opp. 12·6 on A, opp. 1·833 (ft. girt on D is ans., again on A = ·535 cub. ft.—BUTTERSHAW, near Bradford.

[33236.]—**Slide Rule.**—I would advise "Cotswold" to get one of Routledge's books on the rule. They cost 6d., and will explain more than I have space or time for here. They can be got at most scientific instrument makers. The figures under the heads of square, cylinder, globe, &c., are gauge-points for finding the weight of metals, &c. You must have a proper timber-contenting rule for measuring timber.—HENRY PALMER, Nunnery Colliery, Sheffield.

[33236.]—**Slide Rule.**—I have a pamphlet entitled "Directions for Using the Engineer's Sliding Rule, with a Description of the Several Lines Upon It," which is printed—and, I suppose, published—by H. Kemshead, Lower Kennington-lane, Lambeth. If he procures this I think he will find in it all he wants to know, or if he likes to advertise his address I shall be happy to lend him mine.—A. A. WATKINS.

[33237.]—**Gas and Formula.**—This query is so loosely worded that it is next to impossible to be comfortably certain as to its meaning. If "T. G. H." will write again, and state his wants more clearly, I shall be glad to help him, if able.—WM. JOHN GREY.

[33237.]—**Gas and Formulæ.**—This query is very indistinctly expressed. Perhaps this will answer it:—Refer to your table of atomic weights. C equals 12; H, 1; O, 16; S, 32. Then CH_4 equals 16; CO_2, 44; CO, 28; H_2S, 34. The percentage composition of CH_4, for example, is easily found by proportion, as 16 : 100 :: 12 : 75; and 75 per cent. carbon leaves 25 per cent. hydrogen. The law that most compound substances have vapour densities (compared with H as 1) which are the halves of their molecular weights will enable you to calculate these weights. Thus, 1 litre of H at standard temperature and pressure weighs ·0896 gramme (1 crith); and the same volume of H_2S weighs 1·52 gramme (1·52 divided by ·0896 = 17 criths). If, therefore, we call the density of H 1, that of H_2S will be 17, which is half its molecular weight, 34.—DAGHBERT.

[33242.]—**Right Ascension.**—Long. and lat. may be deduced from R.A. and dec., and vice versâ, by the following method:—In the figure let *s* represent the object whose R.A. and dec. are known, ♈ the first point of Aries, ♈ L part of the equator, ♈ L′ part of the ecliptic, so that ♈ L = R.A. of object S L dec. ♈ L′ long., S L′ lat., and L ♈ L′ obliquity of ecliptic. Now, by rules of spher. trig. (see Fig. 1), cos. ♈ *s* = cos. R.A., cos. dec. (1) and cotg. S ♈ L = sin. R.A. cotg. dec. (2); also in the right-angled triangle, S ♈ L′, we know ♈ S; the right angle, S L′ ♈, and the angle, S ♈ L, which = S ♈ L − L ♈ L′. Then, from the triangle, S ♈ L′, we get sin. long. = sin. ♈ S, sin. S ♈ L′ and tan. lat. = tan. ♈ S cos. S ♈ L′. Take for example Capella: R.A. 5h. 5m. 42·03secs. (in arc 76° 25′ 30·45″), dec. 45° 50′ 22·4″ N., the obliquity of the ecliptic 23° 27′ 25·47″.

FIG. 1

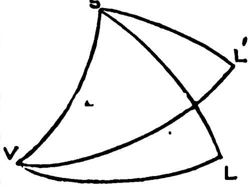
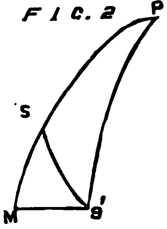


FIG. 2



R.A. cos. 9·3705425
Dec. cos. 9·8430271

♈ S 80° 35′ 19·54″ cos. 9·2135696
R.A. sin. 9·9876948
Dec. cotg. 9·9872707

S ♈ L 46° 39′ 1·68″ cotg. 9·9749655
Obliq. 23 27 25·47

S ♈ L′ 23 11 36·21
♈ S tan. 0·7805452
S ♈ L′ cos. 9·9634009

Long. 79° 46′ 40·94″ tan. 0·7439461
♈ S sin. 9·9941147
S ♈ L′ sin. 9·5953153

Lat. 22° 51′ 48·12″ sin. 9·5894300

The following is the inverse problem employing the long. and lat. already found:—

Long. cos. 9·2491053
Lat. cos. 9·9644643

♈ S 80° 35′ 19·54″ cos. 9·2135696
Long. sin. 9·9930515
Lat. cotg. 0·3750342

S ♈ L′ 23° 11′ 36·21″ cotg. 0·3680857
Obliq. 23 27 25·47

S ♈ L 46 39 1·68
♈ S tan. 0·7805452
S ♈ L cos. 9·8366072

R.A. 76° 25′ 30·45″ tan. 0·6171524
♈ S sin. 9·9941147
S ♈ L sin. 9·8616416

Dec. 45° 50′ 22·4″ sin. 9·8557563

The angular distance of two objects may be computed thus:—Let P be the pole, and S and S′ two stars whose places are known, then P S and P S′ will represent their polar distances, and the angle S P S′, will be the difference of their R.A.'s. Draw S′ M perpendicular to P S produced. Then, tan. P M = cos. S P S′, tan. P S′, also S M = P M − P S, and cos. P M cos. S S′ = cos. P S′ cos. S M; ∴ distance S S′ = $\frac{\text{cos. P S′ cos. S M}}{\text{cos. P M}}$. Example (Fig. 2): Required the distance from Aldebaran R.A., 4h. 28m. 57s., dec. 16° 15′ 24″ N., to Sirius R.A., 6h. 39m. 48s., dec. 16° 32′ 56″. Here S P S′ = 6h. 39m. 48s. − 4h. 28m. 57s. = 2h. 10m. 51s. − 32° 42′ 45″.

P S = 90° − 16° 15′ 54″ = 73° 44′ 6″
P S′ = 90° + 16° 32′ 56″ = 106° 32′ 56″
P S′ tan. 0·5270361
S P S′ cos. 9·9249988

P M 109° 27′ 3·3″ tan. 0·4520349
P S 73 44 6

S M 35 42 57·3
P S′ cos. 9·4545
S M cos.
P M comp. cos.

S S′ 45° 0′ 50·2″ cos.

Any other case may be treated in the same manner, whatever the decs. may be, observing that the polar distance is equal to 90° − N. dec. or 90° + S. dec.—L. Harnor.

[33243.]—**Silverlike Polish on Brass.**—A solution of nitrate of mercury will give a silvery appearance to brass, only, however, to make the metal just as bare in a few days as it looks bright at first.—W. J. Lancaster.

[33245.]—**Fancy Walking Sticks.**—Polish with glass-paper, and for a jet-black stain with extract of logwood (hot), and when quite dry stain with iron liquor, varnish or French-polish afterwards. For dark brown use extract of logwood only, more or less, until the desired tint has been obtained.—An Old Mechanic, No. 1.

[33246.]—**Chemical.**—(*a*) If silicic anhydride, calcic fluoride, and sulphuric acid be heated together the first change is—

$$\underset{78}{CaF_2} + \underset{98}{SO_2Ho_2} = \underset{40}{2HF} + \underset{136}{SO_2Cao''}$$

The hydrofluoric acid and silicic anhydride then act on each other thus:—

$$\underset{60}{SiO_2} + \underset{80}{4HF} = \underset{104}{SiF_4} + \underset{36}{2OH_2}$$

(*b*) Fe_2o^6 (generally written Fe_2o^{vi}) would be called ferricoxyl, were it called by any distinctive name, which, however, is very rarely the case.—Wm. John Grey.

[33249.]—**Lancaster's Microphone.**—A telephone must be connected with the microphone to enable you to hear the sounds amplified by the microphone. There are, of course, several forms of telephone that may be used, but up to the present no successful results have been obtained with the microphone as a receiver. I hope to have something in a few weeks to entirely dispense with the telephone.—W. J. Lancaster.

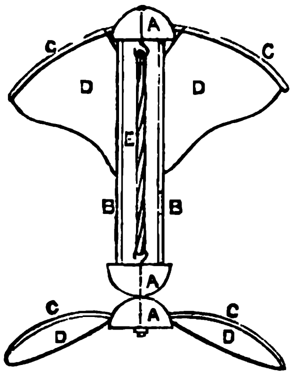
[33250.]—**High Pressure Horizontal Engine.**—This title seems a misnomer. It is a puzzle at first sight how a high pressure engine with a 20in. cylinder, as stated can only develop 15 indicated horse power. This would be accomplished by a mean pressure per square inch on piston of about 5·5lb. Now, unless there is an enormous amount of back pressure, which I infer from the coal consumption, the pressure of steam on entering the cylinder must be very low indeed. It would be very interesting if "H. L." would send diagrams, as he does not give the point of cut-off. But this is apart from the question. I presume that he wishes to get only 15 horse-power out of it, and to reduce his coal consumption. Of course, putting a liner bored 14in. in would be a step in the right direction; but even then there must necessarily be a large amount of waste. The friction of the engine itself will be considerable, and the condensation in so large a cylinder will be great. If "H. L." wishes to attain a maximum economy by working his engine with about 3 or 4lb. of coal per horse-power per hour, he will have to do it with a smaller engine altogether—say, a 9 or 10in. cylinder, and also a higher pressure of steam. Economy of fuel, to a large extent depends on the form of boiler and its setting, as well as the proper distribution of steam in the cylinder, the prevention of condensation, &c. Were "H. L.'s" engine working favourably, he would get about 4 times the power out of it, at least: but when he cripples it by keeping it down to 15 horse-power, he must not expect to work economically. At a very rough estimate the 15 horse-power is costing him about £96 per annum too much if regularly working.—Novus Homo.

[33250.]—**High-Pressure Horizontal Engine.**—There is evidently something wrong here. You call it a high-pressure engine, and yet from the horse-power it develops (according to your statement) you cannot be using steam at a greater pressure than 5¼lb. above the atmosphere. Again, the consumption of coal is enormous for the power exerted. You do not give the mean pressure of steam in the cylinder, nor do you say whether the engine works at all expansively. I should judge not. I fear it is impossible to answer your query, unless you give a little more data to go upon, such as steam pressure in cylinder, purpose for which engine is used, horse-power required, also kind of coal used. I do not see what you want a piston speed of 285ft. per minute for, especially when you say that the engine is too powerful. I am sorry to say it is too often the case that engines are put down under powered; very rarely the reverse.—Henry Palmer, Nunnery Colliery, Sheffield.

[33250.]—**High-pressure Horizontal Engine.**—"H. L." should first turn his attention to the boiler and stoker. See if the boiler is set on the best principles; that no "scale" is formed on the shell and tube inside; that the feed-water is sent into boiler hot, and near the low water level; that the stoker understands his work thoroughly. If the boiler and its appendages are in good working order then the most economical plan to reduce your very large consumption of fuel will be to take out the 20in. cylinder, and replace it with a 12in. This will do for anything up to, say, 25 I.H.-P., with the same pressure of steam as you are now using. Casing the 20in. cylinder to 14in. would not answer very well, as the ports and valve would remain the same, whilst the cost would be nearly as great as a new cylinder, to say nothing of the loss of heat by condensation in the passages. I have no doubt that you could get a good second-hand 12in. cylinder, with piston, &c., complete, in this district for a very low price—in fact, I know of places where cylinders of this size have been taken out to put in larger. In conclusion, you are burning at present at least 10lb. of fuel per I.H.-P. per hour too much, and if your engine works, say, 10 hours a day, the amount of fuel wasted amounts to nearly 10cwt. weekly, sufficient to keep an engine and boiler at work giving out the same I.H.-P. as yours. Having plenty of time on my hands just now I should like to superintend the job for you, guaranteeing the result. If you want me, advertise.—Lancashire Fitter.

[33250.]—**High Pressure Horizontal Engine.**—Is not "H. L.'s" trouble rather an advantage, if properly looked at? Instead of the curious alteration he suggests, would not cutting off the steam earlier and getting considerable expansion be the more rational and at same time economical way of tackling the difficulty?—F. W. S.

[33253.]—**Mechanical Bat.**—The common toy is made thus:—A A A, cork; B B, wood strips; C C C C, thin twigs or cane; D D D D, a fine tissue, skin, or paper; E, indiarubber, double or quadruple, attached to wire hooks. The bottom hook is loose and free to turn in the middle cork; the bottom wings are twisted round, while the upper ones are held, and when released the elasticity of E causes a rapid rotation in both pairs of wings, and the toy ascends with an erratic flight. The webs, D, must not be stretched flat, but loose at their lower margins, so that in revolving they screw their passage through the air. All the parts must be as light as possible.—Novus Homo.



[33254.]—**Electricity.**—You cannot very well platinise a carbon block, and if you require it for a microphone you may mercurialise it. Place it either in the fire or in a Bunsen's flame until it is white hot, then plunge it into a vessel containing sufficient mercury to cover it, when in put a weight on the top, and cover the top to prevent the fumes entering the room. When quite cool remove it. You may magnetise the bars by means of a large electro-magnet, well rubbing each half alternately on the two poles of the electro-magnet. A large horse-shoe magnet will do as well as the electro-magnet.—W. J. Lancaster.

[33255.]—**Electro-plating Birds' Feathers.**—I have coated an insect with a metallic deposit by the following method. No doubt it would answer for feathers also. The object was attached to a platinum wire, and soaked for about a day in saturated solution of silver nitrate in wood naphtha, then partially dried, and exposed to ammonia vapour by hanging it under a glass shade, in which is placed a saucer of ammonia solution. The ammonia reduces the silver nitrate, leaving a deposit of metallic silver. The object was then dried thoroughly, and inclosed in a test tube with a globule of mercury for 10 hours. The mercury was occasionally heated to increase the formation of vapour, which combines with the silver to form a conducting coat of amalgam on the object, which can then be electro-plated in the ordinary way.—J. Brown, Belfast.

[33256.]—**Photographic.**—Print your ferns on albumenised paper (sensitised, of course) in a printing frame till a dark brown, and then tone it a purple black, then fix in hypo bath.—G. O.

[33256.]—**Photographic.**—Prepare some albumenised paper with nitrate of silver solution, 60grs. to the ounce of distilled water; then hang up to dry, and when dry place behind a fern frond, with a glass in front. Expose to a bright sky until the black part is blacker than you want it; then take the paper into a dark room, and well wash it in water until the water remains clear; then tone in the following solution:—Distilled water, 10oz.; chloride of gold, 2 grains; acetate of soda, 40 grains. Then fix for five minutes in water, 10oz.; hyposulphite of soda, 2oz. Afterwards wash for four to six hours.—W. J. Lancaster.

[33257.]—**Diaphragms in Telescope Tubes.**—If you will refer to my answer you will find I wrote about a string touching edge of each diaphragm and the eyepiece tube. You cannot depend upon the eye; and, besides, the diameter of pupil is less than the high-power field lens.—W. J. Lancaster.

[33258.]—**Methylic Chloride.**—As I am at present engaged in special laboratory work I am sorry I cannot answer more fully "Handsworth's" query. I have not heard of a satisfactory investigation of this compound, but I understand that one of ou leading English chemists commenced, but gave u the enterprise. I have not heard anything of Mr. Vincent or of his paper, read to the French Academy more than was stated in the English Mechanic He is in error in stating that it liquefies at −33° C. for it is liquid at 12° C. higher, but he is right i stating that it can be kept for any length of time i sealed tubes, and that on its evaporation it produce a very low temperature capable of freezing mercury Further, he states that it is a very cheap mode o producing a very low temperature, which statemen I am not at present prepared to challenge, but I ma say, in passing, that M. Pictet's method of producing ice in large blocks is the best method of doin so that I know. As for Dr. Frankland's method have not heard of it. He does not speak of it in hi latest work, and if he does make ice by saline solutions and pressure there is nothing new, since thi is part of Pictet's process, which can be observe daily at the Paris exhibition. By way of supplementing what I have already stated about methylic chloride I may say that it is a gas without colour, havin a sweetish taste, and an etherial odour. It may b collected over water which dissolves 2¾ times it amount at 16° C. The gas has a specific gravity o 1·74. It burns with a white flame, tinged wit green, and produces by combustion OH_2, HCl an CO_2. When heated to 100° C. with KHo, KCl an CH_3Ho are produced. A very good method of preparing CH_3Cl is by boiling $ZnCl_2$ in twice its weigh of methylic alcohol in a flask, with which is connected an inverted condenser and a wash bottle, an passing a current of HCl through the boiling solution. The Ho in CH_3Ho is supplanted by Cl, an the impurities in the alcohol form a black visci mass. Dr. Richardson has made some slight investigations with CH_3Cl in connection with CH_2Cl_2 an $CHCl_3$. He does not think it is likely to come int general use medically, but he found that it acts as pleasant and powerful intoxicator by adding a littl sugar to ½oz. diluted with water. In smaller dose he considers that it might be useful as a soothin and refrigerating agent.—Hugh Clements.

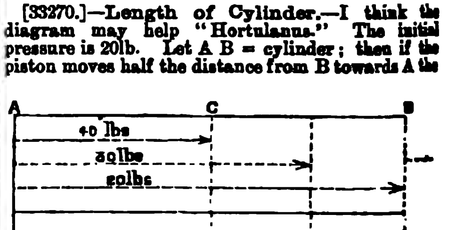
[33260.]—**Screw Cutting.**—As A. Lathan does not give the pitch of his leading screw we will suppose it to be 2 threads to the inch, and we want to cut 28 to the inch, what wheels must we have? Multiply both numbers by any other number, say 10, then $\frac{2}{28} \times 10 = \frac{20}{280}$; but as we have no 280 wheel, we say $\frac{20}{280} = \frac{5 \times 4}{20 \times 14}$; add ciphers = $\frac{50 \times 40}{200 \times 140}$; but as we have no 200 wheel, we divide by 2, which gives $\frac{25 \times 20}{100 \times 70}$. 25 spindle end, 100 stud-wheel, 20 socket pinion, 70 leading screw, or put both numbers down, and put any number you may select on either side of them, then multiply the two first numbers each by a number, and multiply the other two each by a number; for example:—

Threads.		Threads.	
8	28	2	8
	3		12
24	84	24	96

and you will find that 24 on the spindle end, an 84 stud-wheel, a 24 socket pinion, and 84 on the leading screw will give 28 threads to the inch. A set of change wheels generally consists of 22 wheels, increasing by 5 in number of teeth from 20 to 120, two of these being alike.—J. Pollitt.

[33261.]—**Crayon Drawings.**—If "J. Q. C." will get them carefully framed with glass in front and properly fix to back of gilded slip, and the whole rendered air-tight with paper pasted all round the edges, his drawings will not rub nor lose their freshness for many years.—An Old Mechanic, No. 1.

[33270.]—**Length of Cylinder.**—I think the diagram may help "Hortulanus." The initial pressure is 20lb. Let A B = cylinder; then if the piston moves half the distance from B towards A the pressure will be 40lb. = pressure at C. Now, $\frac{40 + 20}{2}$ = 30lb. equals pressure half-way between B and C; but the piston had passed over a space of 2 inches when a pressure of 30lb. was reached. Therefore B C = 4 inches, and total length = 8 inches.—Henry Palmer, Nunnery Colliery, Sheffield.



[33270.]—**Length of Cylinders.**—The data stated are not sufficient, and before the question could be answered the relation between the pressure and density must be given or supposed understood. If the density be supposed to vary directly as the pressure (which is practically true at ordinary temperatures and pressures) then, by increasing the pressure in the ratio of 2 to 3, we increase the density in same proportion, and consequently decrease the volume in the ratio of 3 to 2—that is, we have reduced it by ⅓ by forcing the piston through 2in.: therefore the distance between piston and bottom of cylinder at beginning of experiment was 6in.—J. Brown, Belfast.

[33270.]—**Length of Cylinder.**—As the piston in moving 2in. increases the initial pressure by ½, or, in other words, multiplies it by $\frac{3}{2}$, it must reduce the cubical contents by ⅓, which would indicate that the cylinder is three times 2in. long, or 6in. I presume that the piston before starting was at the end of its stroke.—A. A. Watkins.

[33270.]—**Length of Cylinder.**—The length of cylinder will be 6in.—Novus Homo.

[33271.]—**Leclanche and other Batteries.**—The following is the way I have made several very good Léclanché cells, and will perhaps suit "John:"—Select outer jar (preserve or pickle jar with large open mouth), and get an empty medicine bottle that will stand inside the outer jar, and leave the neck protruding from the top. Bind some strong twine round the bottom of the bottle several times and tie tightly, and then with a small hammer give the bottom a quick sharp blow. If the string is tied tightly, and the blow well directed, in nine cases out of ten the bottom will crash in, leaving the rest of the bottle whole, but it is none the worse if there are a few cracks striking upwards. Trim the ragged edges as well as you can by gently tapping any sharp points with the hammer, and afterwards rub down with a file, then make a bag of three or four thicknesses of calico that will just draw tightly half-way up the bottle. The carbon pole will have to go up through the hole in the bottom of the bottle, and should just reach up to the neck. Now drill a hole down the top of the carbon and solder in a piece of brass wire, about ⅛in. thick, that will go up through the neck and protrude about 1in. Let this wire pass through the cork, which should be cut down to a level with the top of the neck, and well sealing-waxed over to make airtight. Now pack the carbon pole round with a mixture (in equal quantities) of peroxide of manganese and charcoal. Draw on the calico bag, and tie it round about an inch from its top with string. The zinc should be about as long and as broad as the bottle, and about ⅛in. thick, and also have a piece of brass wire soldered on to stick up about 1in. above it. Now fill the outer jar rather more than half full of water, put in sal-ammoniac in proportion of 1½oz. to a pint of water, and let it stand till dissolved. Then put in the bottle containing the carbon and the zinc, and after standing a few hours a very good and strong battery will be the result. One thing more may be done which I am inclined to think is an improvement, and that is, fold up some clean blotting-paper, about four thicknesses, and about the size of the zinc plate, and place it between the zinc and the bottle containing the carbon. I use two cells made in this way for my microphone with very good results indeed.—T. J. Mercer.

[33271.]—**Leclanche and other Batteries.**—In the English Mechanic of June 7th, page 321, No. 32963, I gave a detailed description of how to make a constant battery, such as you want. Follow the directions given there, and you are sure to succeed. If you cannot get the porous pots make them thus:—Cut strips of brown paper 5in. wide and 20in. long, and roll each of these over a broomstick into a cylinder, fold over the bottom, and fix bottom and joints with sealing-wax. If you find any difficulty write again.—Wiesendanger.

[33271.]—**Leclanche and Other Batteries.**—If "John" will follow my instructions he will, I think, succeed in making a Léclanché cell. If he can procure no porous pots, a bag made of sail-cloth will do, as the object of the porous pot in the Léclanché is merely to restrain the pounded carbon from mixing with the sal-amoniac solution. Firstly, let "John" procure a common preserve jar of a good size, a piece of common sheet zinc about 1¼in. × 6in., and solder a bit of copper wire to the top. Next make a bag of sail-cloth, round, and about 2in. in diameter and in. to 7in. long; get some coke, broken up into little pieces, the size of peas, and a stick of gas carbon, with a bit of wire at one end (the deposit formed inside gas retorts). To put the cell together place the carbon inside the bag, or, better, porous pot, and pack the pounded coke round it—this forms the inner cell; place this in the preserve jar and put the strip of zinc in the jar outside the bag. Fill the outside jar about ⅔rds full with a saturated solution of sal-ammoniac, or, if this cannot be got, common salt. I have never tried flower-pots, but if the bottom hole was stopped with plaster of Paris I see no reason why they should not answer: their shape would make no difference. The zinc should be amalgamated; this is easily effected by dipping the zinc in sulphuric acid and water in proportion 1 to 11 or 12, and then placing on the surface a drop of mercury and rubbing over with a piece of cloth. A couple of such cells will ring an electric bell.—Alpha Beta.

[33272.]—**Diseases and Shoeing of Horses.**—The most modern book I know of is one published by Chapman and Hall, 193, Piccadilly, by G. Fleming, F.R.G.S. I got one a few years ago for my young men to read; but with all that they want practice and instructions.—Andes.

[33274.]—**Telephone.**—The noise of the shots would prevent you from hearing the faint sounds of a telephone. Give up the idea.—Wiesendanger.

[33274.]—**Telephone.**—I have tried the telephones at the rifle range of the 4th Surrey, Streatham-common, and they worked splendidly through 600 yards of wire—the longest I had with me—No. of wire 22 B.W.G., indiarubber and cotton-covered, laid carelessly through the grass, the novelty being in the earth circuit, which was as follows:—A rifle-cleaning rod being stuck in the ground at the target end, with a piece of naked wire round the top, and connected to instrument, the same being done at the firing point with another rod and naked wire, of course, line wire being connected to instrument at each end. I hope to have it at work again on July 6th, at the place named above. If "W. G." is in that vicinity I shall be pleased to show it him.—Oliver Powell.

[33274.]—**Telephone.**—I am not aware of the telephone having been used for rifle practice. I do not see that anything would be gained. The signals are so good, and so easily seen by every one, that there is no need for telephones.—W. J. Lancaster.

[33275.]—**Dispersion of Sound.**—The dispersion of sound is not an accomplished fact, nor do I think it ever will be accomplished. The difference between undulations of light and vibrations of sound is sufficient to account for the non-dispersion of sound. I do not consider the convergence of sound-waves behind a collodion balloon to be due to refraction—that is, refraction in the media used (as with light),—but simply the retardation and bending over of a sonorous vibration—in point of fact, resembling more the reflection from a curved surface in going in a straight line from the reflecting surface. Thus a sonorous condensation reaching the convex surface of the balloon would be retarded, and its concentric vibrations would fall over towards centre of balloon, and thus pass through the opposite side of balloon, and so be converged; but I believe the movement of a watch from and to a balloon would not, as in the case of light, have its focus altered. I have never been successful in obtaining results proving refraction of sound.—W. J. Lancaster.

[33279.]—**Composition.**—Mix 14lb. of glue, 7lb. resin, ½lb. of pitch, 2½ pints of linseed oil, 5 pints of water, more or less, according to the quantity required. Boil the whole together until dissolved, and as much whiting as will make a stiff dough; mix well. (From "Workshop Receipts.")—G. O.

[33279.]—**Composition.**—I think guttapercha would answer your purpose, as it can be easily softened in warm water, and moulded into almost any shape, which shape it retains when cold. It also, if necessary, can be dissolved in naphtha.—A. A. Watkins.

[33279.]—**Composition.**—Take powdered chalk and as much thin glue as will make it into a paste, knead well, then oil the moulds, and press the composition well in. It grows very hard. Make no more than is wanted at once.—Another Sand Rat.

[33285.]—**Cutting Grindstone.**—Chip it true with old files. Have the stone dry before beginning, and have some one to turn it towards you while you chip it true. The end of the file, when smooth, may be broken off, and the remaining part again used.—W. J. Lancaster.

[33285.]—**Cutting Grindstone.**—Use iron hooping (about ⅜in.) as you would a lathe tool. You must have a rest, and as soon as an edge is ground on the hooping turn it over; use plenty of water.—F. C. F.

[33290.]—**Nodules in Limestone.**—A nodule consists of a central nucleus, around which limestone, flint, ironstone, &c., may have aggregated. Thus a minute organism may be the centre around which the deposit has taken place, and I have numbers of flint nodules containing algæ, &c. Sometimes the nodule has an inorganic nucleus. Ironstone nodules are very often found, and are probably the ones you refer to in query.—W. J. Lancaster.

[33297.]—**Magnesium.**—Magnesium, to be of use as an illuminating agent, must be burned in its solid form; but its high price—15s. per ounce—will prevent its being used.—W. J. Lancaster.

[33298.]—**Solar Microscope.**—To Mr. W. J. Lancaster.—At once the best, most effective, and, I may add, cheapest light, is the limelight. For your purpose it is essential to have a brilliant source of illumination. To convert your solar microscope into an oxyhydrogen microscope you will have to use it in its present form, with lowest power objective, and low power eyepiece. In place of the mirror you will require a condensing lens, made up of two planos 3½in. diameter, and 3in. combined focus. Immediately at the back of stage you can have a concave lens, about 1in. in diameter, to convert the pencil into a pencil of parallel rays; then use the microscope in a horizontal position, and cover all over, so that no light may be lost. Have the screen about 3ft. away, when you will be able to obtain a very good image. Still, at the best, it will not be so satisfactory as by using an ordinary microscopic power, and if you think of making an oxyhydrogen microscope write another query, and I will give you all the information.—W. J. Lancaster.

[33301.]—**Telephonic.**—The wire ought to work well on short circuits, and should answer every expectation on the magnets. There is one point you have gone wrong in—that is, the central magnet: instead of being in a ½in. bring it out ¼in., and let it be about ⅛in. from plate, then they will work well. For longer distances use 32 to 35 wire. The 28 is of no use for a large electro-magnet: it would do very well for an electro-magnet for a bell, but not for a larger one. 16 to 18 would do.—W. J. Lancaster.

[33304.]—**Old Tin Goods.**—Please to refer to No. 681, page 128, of present volume.—Telescope Tele.

[33308.]—**Photography.**—Have a longer camera, or make an adapter to take the lens 4in. long, so that you can get close up to engraving. With such a lens you can easily copy full size, if your camera is long enough.—W. J. Lancaster.

[33316.]—**Preserving Moths, &c.**—After they are set dip them in a solution of corrosive sublimate in methylated spirits. The solution must be weak, or it will leave an unsightly deposit when the spirit has evaporated.—F. C. F.

[33321.]—**L. and N.W. Engines.**—Isabella, Hardwicke, Princess Helena, and Abercrombie all belong to the class of 4-coupled Ramsbottom engines, cylinders, 17 × 24; driving and trailing wheels, 6ft. 7½in. in diameter. This class comprises those engines numbered 1,513-1,531, 1,480-1,489, 1,666-1,685, and also the 380, 393 class, and the 1,744 class. Sphinx is one of a very numerous class of engines of the same design as the 1,480 class, only 6ft. wheels. Prince of Wales (291) was in the Abergele accident; it was repaired, and has been at work ever since. I do not know what the accident "Murano" refers to was, but if he means the Tamworth accident the engine was Stephenson (279), and if he means the Harrow accident, Clyde (833) was one of the engines. Antelope's number is 2,183, and that of Princess Louise is 1,177. I was much astonished to read that the G.N. Company have only 38 engines over twelve years old. On the N.W. there are 30 passenger engines, all of one class, whose dates range between 1857-1860, and more of other classes than I can enumerate. It is in a great measure owing to the inefficiency of these engines that so many complaints are made on the North-Eastern division, especially in winter. I hope "Itzaex" will have time soon to give us some of Cornwall's performances.—L. L.

[33322.]—**Cementing Iron Pipes.**—1 sal-ammoniac, 2 flowers of sulphur, 80 iron borings. Pound up in a mortar the two first, then mix the three when wanted, add water to make of a proper consistency, and then apply.—Telescope Tele.

[33341.]—**Lawn Tennis Balls.**—You might give it two or three coats of paint put on lightly, or if that will not do, re-cover it.—Telescope Tele.

[33345.]—**Duration of Sunshine.**—The amount of sunshine at Greenwich is obtained by Campbell's registering sun-dial. *Vide* "Registrar-General's Reports."—X.

[33347.]—**Battery.**—If you will use strong nitric acid in the outer (iron) cell, and dilute sulphuric acid in the inner (porous) cell, you will find the battery a very powerful one, but rather expensive on account of the nitric acid.—J. T. W.

[33347.]—**Battery.**—If the outer covering, A, were made of copper the cell would be a Daniell's, which is worked by dilute sulphuric acid (10 parts of water to 1 of acid) in the porous cell, and sulphate of copper in the outer pot. I should think that, by substituting a saturated solution of sulphate of iron for the sulphate of copper, your battery would work well. If there is a shelf in the outer compartment it should be filled with solid lumps of sulphate of iron, which makes a very good constant cell. The iron, by this means, would not be dissolved at all, but rather improved by use. The zinc should be amalgamated with mercury, which prevents it being worn away too soon, and increases the steadiness of the action.—F. W. S.

UNANSWERED QUERIES.

The numbers and titles of queries which remain unanswered for five weeks are inserted in this list, and if still unanswered are repeated four weeks afterwards. We trust our readers will look over the list, and send what information they can for the benefit of their fellow-contributors.

Since our last "R. N. H." has replied to 32608.

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32773. Sir Isaac Newton's Magnet, 176.
32775. Fossil Fern, 176.
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QUERIES.

◆

[33350.]—**Copper Smelting.**—Would any correspondent acquainted with the process of copper smelting kindly inform me how much silica I must add to an ore having the following composition, so as to form a slag which must not contain more than two per cent. of copper?

SiO_2 = 10·00 per cent.
Al_2O_3 = 2·00 „
Fe_2O_3 = 70·00 „
CaO = 5·00 „
Cu, Zn, S, and Pb = 13·00 „
100·00 „

Also please show by chemical formula how to arrive at the correct quantity of silica to satisfy each constituent?—Frank.

[33351.]—**Rifle Shooting.**—I have often heard it asserted that with a given elevation a rifle bullet will drop sooner if fired over water than over land. Is this correct, and if so, why?—Wm. John Grey.

[33352.]—**Gas Meter.**—Will some one be kind enough to direct me how to run a gas-meter back to 0?—W. P. Iron.

[33353.]—**Ash in Tea.**—To Mr. Allen.—Upon what authority does Mr. Allen state that the real proportion of ash in genuine tea is 5·66 to 5·75 per cent, as it is something different to that?—J. Saunders.

[33354.]—**Salt Pan.**—I wish to form a salt pan for opening an evaporation of sea water, also to entirely free such salt from atoms.—Urra.

[33355.]—**Injector.**—I have a small boiler which I want to feed with an injector but cannot get one small enough. Will any reader kindly give me details of the most approved pattern? I wish to make one myself.—J. C. R., Nottingham.

[33356.]—**Qu.**—The letter q is, in ordinary orthography, always followed by u. Why then are these two letters not cast in type together as one? Of course with the capital Q this would not do, as it is sometimes followed by a capital, sometimes by a small u, and sometimes stands alone.—J. Brown, Belfast.

[33357.]—**Tanning.**—What Australian and other barks are used by English tanners, and has mangrove bark ever been used or tried? Kindly give details of the most successful tanning process not requiring machinery, also description of pits required, &c.—Urra.

[33358.]—**Chemist and Druggist Receipt Books.**—Will any of our chemical friends inform me of a good chemist and druggist receipt book?—T. H. A.

[33359.]—**Unfermented Bread.**—Noticing in April last a letter signed "A Physician," recommending a process for making this by using acid hydrochlor., sodæ bicarb., and salt, I have been induced to have a try. The result is not satisfactory. We have closely followed the directions given—all the proportions have been strictly observed, and the bread is as sad as I am when I taste it. My wife is very good over the matter, making no remarks about "new-fangled ideas," and even suggesting another try, but on the whole I think we will wait a bit. Possibly "A Physician" can suggest a reason for the bread not having "risen" properly—in fact scarcely at all. It was upon being made put straight into a hot oven, and, as I have said, is "heavy."—R. M. Summer.

[33360.]—**Willows.**—Can any of our gardening correspondents assist me under a difficulty? I have recently purchased a piece of land in an exposed situation, and planted a number of slips of willow for protection. I do not reside near the place to look after it, and the children of an adjoining parochial school amuse themselves by pulling up the cuttings and carrying them away—perhaps out of mischief, possibly with no motive whatever. If properly rooted there would be difficulty in tearing them up, as it would take some trouble to do so. It occurs to me that if planted in the form of seed the plan would be just the thing, as they would not show through the grass until pretty strong. Is there such seed? Are they the willow catkins, and would they be pretty sure to grow? If so, when could they be obtained from a nursery man, at what time should they be gathered, and would it do to plant them late in the year, say in September?—Semaj.

[33361.]—**Shutting Cast-Steel.**—How can I best shut cast steel together?—W. Edwards.

[33362.]—**Telephonic.**—To Mr. W. J. Lancaster.—1. Would you kindly say whether Bell's telephones are used with a battery or not for ordinary speaking, as a friend whom I wish to convince to the contrary will not believe me, but says he will believe you? 2. Having made a rather defective pair of telephones and a microphone (after your excellent pattern), which is extremely sensitive to every sound, I wish to know whether it is usual in using the microphones to hear a continual roar or rattle which very much interferes with trying to hear any particular sound which you may wish to listen to; also are general sounds such as carts and carriages moving, doors shutting, people walking, &c., in the best microphones distinctive—in fact do you hear the exact sound of a door shutting or do you merely hear a roar, because that is all I hear? Do you think it is the telephone or microphone in fault, if either? I may say that I have heard a watch ticking quite as loud as if at my ear through 120 feet of wire. 3. Ought a weak magnet to have more wire round it than a strong one, or *vice versâ*?—W. B. Prideaux.

[33363.]—**Battery Power.**—Would some one of our electrical friends kindly advise me in the following? A box containing a series of soft-iron wires wrapped with fine silk-covered wire, with the ends of the iron wires exposed at one end of the box—these exposed ends are placed opposite other wires in another box. Now, by sending a current of electricity through the covered wires, would the soft iron wires be sufficiently magnetic to draw the wires in the second box from their places, say half an inch, the size of these wires being ¼ by 5 inches, and what strength of battery would be required?—Would-be Inventor.

[33364.]—**Blueing.**—I have been trying some experiments in blueing the heel plate of a gun, which is curved and irregular in form. I use an ordinary sheet-iron pan placed over a forge fire; the open pan is filled with powdered charcoal, and I place the brightened surface of the heel plate in it, the whole of it imbedded in the charcoal. I find it does not succeed; that part which touches the red hot pan is well blued, but the raised or curved part further from the pan is only purple or brown. How can I blue the surface perfectly and evenly? Some of the patent glass-cutters are well and evenly blued.—Lodovic.

[33365.]—**Transparent Polish for Walnut.**—Will some one tell me what would be the best transparent polish for walnut? I do a great deal of fretwork and want a very high polish. Please tell me how to apply it.—Beaumont.

[33366.]—**Raising Water.**—I am much obliged to "Sigma" for his suggestion of a windmill, but it would hardly answer my purpose at this season when there is little or very uncertain wind. I know that some little time since a correspondent in the English Mechanic described a self-acting siphon, of which he said he had put up one or two, if I mistake not, in one or two houses in London. There was also a diagram of it, but unfortunately I cannot lay my hands on the number containing it. Can any reader kindly help me to recover it?—Habitans in Sicco.

[33367.]—**Astronomical.**—Will any one versed in astronomy explain how to erect a scheme or figure of the heavens for any given time?—Triangle.

[33368.]—**Hay Fever.**—To "Incog."—Would you mind turning your experience in the direction of a very troublesome and distressing, if not serious, "ill that flesh is heir to?" I have hay fever from middle of June to end of July, and its attacks almost incapacitate me for any business during these six weeks, besides making me very miserably uncomfortable and irritable. I believe there are many others who suffer similarly. I have found relief in snuffing up my nostrils a weak solution of quinine, and the application outside the nose of glycerine well rubbed in; but to say the least these are somewhat conspicuous treatments as the glycerine looks curious, and the quinine involves a prompt flow of a peculiarly tenacious gummy mucous from the nose and throat. That hay fever is constitutional I think is proved by the fact that even at sea very far from land, consequently all hay, I have found on awakening that my eyelids were literally glued together with a quantity of gummy matter exuded during the night from the corners of my eyes—otherwise I did not suffer, unless I drank a bottle of porter, when very curiously I at once had a sneezing fit, same as characterises it on land. Bitter beer has no effect, and brandy and soda-water seems even to be beneficial. After an attack the whole body is most disagreably heated, and the face is gummy with a peculiar perspiration which I find best removed with warm water and brown soap, alkali seemingly having a decided power over it.—F. W. S.

[33369.]—**Stamping Foreign Goods.**—I have recently placed an order on the Continent for the manufacture of an article (which I cannot now obtain in England at the price), upon which it is necessary my name and address should be stamped. The manufacturer has, however, written to say that he cannot do this without getting into trouble with the Board of Trade, it being illegal to stamp foreign goods. Is this so? I shall be glad if some one would kindly enlighten me.—Puzzled.

[33370.]—**Clock Stopping.**—Will "Seconds' Practical Watchmaker" kindly say what is the reason of a clock stopping in the winter time which goes well in the summer? It has been cleaned two or three times without making any difference. It is one of those old-fashioned hall clocks with mahogany case.—Telescope Tele.

[33371.]—**Yacht Designs.**—Can any one tell me where I can find drawings to scale for building a model yacht? The model shops in London don't sell them. I have seen this question asked, but the only answers have been three or four sections drawn by the eye, and are no use for building a good yacht. One I built, from drawings in an encyclopædia supposed to be perfectly correct, had to have several ribs changed before I could get a good clean run all over. If any other readers are in a like dilemma they will find two very good designs in the "Encyclopædia Britannica" of the "Titania" and "America," in the article "Ship Building," Vol. XX. I shall be very glad to send a copy of either to any one in exchange for a like design of any well-known cutter or schooner, the design to include deck plan, vertical sections not less than six, and elevation.—W. F. Knox, Greenhill, Coleraine, Ireland.

[33372.]—**Sulphuric Acid.**—Will Hugh Clements, or some equally gifted chemical correspondent, be good enough to inform me with what addition of water sulphuric acid reaches its best strength for combining with oxide of iron, and assuming the initial gravity of the acid to be 1,750°, what should be its gravity when combined with the quantity of water recommended, and also when its power of combining with oxide of iron has reached its minimum?—English Mechanic Apprentice.

[33373.]—**Bleaching Gutta-Percha.**—Will some one tell me how to bleach small quantities of gutta-percha?—G. C. B.

[33374.]—**Steam Heat.**—What pressure would steam indicate at 200°, 300°, and 400° Fahr.?—G. C. B.

[33375.]—**Wild Flowers.**—Would any correspondent oblige me by naming a mixture that will preserve the colour of blue or purple flowers, and prevent them from turning brown when dried?—W. W.

[33376.]—**Measuring Focus.**—Will any of "ours" enlighten me on the above? In measuring the focus of a lens where do you measure from—the side nearest the focus or the side farthest from it, or midway between the lens?—J. A. W.

[33377.]—**Cloth Analysis.**—I work in a weaving factory and am anxious to learn how to analyse cloth, so as to be able to make a draught for the healds and a tie-up for the tappet. Can any one recommend me a good book on the subject? This is a subject which might be discussed in your pages with advantage.—Frogg.

[33378.]—**Works on Chemistry.**—Thanks to Mr. Allen and Mr. Lancaster for replying to this query. I am afraid I did not put my question intelligibly. I want to know what work would be recommended for a course of general chemistry before proceeding to actual analysis—a work both theoretical and practical that could be worked through. Would you kindly advise? Have access to Miller (old edition).—F. C. F.

[33379.]—**The Zodiacal Light.**—I shall be very greatly obliged if any of your correspondents will inform me if the zodiacal light has been observed in the British Isles during the current year, and where I can find the dates and places.—X.

[33380.]—**Daniell's Cell.**—I took a glazed
which I put a cylinder of sheet zinc (probably i
within this I placed a porous pot, and a strip of
therein; the porous pot was filled with crystals o
sulphate and water, and plain water was placed
outer jar. After working a little while I find that t
becomes covered with a black deposit (what is it
that bubbles come up from the zinc, showing local
even when the poles are not connected. This occ
after time, though not so much after amalgamat
zinc. Why is it, and how can it be prevented?—Z

[33381.]—**Wind Instruments.**—I have bee
scriber to the English Mechanic since Vol. X., a
read nearly every line that has appeared in it sinc
indeed, many parts a good many times over. Duri
time, although music and musical instruments hav
fair share of your pages, the chief attention h
given among musical instruments to organs, pian
and violins, and very little to what are called wind
ments, though of course the organ is a wind inst
But I refer to the wind instruments in an orchest
more especially to the brass ones. Is there no one
us as gifted in this department as was "The Har
Blacksmith" in his? There were some excellent
by "E. J. P." on the arrangement of music f
instruments, but nothing about the instrument
selves. Take the French horn, for instance: whe
first used in an orchestra and when did it develop
Then the trombone? I have been told that the
trombone was revived from a Pompeian drawing.
that what I have written will evoke some inform
a subject which, I am sure, will be interesting to
your subscribers.—R. G. L.

[33382.]—**Making Bicycle Wheel Rigid.**-
a 54in. bicycle, the wheel of which I want to make
inserting four wires inside hubs, as described i
14452, and would be obliged to know the thicknes
steel bars fixed between the hubs, and if fixed in b
of nuts or screwed through both hubs; or would
clamp a piece of iron of proper shape on the axle
the hubs and attach the wires to it, which way
prefer if the clamp would not slip on axle.—R. E.

[33383.]—**Roller Bearings.**—I am thinking o
roller bearings to front wheel of my 54in. bicycle
has at present coned bearings, one cone being fixed
the other on an adjustable crank; but before d
would like to know if I would gain much advan
speed. My axle being ⅝in., what should be the d
and number of rollers, and would a gun-metal cas
contain the rollers? I do not wish to take the co
hub away, and would be obliged to know if it w
much in the way. I should have room to have the h
1¼in. long.—R. E. S.

[33384.]—**Microscopic.**—Can any reader inf
how I can, with a microscope, project object on a
the disc of light not to be more than 4½in. in dia
what kind of light to use?—A. Sells.

[33385.]—**Painting.**—Can any one explain wh
in most, if not all, tar varnishes that corrodes ir
suggest any cheap iron paint that will not corrode?
lamp-black and boiled oil alone suffice for iron hard
propose making a series of experiments on a sma
with the many different kinds of cheap tar varni
wood, and would be obliged to any reader wh
advise with respect to the size, thickness, situatio
exposed, and of the wood used. I wish to do it thor
using as I do a large quantity; and I would publi
results, if acceptable, in the Mechanic.—Structu

[33386.]—**Noise in Water Pipes.**—Having
come to reside in a new house and locality we fi
selves occasionally annoyed when the city water is
on and the cistern just full by a booming sound a
passing through the pipes, the ball tap at the sa
vibrating up and down on the surface of the water.
gently pressed down by the finger the ball remai
nor does it always vibrate when the cistern is filled
simple remedy that could be personally attended to
much oblige—North Countryman.

[33387.]—**Silico-Ethers.**—To Hugh Clem
Many thanks for "anhydride" reply, and may I
following?—1. There seems some mistake in th
or notation of the following:

Silicio-triethylate SiE_4O BP 153°;
Silico-nonylic alcohol $SiE_3C(MeH)HO$ BP 1

The sum of the elements are in both cases id
2. What are the simplest notations for the f
bodies?—Ethylic-diethoxalate, chlorether, ethyl
ther, diethylated-ethylic ether. The desire is to kn
these bodies are apart from the double atoms of t
tions, which have occasioned some confusion,
probably my fault. 3. How is it that so many
bodies are one vol.?—

		Weight.
Silico-heptyl-hydrogen ...	SiE_3H	116
Silico-triethyl ether ...	SiE_4O	160
Silico-diethyl ether ...	SiE_4O_2	176
Silico-methyl ether ...	$SiMe_3EO_3$	150
Triethyl silicol	SiE_3OH	132

—One in a Fog.

[33388.]—**Larder.**—I live in a house where th
cellar. Can any one inform me how to const
moderate expense either inside or outside the
place where meat, &c., can be kept cool during
weather without going to the expense of constr
cellar?—Y. L.

[33389.]—**School Board Education.**—I
formed that an interesting work has been p
during the last three or four months, pointing
shortcomings and the costly expenditure of the
system of School Board education. I should b
obliged if any of your readers could kindly giv
title of the book or the name of the publisher.—C
ton Moore.

[33390.]—**Shellac.**—I wish to remove the
matter from an alkaline solution of shellac.
will not answer. I believe it can be done with
charcoal. Will some experienced reader kindl
how?—W. H. P.

[33391.]—**Canary.**—Amongst the valuable hi
have lately appeared in the E. M. for the prop
canaries, and cure of the complaints which cana
heir to, I have seen none which will apply to
which appears to be suffering from some chest o
never singing as he used to do, but continually
and panting, although in good condition app

Can any one suggest a remedy ?—Wild

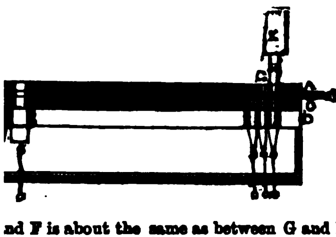
upiter and Saturn.—Having ascertained ets Jupiter and Saturn will be very near at s of 1880 and 1881, I should feel myself in- of your correspondents who will inform me arest approach of Jupiter and Saturn takes they will then be seen together in field (40′ of telescope.—G. T. G.

eclanche Cell, &c.—Will Mr. Lancaster he only half fills a Léclanché cell with sal- ution ? Also how much wire should I wind on 5in. long, ½in. diameter, and what size ferro- ould I use ? What difference would there be tton-covered wire instead of silk-covered th cases) ?—R. N. C.

Piano.—Having had a new one in use a few and five of the top notes having more or less and when struck by the key, although the r to sound right when plucked by the finger, ch obliged if any of your musical correspon- dly inform me if, and how, the notes can be eir proper tone again.—P. S.

The Harvest Moon.—Will any one be to give me a reliable rule for ascertaining the arvest moon in any year, and tell me when enon will occur in 1878 ?—X.

Organ.—I am in rather a fix as to the sound- all organ I am now building. My difficulty ing the holes in the boards. It appears to noving the slide B to the right so as to bring the slide B under F, it will shut off the base t so with the treble pipes because the distance



nd F is about the same as between G and H, oles in the treble of the slide will simply pass me pipe, G, to the pipe, H, thereby allowing it t did before the slide was moved. An expla- blige.—E. W.

Hoist.—Would any correspondent oblige an r by giving plan, &c., of a hoist, by which a raise and lower himself by his own power, three stories, outside a building ? It would red to raise goods and should consist of a T. W.

Lime Juice or Lime Cream.—Can iber oblige me by giving receipt and mode of ove, such as made by "Letchford ?"—J. T. W.

Polypus.—I am troubled with a polypus in hich prevents breathing through one nostril perpetual thick discharge. I have had this by a surgeon, who extracted as much as he with the forceps and gave temporary relief ; han two months the tumour has grown up as distressing as ever. I am told that this ally be so, and that periodical operations will without, as it appears, any hope of perma- by surgical means. In this position I shall liged to "Incog" or any other of our corre- ho can and will kindly indicate to me some atment, other than surgical, by which I may am told by the surgeon that my polypus is peduncular" character but is spread over the e interior wall of the nose (I don't remember nal terms), this, of course, renders operations lt as it can only be removed piecemeal.—

Weirs.—Will any reader kindly give the t accurate method of calculating the quantity ning over a weir or sluice in a given time ?— Fitter.

Music.—I have some four-part songs which arranged for two violins, flute, and cornet, s instrument ; what part should each play ?— ian.

Rough Powerful Battery.—I want to h powerful battery for experimenting, which ap in construction and use ; the bichromate think, suit best, but I want to know if it is necessary to have one zinc between two Vill not the reverse answer, as I have plenty y disposal, and but few carbons ? I intend series of about 15 cells.—Sammous.

Glass Cutting.—How can I cut a circular in. in diameter in a piece of glass ? I have a diamond, but have failed.—An Old Me- 1.

Lens Grinding.—I have some pieces of stal, and would try my hand at lens grinding, now very well how to proceed. I have a lathe ot grudge the trouble of making an attach- above purpose. Could Mr. W. J. Lancaster, lse who knows, give some details ? I wish, as pt, to make an eye-glass (or perhaps a read- the proper name) about 2in. diameter; the thick.—An Old Mechanic, No. 1.

Chinese.—Would some of your subscribers mmend two poor students books which would without external assistance, to gain a know- Chinese language ? Would they also please prices of such books, and publishers, and any h might seem of use to—Hillenne and

Belemnites.—Can any of our readers e the chemical constituents or palpable con- belemnites, or arrowheads, that are found in rmation, and are supposed to have belonged ost gigantic cuttle fish ?—E. B. I.

[33407.]—**L. and N.W. Engines.**—Will "W. J. S." please give the numbers of the engines he mentioned on page 316 ? Since Mr. Webb went to the L. and N.W. Co., many engines have been re-numbered, &c. "Avon" was formerly No. 198, a four-coupled outside cylinder tank ; while "Trentham" and "Torch" (Nos. 92 and 51 respectively) were single outside cylinder engines, with outside bearings to the carrying wheels. I shall be glad if "W. J. S." will give a description of the "Bloomer" engines.—R. N. H.

[33408.]—**Albumen.**—I will feel obliged for details of the process of making albumen from blood, or to be informed where I may get the information ?—A Constant Reader.

[33409.]—**Oxygen Gas Bag.**—Will some kind friend say how a gas bag is best kept when not in use ?— J. C. L.

[33410.]—**Chemical.**—What are the symbols for citric and tartaric acids, and what is equation for Deacon's process of preparing Cl ?—F. W. Woodman.

CHESS.

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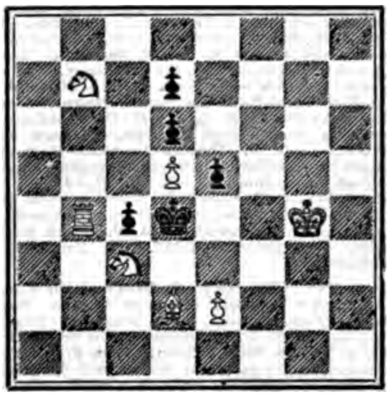
All Communications intended for this department must be addressed to J. Pierce, Copthill House, Bedford.

PROBLEM CCCCXXXIII.—By H. F. L. Meyer.

Black.



White.

White to play and mate in three moves.

Solution to 481.

White.	Black.
1. K to Q 8.	1. K moves.
2. K to K 7.	2. K moves.
3. K to Q 6.	3. K moves.
4. K to K 5 disc. ch. mate.	

Notices to Correspondents.

H. C., Adelaide.—The package was not lost, for our notice referred to the picture which Mr. Meyer sent you.

J. P. Taylor says of 482, "though easy, very neat and graceful, the mates being of unusual purity."

In solution of 480 the first move should have been B to R 3.

J. G. Finch.—Your solutions to 489 and 480 are correct Thanks for the problems.

Grove's Gas Battery.—H. F. Morley, in the *Philosophical Magazine*, says that his experiments show that at least a part of the current in the gas battery is due to dissolved gases. By arranging a battery with plates wholly immersed, and raising these until the platinum cuts the surface, it is shown that the increase of current consequent thereupon is too small to necessitate the assumption that a new force is thereby brought into action. Strength of current suddenly falls when resistance is suddenly increased, but it rises again to nearly its former value. So, when resistance is diminished, the current rises suddenly, but afterwards falls to nearly its former value. In the first case the diminished current causes a diminution in the amount of gas used; the electromotive force, and therefore the current, being thus raised. In the second case the increased current uses more gas; the electromotive force is therefore diminished, and the current falls. It is further shown that the current is directly as the pressure. This seems to prove that there is really no antagonistic force kept up by hydrogen attached to the positive wire, as supposed by Gaugain.

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SPHINX.

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*** *All communications for the "Sphinx" should be addressed to* T. Mitchesson, B.A., *City of London School, Cheapside, E.C.*

Owing to the influx of mathematical correspondence a little time will be required for a satisfactory perusal and election for insertion, the space allotted for the "Sphinx" being necessarily restricted.

Questions.

766.—Solve the equation

$$(y+3)^2 y^4 + 6y^4 + \frac{115}{6}y^3 + \frac{25}{2}y^2 + \frac{7}{2}y = \frac{5}{6}$$

—Amara.

767.—Prove by the aid of trigonometry that if

$$1 + xyz = x + y + z + xy + xz + yz,$$

then

$$\frac{16(1-x^2)(1-y^2)(1-z^2)}{(1-6x^2+x^4)(1-6y^2+y^4)(1-6z^2+z^4)} = \frac{1}{yz}\cdot\frac{1-x^2}{(1-6x^2+x^4)} + \frac{1}{xz}\cdot\frac{1-y^2}{(1-6y^2+y^4)} + \frac{1}{xy}\cdot\frac{1-z^2}{(1-6z^2+z^4)}.$$

—Amara.

768.—A bullet is projected vertically into the air from a gun. Proof is required that the force with which it subsequently strikes the earth is precisely equal to the force with which it was originally propelled.—Anon.

769.—Express as a surd the value of the continued fraction

$$\frac{1}{1+}\,\frac{1}{10+}\,\frac{1}{1+1} + \frac{1}{10+}\;\dots$$

And hence show that $\sqrt{35} - 5$ is intermediate to $\frac{120}{131}$ and $\frac{131}{143}$.—A Student.

770.—Show that if $a = b(a^2x^2 + b^2y^2 + c^2z^2)(x^2 + y^2 + z^2) + a^2b^2c^2 - b^2c^2(y^2+z^2) - a^2c^2(z^2+x^2) - a^2b^2(x^2+y^2)$ is divisible by $x^2 + y^2 + z^2 - a^2$, and find the quotient.—A Student.

771.—If α and β are the roots of the equation $x^2 - ax + b = 0$, then (without solving the equation), show that $\alpha + \beta = a$, $\alpha\beta = b$. Find equation whose roots shall be the cubes of the roots of the equation $x^2 - 4x + 5$.—A Student.

772.—Find the radius of a globe such that the distance measured upon its surface between two places on the same meridian whose latitudes differ by 1° 10′ may be one inch, assuming the unit of circular measure to be $\frac{7}{11}$ of a right angle.—West-Nor.-West.

773.—Explain the notation $\tan.^{-1} m$. If $\tan.^{-1}\alpha + \tan.^{-1}\beta + \tan.^{-1}\gamma = \pi$, prove that $\alpha + \beta + \gamma = \alpha\beta\gamma$.—West-Nor.-West.

Solutions.

678.—Assuming the mechanical advantage in this case to be $\frac{P}{W} = \sin.\alpha - \mu\cos.\alpha$, it is clear that as the co-efficient of friction, μ, increases, $\frac{P}{W}$ decreases. Now if $\mu = \frac{1-\sin.\alpha}{\cos.\alpha}$, $\frac{P}{W} = 1$, and any value higher than $\frac{1-\sin.\alpha}{\cos.\alpha}$ lessens the advantage, and *vice versâ*. But

$$\frac{1-\sin.\alpha}{\cos.\alpha} = \frac{\sin.^2\frac{\alpha}{2} + \cos.^2\frac{\alpha}{2} - 2\sin.\frac{\alpha}{2}\cos.\frac{\alpha}{2}}{\cos.^2\frac{\alpha}{2} - \sin.^2\frac{\alpha}{2}}$$

$$= \frac{\sin.\frac{\alpha}{2} - \cos.\frac{\alpha}{2}}{\sin.\frac{\alpha}{2} + \cos.\frac{\alpha}{2}} = \frac{\sin.\left[45^\circ - \frac{\alpha}{2}\right]}{\sin.\left[45^\circ + \frac{\alpha}{2}\right]}.$$

—Maggie.

734.—(Amara.)—In this case the pile will terminate in a single row. Suppose p the number of balls in this row, then the nth layer reckoned from the top has $p + n - 1$ balls in its length, and n in its breadth, and ∴ contains $n(p + n - 1)$ balls. Hence number of balls in n layers is

$$\frac{n(n+1)}{2}p + \frac{\overline{n-1}\,|\,n(n+1)}{3} = \frac{1}{6}n(n+1)(3p + 2n - 2)\quad\dots\quad\text{(I)}.$$

Now, suppose the pile complete, to find the number of balls left out:—In (I) we have $n = 4$, and $p + n - 1 = 7$; ∴ $p = 4$; ∴ number of balls left out $= \frac{1}{6}n(n+1)(3p + 2n - 2) - 7 \times 4 = \frac{1}{6} \times 4 \times 5 \times 18 - 28 = 32$;

∴ number of balls in complete pile

$$= 122 + 32 = 154;$$

∴ substituting in I again we have

$$\frac{1}{6}n(n+1)(3p + 2n - 2) = 154 \text{ (and } p = 4)$$

$$\therefore n^3 + 6n^2 + 5n - 462 = 0;$$

$$i.e., (n - 6)(n^2 + 12n + 77) = 0;$$

$$\therefore n = 6;$$

∴ number of layers in truncated pile $= 6 - (4 - 1) = 3$. Answer, 3.—A B C.

[If F A is not in the same straight line with A E, produce the former to B C, which makes the *reductio ad absurdum* apparent.—Ed.]

740.—Let x be the number of pigs bought by one gentleman, y the number bought by his wife (!) Then he spent x^2 shillings and she y^2.

$$\therefore x^2 - y^2 = 63.$$

There are only three positive integral solutions of this equation, viz.:

$$x + y = 63, 21, \text{ or } 9;$$

$$x - y = 1, 3, \text{ or } 7;$$

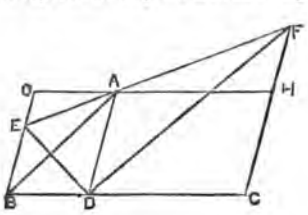
$$\therefore x = 32, 12, \text{ or } 8;$$

$$y = 31, 9, \text{ or } 1.$$

Since Tom bought 11 more than Eliza, Tom bought 12 and Eliza 1; and since Dick bought 23 more than Mary, Dick 32 and Mary 9; the only numbers remaining are 8 for Harry and 31 for Jane.—Amara.

(This problem has appeared before.)

735.—A B C is any triangle, D a point in the base, B C; D E, B E, are ∥ A C, A D, respectively. Show that E A F is a straight line by principles enunciated in Euc. I., as far as prop. 43.—(Maggie.)—Through A draw O A H ∥ B C, and terminated by B E, C F. Then angle E O H = angle O H E, because they are alternate angles. Also



angle O A F = angle A H F + angle A F H; and angle O A F = angle A O E + angle A E O. (I. 32); ∴ angle A H F + angle A F H = angle A O E + angle A E O; but angle A E F has been shown to be equal to angle A O E; ∴ angle A F H = angle A E O; and these are alternate angles; ∴ E A F is a straight line.—A. B. C.

744.—As an index: $x^{\frac{1}{2}}$ has two values, $a^{\frac{3}{4}}$ has four.—Amara.

749.—If A D, A E, be the bisecting lines; D A B = $\frac{1}{2}$ C A B; and B A E = $\frac{1}{2}$ B A G; ∴ D A E = $\frac{1}{2}$ (C A B + B A G). But C A B + B A G = 2 right angles: ∴ D A E = a right angle.—John Stephens.

750.—If A B C be the triangle, A B + A C > B C; ∴ B C < A B + A C; ∴ B C − A C < A B.—Amara and H. B. C.

751.—A B + A C > B C; ∴ A B + A C + B C > 2 B C. Also B C < A B + A C; ∴ A B + A C + B C < 2 (A B + A C).—Amara and C. Mitchell.

752.—In this question a "stone" is 14lb.—Amara.

Answer.

C. E.—You must state your question in words.

USEFUL AND SCIENTIFIC NOTES.

An Improved Leclanche.—At the Paris Exhibition, M. E. Barbier shows different forms of the new agglomerated Léclanché element, in which the highly resisting porous pot of clay is suppressed. The peroxide of manganese and carbon formerly contained within the pot are in this cell agglomerated together into a solid mass by a pressure of several thousand pounds in heated moulds of steel. Besides their firm indissoluble nature, the resistance of the agglomerated plates or cylinders thus obtained is so small that a single element can redden a fine platinum wire, so that the agglomerated form is suitable for lighting gas jets. Its advantages over the older element with the porous pot have led the great railway companies of France to adopt it in preference to the latter, more than 40,000 elements being now in use amongst them. Rings of wood or indiarubber round the zinc rod are employed to keep the two plates, the zinc and the carbon agglomerate, from touching within the cell.

Death of Mr. Thomas Winans.—Mr. Winans, of Baltimore, a son of the late Mr. Ross Winans, died on the 10th June, aged 58 years. Mr. Winans received his practical education in his father's shops in Baltimore, and was afterwards sent by him to Russia with some locomotive engines. While there he entered into a partnership with Mr. Harrison, of Philadelphia, and the firm received several railway contracts from the Russian Government, from which they made very large profits. Mr. Winans returned to Baltimore with a large fortune some twenty years ago, and has not since engaged actively in business. He was much interested in mechanical pursuits, and was constantly inventing something new, the magnificent house he built in Baltimore being full of ingenious contrivances. In 1859 he built the "cigar steamer," with which he made many experiments, and afterwards constructed a second, both of which lie in the Southampton harbour, and must be looked upon as practical failures. He also made, early in the American civil war, a steam gun, which was the subject of a great deal of talk, but was never actually used. He leaves a son and daughter, who inherit a large fortune.

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ANSWERS TO CORRESPONDENTS.

*** *All communications should be addressed to the* Editor *of the* English Mechanic, 31, *Tavistock-street, Covent Garden, W.C.*

HINTS TO CORRESPONDENTS.

1. Write on one side of the paper only, and put drawings for illustrations on separate pieces of paper. 2. Put titles to queries, and when answering queries put the numbers as well as the titles of the queries to which the replies refer. 3. No charge is made for inserting letters, queries, or replies. 4. Commercial letters, or queries, or replies are not inserted. 5. No question asking for education or scientific information is answered through the post. 6. Letters sent to correspondents, under cover to the Editor, are not forwarded; and the names of correspondents are not given to inquirers.

The following are the initials, &c., of letters to hand up to Tuesday evening, July 2, and unacknowledged elsewhere:—

J. P. Strangman.—W. Pumfrey.—Rev. A. Willan.—F. Hoffman.—G. Guyon.—J. B. Cann.—T. Fletcher.—Jas. Elliot.—Mottershead and Co.—J. H. Biggs.—Arthur J. Hunt.—G. Calver.—H. Greenwood.—J. Richards and Co.—F. Boaler.—C. F. Tootal.—C. E. S.—Mercurio.—Old Man.—Ruby.—A. Percy Smith.—B. Riley.—Xylon.—T. J. H., Bury.—Sylvester.—A. T. N.—Itzaox.—J. H.—Frank Smith.—W. R. S.—Dr. Bosworth.—B.—A. N. H.—More Light.—W. A. S.—R. Cooper.—Fireman.—Jonah.—Amara.—Ko Vavu Sotia.—Plymouthian.—Another Vegetarian.—Ne Sutor.—Hesper.—Arturo.—Penance.—Point.—E. C. S.—M. O.—Shoeblack.—Experientia Docet.—Hugh Clements.—C. Lark.—F. W. Woodman.—G. B.—Tangent Amateur.—E. P. Toy.—Black Witch.—Novus Homo.—F. C. Smith—Aquilarius.—Foot-plate.—Gimcrack.—R. S. H.—J. A. M.—J. Harris.—E. C. R.—Zinc.—W. Adamson.—8½in. O.G.—Mortise and Tenon.—I. F. Ballard.—Daghbert.—F. J. Jackson.—F. C. Dennett.—G. A. P.—Finem Respice.—Alpha.—Ginnindera.—Cantab.—W. Burns.—Bernard McGuire.

Accountant. (You can hardly have read the paragraph on p. 380).—Nautilus. (We know of none. You must be a very recent reader, or you would have found what you want in the earlier numbers of the present volume. See p. 159, No. 683.)—Experimentum Fiat. (You can obtain it at any gas-works, but you will find it difficult to cut. It cannot be made on a small scale.)—Ajax Secundus. (We must decline advising on the very curious entanglement you describe; only a solicitor well up in the marriage laws can give you counsel worth listening to. The man is certainly liable to a criminal prosecution for bigamy).—Urra. (The portable Norwegian houses were, we believe, imported into England; but whether the importers still sell them we do not know. This query and another which is excluded are really advertisements.)—A. Smith. (We do not find anything of special novelty in your microphone made up of alternate layers of charcoal powder and mercury inclosed in a paper tube, while if "three quart Daniells" are necessary it can scarcely be a very delicate instrument.)—B. J. Fell. (Mother-of-pearl buttons are cut out of the shell with a small cylindrical saw. The discs are turned in a lathe, and if thick enough split, so as to form two or more buttons. A dovetailed hole is drilled to receive the shank, which is fixed by a slight blow with a hammer, its lower part expanding into the dovetail, so as to prevent its being readily withdrawn. Ornamental patterns on the buttons are executed in the lathe by means of an eccentric chuck and slide-rest.)—R. T. (We cannot say; the places of public worship in the United Kingdom are certified by the Registrar-General as belonging to 154 different religious sects.)—West Indian. (The aboriginal spelling was "Xaymaca"—a land of wood and water; the present population of Jamaica is about 300,000.)—J. E. O'Kill. (We never object to reasonable remonstrances. We know it is difficult in all cases to define what is an advertisement and what is not. When a name only is given, as in one of the instances you refer to, we generally let it appear, and in cases where a novel or scarce article is in question we give the address as well. But these, as you must know, are exceptions, which seldom are made. We cannot give the address you ask for, first because we do not know it, and next because it is against the rules laid down in "Hints to Correspondents." You can, if you choose, advertise for it in the proper column. Many thanks for replies, which will appear next week.)—Ralph. The following are the fusing points asked for:—Platinum 3,992 degrees Fahr.; white cast-iron 2,282 do.; gold, 2,282 do.; lead 617 do.; copper, 1,742 do.; tin, 428 do.; silver, 1,832 do.; zinc 707 do.; antimony, 797 do.; bismuth, 500 do.)—A Mooltanee. (The inventor intends manufacturing for sale shortly, when the prices will probably be advertised in these pages. Your other queries would be answered by consulting Mr. Stanley's pamphlet, "Photography Made Easy," also advertised herein.)—Pimpernel. (Your wishes and those of other readers will, we are glad to say, be complied with. Mr. Davies has promised to commence shortly a series on "How to make a Pianoforte." As a reminder to that gentleman, and a hint as to the scope of your wishes, we quote the final passage of your letter: "If Mr. Davies would select a good class iron-backed instrument and describe its construction throughout, explaining all the technical words, and giving us a pattern that would not require special planes, cauls, or apparatus, it would indeed be appreciated.")—A Tyro in Art. (See advertisements on front page of the *Building News*.)—Hawks. (We have repeatedly recommended the careful continuous application of acetic acid, which never fails to remove corns if persevered with.)—E. Meyerstein. (You had better write the journal from which we quoted. We cannot undertake to examine the claims to priority of rival patentees, and, moreover, the insertion of your letter would subject us to an action for libel.)—W had better take him to one of the orthop tions; or, if able to do so, consult some surgical mechanician. We have seen some appliances contrived by Mr. J. Gillingha Somerset, an old correspondent, and should you to write to him.)

Urra, A Reader, Camera, Photo, W. F., F. See indices to back vols.

F. T. M., Areus, A Working Joiner, F. I queries are advertisements.

G. O., Daghbert, Adye Douglas, W. L. J., have replied to queries already similarly an

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WILLIAM J. VIAN,

The English Mechanic
AND
WORLD OF SCIENCE AND ART.

FRIDAY, JULY 12, 1878.

ARTICLES.

VOL. XXXII. OF THE PALÆONTOGRAPHICAL SOCIETY FOR 1878.

WITH another year comes the grand annual contribution to British palæntology of the Palæontographical Society, the shape of a massive quarto volume of me 370 pages of letter-press, illustrated ith 47 lithographic plates containing hunreds of figures of fossils, besides woodcuts the text. Nor has the quality of the ork in any way deteriorated, either in a terary or artistic point of view. As for a rge proportion of the figures of fossils, ey are seemingly stereoscopic in their lelity to the originals; and to all to whom ich originals are not accessible may stand their practical equivalent for every pur-se of identification or comparison. The onographs which they illustrate, too, are, heretofore, the work of men of the ighest eminence in their respective ranches of science; and the names of Boyd awkins, Davidson, Miall, Owen, Wood-ard, and Wright, will suffice to give rnest that there has been no falling off in is respect.

The first part of the volume consists of the ntinuation of Dr. Wright's monograph n the British cretaceous echinodermata— class of organisms represented at the esent day by the spiniferous Sea-Urchin commonly found upon our shores after a le of wind. The fossils themselves must be miliar to all those of our readers who have er sojourned in a chalk district, as hemiobular or cordate bodies varying from the e of a tennis-ball, and covered with inute pores. Dr. Wright's paper is folwed by an elaborate and exhaustive index the Oolitic Echinodermata, the work of e indefatigable Honorary Secretary of the ciety, the Rev. Thos. Wiltshire.

Visitors to the Brighton or Westminster quariums will remember the strange-lookg Limulus, or King Crab, with its curisly disproportionate carapace and (if we y coin such a term) generally uncrab-like ntour. The sub-order Xiphosura, to ich this remarkable crustacean belongs, of the most stupendous antiquity, amples being found on a very early ological horizon indeed; and the third vision of the work under review is voted to a description by Dr. Woodward various forms, ranging from the Silurian cks up to the Triassic ones. It contains, reover, a mass of detailed information to the anatomy and development of the ent animal.

Dr. Woodward's paper is followed by a ntinuation of Mr. Davidson's description the Jurassic and Triassic Brachiopoda. at very common chalk bivalve with a rforation in the beak, the Terebratula, is amiliar example of a Brachiopod; a family ich has been called "the Fossil Arisracy," from the incalculable antiquity of lineage.

In the fifth monograph Dr. Wright (who l be remembered as the recent Wollaston dallist for his researches in the rassic Rocks), commences an account the British Lias Ammonites. This is faced by an admirable description of the ysical geology of the Lias formation as veloped in Gloucestershire, on the banks of Severn—in Somersetshire, Glamorganshire, and Dorsetshire. Elaborate lists of the fossils characteristic of each particular bed are also given, so as to render the identification of any particular one a matter of certainty. This preliminary matter, occupying 48 closely-printed pages, is followed by 8 plates of the various Ammonites found in the strata of the Lias. The 39 figures which these plates contain are beautiful specimens of scientific art; while their fidelity is unquestionable.

Professor Miall comes after Dr. Wright with a description of the Sirenoid and Crossopterygian Ganoids; an order of fish whose existence extends from a very early geological date down to the present day. The sturgeon, which may not unfrequently be seen in fishmongers' shops, and which is characterised by its dermal skeleton and unequally lobed tail, is the most familiar living example of a Ganoid. Mr. Miall's illustrations chiefly refer to the palatal teeth of various Ganoidal fish, which are so abundant in the well-known Aust-Cliff, on the Severn.

Following Mr. Miall, we have a continuation of Professor Owen's monograph on the Crocodilia of the Wealden and Purbeck. The mere mention of the author's name almost absolves us from the necessity of saying that this contains an exhaustive anatomical description of the remains of these reptiles, and teaches everything that can be known of their structure and habits

Possibly on the schoolboy's principle of saving the piece of brown skin to the last, the editor of the volume would seem to have reserved the paper of the greatest popular interest for his concluding one. It is by Professor Boyd Dawkins, and consists of "a preliminary treatise on the relation of the Pleistocene Mammalia to those now living in Europe," as an introduction to a description of the British Pleistocene Mammalia generally. To every one who is seeking information concerning the origin of the various animals, wild and domesticated, which are either now living in Great Britain, or have been exterminated within the historical period, Professor Dawkins's paper cannot fail to prove most valuable and instructive. When we reflect that it is but within a relatively recent period that the wolf, the bear, the beaver, and the wild boar have disappeared from Britain, and that even the reindeer has existed in this country in times of which contemporary records are extant, we need not travel beyond Mr. Dawkins's 38 pages to be convinced how eminently the questions he discusses are worthy of investigation. We will not spoil the effect either of the author's description or argument by quoting isolated and detached passages from it. Rather would we refer the reader to the volume itself, which so worthily culminates in this remarkable paper. We shall be both surprised and disappointed if he does not thank us for the recommendation.

A RECEIVING MICROPHONE.

IN our "Scientific News," p. 366, we mentioned that Mr. Blyth had succeeded in devising a form of microphone which served both for receiver and transmitter, and was simplicity itself, being merely a few pieces of gas cinder placed in a jelly can, covered with water, and connected by means of strips of tin-plate, attached to wires. So far as we know, no one has succeeded in repeating Mr. Blyth's experiments, but Prof. Hughes has succeeded in making a receiving microphone which, though by no means satisfactory, has demonstrated the possibility of constructing a perfect instrument in the future, while it helps to illustrate the true theory of the microphone. A small cylinder, such as may be easily made from a tin can, has a covering of parchment stretched tightly over one end. In the centre of this membrane a small piece of thin pine is glued or cemented, serving as a platform to which the microphone is attached in such a manner that it is kept clear of the membrane throughout its length. The microphone is made in the usual way. A piece of thin pine carries at one end a small block of pine charcoal, against which a similar block—attached to a brass beam—is caused to press by means of a spiral spring, the tension of which can be regulated by winding a silk thread upon a screw with a milled head. The brass beam is pivoted at its centre, between two supports, though some makers prefer to cut a notch in the lever, and rest it upon a knife-edge. The piece of thin pine forming the platform is attached to the piece of pine on the membrane, so that the two blocks of carbon are directly in the centre of the drumhead formed by the membrane and the cylinder, while the other end of the platform projects over the edge if the can employed is only a small one. The wires are connected respectively to the brass beam and to the carbon block affixed to the platform. If the instrument thus briefly described is placed in a circuit with a battery, and one of the pencil microphones (see Fig. 3, p. 256), the ticking of a watch placed on the baseboard of the pencil microphone can be heard by putting the ear to the open end of the tin cylinder forming the "drum" of the receiving microphone. Speech can also be heard, but not so distinctly as with the Bell telephone; in fact, the latter instrument is by far the best receiving apparatus yet invented, though various modifications of magnets and diaphragms may be found to give fairly good results.

In the New York papers of June 27 Mr. Edison replies to the telegram sent by Mr. Preece, and shows that he has not yet read all the announcements made in connection with the microphone. In reply to Mr. Preece's statement, "Hughes has not brought out any thermopile," he quotes a passage from a contemporary, but although he thus shows that he had some ground for thinking Prof. Hughes had invented a "thermopile," his quotation is scarcely of much value, for Mr. Preece's statement remains a fact. However, in another place we publish a long letter from Prof. Hughes, which reached us too late for insertion last week, and until Mr. Edison has read the arguments on the other side it is useless to hope for a settlement of the dispute.

SLATE AND SLATE QUARRYING.*

THE Cambrian was at one time considered the earliest formation in which life made its appearance, but subsequent researches have led geologists to place the dawn of life in the Laurentian series; but we shall not be far wrong if, in writing about slates, we speak of them as one of the oldest rock formations, the production of which must have been commenced many ages ago—so long ago, in fact, that the mind at first refuses to apprehend the enormous periods which, according to modern geology, were absorbed in the formation of the rocks as we now see them. Beds of slate were deposited in the form of mud at the bottom of the sea, where they became hardened into stone, and subsequently, under the influence of pressure, acquired the peculiar properties of slate. Between the beds, however, we find, here and there, bands of harder rock, which it is supposed were formed of molten matter ejected through cracks in the crust of the earth, sometimes flowing over the adjoining surfaces, though most frequently represented by the long dykes and bosses of greenstone and similar substances seen in a slate quarry. These harder rocks have had an important influence in determining the nature of the sedimentary strata amongst which they are found. We know that slate was originally deposited as fine mud in the sea, because the remains of former sea-life are found in abundance in some beds, which have obviously been deposited in layers, and subsequently subjected to enormous pressure. The chemical composition of slate, too, shows that it has been made up of the detritus from older rocks mingled with the salts existing in sea-water. Silica is the principal component, rarely forming less than one-half, and often approaching five-eighths of the sample examined, with alumina varying from 16 to 26 per cent. Magnesia, potash, soda, and lime also enter into the formation of slate, together with a considerable proportion of protoxide of iron. Besides the ordinary clay-slate, from which the commercial articles are obtained, there are mica slate, talcose slate, and hornblende slate, which have their uses, but are of little interest as compared with the better-known varieties. The protoxide of iron above mentioned is the colouring matter of roofing slates, the most usual tint of which is the peculiar slaty blue, varying from a dark blue, through grey blues, to a greyish black. The red and purple slates owe their colour to peroxide of iron, while in the green varieties the percentage of iron is not sufficient to overcome the effect of the magnesia. In the soft black slates there is much carbonaceous matter, together with sulphide of iron, leading to the conclusion that vegetation of a kind had flourished during the deposition of the layers of mud. The striped or banded slates disclose the fact that at different times the deposit has been tinged with other pigments, while occasionally slates are found with white or pale-yellow spots, formed by little lumps of the original material into which the colouring matter has been unable to penetrate. In a slate-bed, extending over a wide tract of country, much diversity in the quality and appearance of the rock will of necessity be seen; for, as the materials of which the beds are formed were washed down from the older lands by torrents or gently-flowing rivers, there would be some difference in the deposition. The heavier particles would settle first, as soon as water of sufficient depth was reached to enable them to fall out of the influence of the current, while the lighter and finer particles would be held longer in suspension, and would be carried out to considerable distances from the shore. Deposits thus formed would be liable to disturbance from the effects of storms and from upheaval and subsequent sinking of the sea-bottom; they would be fine and smooth where the finer particles had been deposited—rough where the coarser stuff had been left. They may be coloured purple in one locality, green in another, and blue in yet another, according to the quantity and condition of the iron in the water; they may be stained black with carbon, from decayed vegetation, or be quite free from that element if the bed was deposited so deeply that vegetable life could not exist. These facts lead the prospecter for slates to remember that although one portion of a course may yield slate of good character, it by no means follows that similar quality will be found throughout the bed. The converse, of course, holds equally good. If we take a piece of slate and examine it carefully we shall be able to trace with distinctness a number of lines, probably straight, perhaps wavy, running across it. These are the lines of bedding, or, in other words, the lines marking the layers of mud deposited. The direction in which our piece of slate has been split is probably at right-angles or thereabouts to the lines of bedding, and this phenomenon —cleavage—is perhaps the most interesting fact in connection with slate. The direction of the lines of cleavage coincides with the strike of the beds, or the direction which the latter take across country, and is invariably at right angles to the dip or inclination of the strata. As regards the planes of bedding, cleavage occurs at almost all angles, for if the beds dip sharply, the cleavage being at right-angles to the dip, it will be seen that instances may be found where the lines of cleavage and bedding nearly coincide. The cause of cleavage has given rise to some discussion, but what is known as the mechanical theory is now generally accepted. According to this view, the sediment forming slate has been compressed to about half its original bulk, and under that enormous pressure the particles have arranged themselves with their flattest sides towards one another—as may be seen in a thin section placed under the microscope. It is not impossible that polar magnetic force may have facilitated the result, for it does happen that the undulations of the strata are in the direction which they would assume on the hypothesis of magnetic currents determining the position of their particles, and disturbing forces bending and twisting the beds in various directions.

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* A Treatise on Slate and Slate Quarrying. By D. C. Davies, F.G.S. London: Crosby Lockwood and Co.

The perfectness of the cleavage seems to depend, to a great extent, on the uniformity of the pressure brought to bear over the surface of the bed. The cleavage is most straight, thin, and uniform in those parts of a bed where the finer particles have been deposited in water so deep as to be beyond the influence of the motion of the waves. An enormous mass of fine uniform mud thus deposited, and subsequently subjected to great pressure over the whole mass, would have the lines of cleavage in their most perfect arrangement; but between such beds it is not unusual to find others of a different nature, the materials composing them being so closely cemented that the bed is little affected by cleavage. These harder layers or strata are known as posts, and the slate between them is, as a rule, of the best quality, splitting easily and uniformly. The explanation of the latter fact will be readily understood from what has been already said. If cleavage depends on pressure being exerted uniformly over a mass, a slate deposit between two "posts" or strata of harder rock, in all probability, underwent a more evenly distributed compression than a bed not so inclosed. Where the intervening strata are thinner than "posts" and made up of coarser material than the slate, they produce what are known as "bends," by which the line of cleavage is refracted, as a ray of light is bent when it enters the water. If the layer producing the bend is of more compact nature than the rest of the bed, the effect is known as a cramp, the slates having a tendency to break off on each side of the layer. Sometimes the latter is seen in the form of a roll or curl (crych), supposed to be produced by a ripple, wave, or current line drifting matter of a different nature into that portion of the bed; while masses of concretionary matter, by their superior hardness, caused bends and contortions in the lines of cleavage. If the slate bed was overflowed by felspathic or porphyritic matter in a molten state its upper surface will probably have been metamorphosed into a hard and unworkable rôck, as is often the case with the portions of a bed adjoining dykes of greenstone or other igneous or eruptive rocks. Since the slate beds were originally formed they have been subjected to many disturbing causes, and in some parts the cleavage lines, once straight, have been bent in such a manner that the rock has been rendered commercially of little value. In other localities instances of double cleavage are found, where a second cleavage crosses the first. The effect of double cleavage is to cut the rock into slate pencil. From what has been said it will be gathered that in any slate quarry there must be a large amount of waste, and, from what Mr. Davies says, the output of a paying quarry will range from one ton of slates out of 16 tons of rock, to one ton out of over 33 tons.

It is beyond our purpose to give here more than a general idea of slate and slate quarrying, so that we do not follow the author into a geological examination of the Cambrian strata and the slate beds of Wales, but those who desire more detailed information will find it in the book, the title of which we give below. "The Early History of a Slate Quarry" is a chapter containing a description of the method of exploring for sites and of opening up a quarry, with an account of the arrangements as to lease and royalty usually made, and estimates as to cost of plant, &c. A "gallery" being ready in the quarry, it is parcelled out into "bargains" of from 10 to 15 yards in breadth, which are let to gangs of men each month, who deliver as many slates as they can get out of it to the company or quarry-owner at a price agreed upon. Six men is the usual number for a "bargain," and of these two are quarrymen —the others being splitters and dressers. The company finds all tools, and generally pay the trammers to convey the blocks to the dressers; but the men pay for the sharpening and repair of tools, and provide their own powder and candles. The blocks are obtained from the bargain by drilling holes and blasting; it is then that the judgment of the quarryman comes into play, for he has to decide which will be the most profitable way of treating the block so as to throw out with least waste the crychs, bends, cramps, &c. Having determined the lines on which he wishes the block to split, the quarryman drives in an iron wedge, or drills a hole and places in two iron wedges, between which he drives a third, when the block usually splits in the direction required. When the block is split up into pieces about 2in. thick, and of length and breadth suitable for cutting into slates, it is loaded into waggons and taken to the dressing sheds. Here the splitter, seated on a low stool, and provided with thin chisels with broad flat edges, takes one of the blocks of slate and having examined it, rests it against his left thigh. With one of his chisels, or splitters, he makes two or three cuts in a line, using a wooden mallet bound with iron. The splitter is then sent well into the block, which begins to split, and a second chisel is inserted, the two being then worked backwards and forwards until the block divides into two pieces. This process is repeated until the slates are sufficiently thin, but as they approach the merchantable state greater care is necessary, splitters being sometimes inserted at the side and the block carefully humoured by the workman. As the latter reduces the slates to the proper thinness he places them on his right side, whence they are taken by the dresser. The latter sits with a wooden bench in front of him, to which is affixed a steel bar or frame, on which he rests the slates while he trims the edges straight by means of a long knife. A notched stick with a nail or a spike at one end serves as a scriber to mark the dimensions of the slate, and it is the business of the dresser to get the largest finished slate he can out of the rough split. Machinery is employed at some quarries for sawing and working up slabs, and for cross-cutting the blocks, so as to provide a smooth edge for the splitter, whose skill and tact in humouring a block so as to obtain a good split is beyond the powers of a machine. Mr. Davies gives full lists of slates, and ample details of the cost of working a quarry. He believes there is ample scope for the profitable employment of capital in the work, if accompanied by good management; and instances, as a notable feature of the trade in North Wales, the number of private owners of quarries who have built up their own fortunes by intelligence and energy. The Festiniog narrow-gauge railway opened the way for the introduction of the locomotive into the mountainous parts of Wales, and with the means of rapid transport, old quarries are being re-opened, and neglected sites re-explored; for the supply is not equal to the demand, and the price is consequently sufficiently high to tempt the most cautious capitalist to speculate in a slate-quarry.

CHIEF PHENOMENA OF THE THREE PRIMARY STATES OF MATTER.

By J. Douglas Scoffern.

Part II.

(*Continued from p.* 285).

THE fact is well established that any two gases, no matter how little disposed to enter into true chemical combination, placed in separate vessels and furnished with a channel for effecting intercommunication, will gradually displace each other; and, further, that this result will ensue notwithstanding the intervention of a diaphragm consisting of either parchment, plaster of Paris, or burnt clay. Indeed, some experiments made by myself appear to afford ample evidence that at high temperatures the material of the diffusion-cell "may even be of wrought or cast iron."

Researches directly bearing upon this subject have clearly shown that the rate at which vapours mutually commingle is susceptible of accurate mathematical demonstration—that it is exactly in the inverse ratio of the square roots of the densities of the respective vapours. For the present I will assume that my readers possess some knowledge relative to "specific gravity" and "density;" we will shortly examine these important properties in detail. The phenomena of diffusion constitute a subject of extreme interest to the student of physical science, and may be exhibited in several ways, of which the following method is perhaps, the most easy of practical application:—

Having selected a glass tube of uniform bore, a metre long, and having a width of about 1 centimetre, we will proceed to secure to its upper extremity by means of a tightly-fitting cork a glass cylinder of about 1 decimetre in length and 4 centimetres wide; we must render the intervening cork disc at the bottom of the cylinder completely gasproof by a coating of melted sealing-wax.

Now let us invert the tube and allow the wide end to dip into a magma or thick paste of plaster of Paris and water to a depth of about [illegible]. In about ten minutes the cement will have set; the tube must then be removed, and if it be placed aside in a warm room for a couple of [illegible], we shall, in this way, be in possession of a porous plug, or "diffusion-cell," by means of which we can examine many of the interesting effects which gases display. Let us in the first place fill the cylinder and tube with water (which may be coloured by the addition of a [illegible] spangles of permanganate of potash), and then proceed to pass in hydrogen at the lower end until the water is displaced to about the middle of the slender portion. While we are charging the tube the porous plug must be protected by a closely-fitting cap of tinfoil, in order to prevent the premature escape of the hydrogen. Upon removing the cover we shall find that the water will quickly rise, thus apparently effecting solution of the gas. If the experiment had been made with a wider tube, completely filled with hydrogen, and having a porous plug at its upper extremity, the water would rapidly have risen to a height of more than two-thirds from the bottom. Suppose, now, that we adapt to the narrower tube a small porous battery cell in place of the cylinder employed, using the same precaution in regard to the sealing-wax; let us, then, pass hydrogen under a bell-jar inverted over the cell, and carefully observe what takes place. Gas immediately escapes from the lower extremity of the apparatus; the hydrogen, in fact, permeates the porous walls of the diffusion-cell much more quickly than the air can diffuse in the contrary direction—*i.e.*, outwards—and the latter is therefore expelled at the lower orifice.

Directly the bubbles cease to escape let the bell-jar be lifted away; the water at once commences to rise as before, in consequence of the tendency on the part of the hydrogen to diffuse into the atmosphere. The vapour which we have used is one very much lighter than air, and in our second experiment bubbles of air escaped from the tube. Were we to surround the porous cell by a gas heavier than air, the water would rise—as in the first experiment. This double effect holds good for all cases, the rise and depression being proportional to the densities of the several vapours. In our first and third arrangement, as a matter of fact, 3·8 measures of hydrogen diffused outwards, while but one measure of air entered in the opposite direction, and the water therefore rose in the tube. What we require to do is to divide unity by the square root of the specific gravity of any given gas, and the fraction so determined gives us the required rate of diffusion of such gas. For example, the specific gravity of oxygen is 1·10563, and that of hydrogen 0·0691. These numbers are to each other as 16 : 1, while the square root of 16 = 4 and that of 1 = 1. From an examination, then, of these ratios in their inverse order, we conclude that the rate at which hydrogen diffuses into an atmosphere consisting of pure oxygen, is as 4 : 1, or we thus learn that the rate at which 4 measures of hydrogen will pass into the atmosphere of oxygen is identical with that at which one measure only of oxygen travels in a contrary direction—that is, inwards; and such, too, is really the case. Again, the specific gravities of air and hydrogen are respectively 1·0 and 0·0691, and their rates of diffusion are, therefore, equal to $\frac{1}{\sqrt{1}}$ (= 1) and $\frac{1}{\sqrt{0{\cdot}0691}}\left(= \frac{1}{0{\cdot}263} = 3{\cdot}8\right)$.

That is, 3·8 volumes of hydrogen pass into the air, whilst only one measure of the latter is being simultaneously diffused into the hydrogen. Other examples will readily suggest themselves to my readers if they but bear in mind the simple process of calculation that is requisite in each case. The phenomena of diffusion are of especial interest, seeing that by their agency a great part of the ventilation of dwellings is effected. We will now pass to other conditions of the gaseous state. Let us take a copper flask furnished with a stop-cock in some part of its neck, and, having exhausted the air from within it, ascertain its exact weight, calling it a. Next allow air to pass in and again determine the weight, which will, of course, have increased. Call it now $a + b$. Then $\{ (a + b) - a \} = b$ will be the weight of the contained air. We will now do this numerically as follows. Grant that the flask alone weighs 100 grams, and that when filled with air—absolutely dry—it weighs exactly 101 grams, then the weight of the air alone is clearly equal to 1 gram. We will now fill our flask with absolutely dry oxygen. It weighs 101·10563; the weight then of oxygen contained will be represented by (101·10563 − 100) = 1·10563 grams: so that we find oxygen to be heavier—bulk for bulk—than ordinary air. Fill the flask with absolutely dry hydrogen, and it weighs but 100·0691 grams, and the weight of one measure of hydrogen is therefore equal to 0·0691 grams, or the 1-14·47th part of the weight possessed by a similar bulk of air; it is, then, very much lighter than it. The list might readily be extended, and we should find that each vapour—simple or compound—has its own or "specific" weight when compared with the known weight possessed by an equal volume of dry air. It is necessary to remark that the gases must be deprived of every trace of moisture prior to being subjected to the process of weighing, and that the estimation must either be made at the "standard temperature and pressure" (0° C., and 760mm. bar.), or the requisite reductions $\left(V = \frac{273.v}{273 + t}\right)$ and $\left(V = \frac{p.v}{760}\right)$ subsequently performed in order to obtain strictly comparable results. Now, the ascertained weight of any volume of a vapour as determined against the known weight of an equal bulk of dry air is expressed as the "specific gravity" of such vapour. We at once perceive, therefore, that the specific gravity of oxygen = 1·10563, and that of hydrogen = 0·0691. Similarly, the specific gravities of $x, y, z = a, b. c.$ Suppose, now, that we take a vessel of such a size that it will contain (at 0° C. and 760 mm. bar.) a *volume* of hydrogen *weighing* exactly 1 gram; its capacity will be equal to 11·19 litres, and for this reason the above is termed *one gas volume.* If the vessel be filled with oxygen it weighs 16 grams; if with chlorine, 35·5 grams; with nitrogen, 14 grams; and if with carbonic acid (carbonic anhydride or carbon dioxide), 22 grams: so on also in regard to the other gases. Thus, then, by subtracting in each case the weight of the vessel itself we shall obtain a series of values representative of what are termed the *relative weights* or *densities* of the respective vapours; so that when speaking of gases it is usual to say:—

Sp. gr. of oxygen = 1·10563
Rel. wt. „ „ = 16; also
Sp. gr. of hydrogen = 0·0691,
Rel. wt. „ „ = 1: similarly,
Sp. gr. of x, y, z = $a, b, c,$
Rel. wt. „ „ = a^1, b^1, c^1.

We have just seen that at 0° C. and 760mm. bar. "11·19 litres of hydrogen weigh 1 gram." In actual practice, however, it is a great deal more convenient to adopt as the *unit of weight for gases* the measure of only 1 litre of hydrogen—that is to say $\left(\frac{1}{11{\cdot}19}\right)$ = 0·08936 gram, or 89·36 milligrams. To this quantity the name of the "*crith*" is given, and it will be advisable at once to determine the uses to which this last factor can be turned. Let it be required to determine the weight of any volume (say 1 litre) of a gas at some one temperature and pressure. We need merely multiply the "crith of hydrogen" by the "relative weight" of such gas, and we straightway achieve the required result. Again, if we require to find the weight of any given volume other than 1 litre, we first multiply the crith of hydrogen by the relative weight, and then the product so obtained by the volume of the vapour in question. For example, required the weight of 1 litre of hydrogen at 0° C., and 760 mm. bar.? Answer: It will be equal to 0·08936 gram, or 89·36 milligrams. Again, what is the weight of 1 litre of oxygen? Answer: 1 litre of oxygen = (89·36 × 16) = 1429·76 milligrams, or 1·4298 grams.

Let us now ask: What is the weight of 4¾ litres of nitrogen? As 4¾ = 4·75, therefore (89·36 × 4·75) × 14 = (424·46 × 14) = 5942·44 milligrams, or 5·94244 grams is the weight sought. To prove the foregoing result by proportion:

4·75 litres : 5·94244 grams :: 11·19 litres : x = (5·94244 × 11·19) ÷ 4·75 = 13·999 grams; and the latter is mathematically equal to 14 grams, the known weight of "one gas volume" of nitrogen, *vide supra.* Finally, I measure out 1,000 cub. centim. of chlorine at 17·5° C., and 740 mm. bar. What volume will it occupy at 0° C., and 760; and what will be the weight of such volume?

(A). To correct for standard temperature: 273° + 17·5° : 273° + 0° :: 1,000 : x = (273,000 ÷ 290·5°) = 939·75 cub. centim., the required bulk of vapour at 0° C.

(B). To correct for standard pressure: (740 × 939·75) ÷ 760 = (695,415 ÷ 760) = 915·02 cub. centim., or 0·91502 litre, the required bulk at 760 mm. bar.

Then as the "relative weight" of chlorine = 35·5, it follows that 1 litre of chlorine weighs exactly (0·08936 × 35·5) = 3·17228 grams; also 0·91502 litre of chlorine must weigh 0·08936 × (0·91502 × 35·5) = (0·08936 × 32·48321) = 2·9027 grams. From the preceding example we learn that the primary measure of 1,000 cub. centim. (= 1 litre) of gas taken becomes reduced to 915·02 cub. centim., or 0·91502 litre at 0° C. and 760 mm. bar.; and, further, that the weight of our vapour is then only equal to 2·9027 grams. It follows from this that if our calculation be correct we are furnished with the data whereby we can re-calculate the "relative weight" of chlorine, for previous working has shown us that "1 litre of chlorine weighs 3·17228 grams." Thus, by proportion (A):

1 litre : 3·17228 grams :: 11·19 litres : x, where x = (3·17228 × 11·19) = 35·4978132 grams. (B.) 0·91502 litre : 2·9027 grams :: 11·19 litres : x, where x = (2·9027 × 11·19) ÷ 0·91502 = (32·481213 ÷ 0·91502) = 35·4978175. Inasmuch as the relative weight of chlorine is invariably expressed to the first decimal place only, it is evident that each of the foregoing results is again mathematically equivalent to 35·5—*i.e.*, the known relative weight in question. Bearing in mind the observations I have but just made, my readers will experience no difficulty in apprehending the following methods of calculation in reference to the constitution, specific gravity, and relative weight of steam or water vapour. Steam is a compound gas consisting of two parts of hydrogen and one part of oxygen by measure, or two parts of hydrogen and sixteen of oxygen by weight. If the two gases, in the above proportions, be heated to above 100° C before, and such temperature be maintained subsequent to ignition,[*] the volume of the resulting steam will always be exactly equal to that of the hydrogen present in the gaseous mixture.

Thus 2 litres of hydrogen and 1 litre of oxygen unite to form 2 litres of water vapour. Chemists, therefore, agree to represent the constitution of water symbolically by H_2O, and say that 16 grams of oxygen combine with 2 grams of hydrogen to form 18 grams of water or steam. Now, if we convert 9 grams of water into steam at 100° C, *it occupies a volume exactly equal to that of* 1 *gram of hydrogen at a similar temperature and pressure*; therefore the relative weight or density of water gas must be 9, because we find that a given bulk of steam weighs nine times as much as an equal bulk of hydrogen. Also the "specific gravity" of water vapour is 0·6219—that is to say, the weight of a given volume of steam determined against an equal bulk of dry air at a similar temperature and pressure, and weighing 1 gram, is equal to 0·6219. This clearly follows from the fact that the specific gravity of hydrogen, multiplied by the relative weight of steam, furnishes the above quantity—that is, (0·0691 × 9) = 0·6219. With a few special exceptions, the fact is established that "the densities of all the elements known in the gaseous state are identical with their atomic weights." From this we deduce the assumption that "the atoms in the gaseous state all occupy the same space." By the term "molecular weight" is meant the united weights of given bulks of elements combining together to form a compound gas, and it is found in regard to such a vapour that its density is only one-half of its molecular weight; or we might say that the smallest conceivable portion of a compound gas occupies a space equal to that taken up by two atoms of hydrogen. We get thus another illustration of the fact already stated—*i.e.*, that "the density of steam is 9," because we now perceive that the "molecular weight" of steam is 16 + 2 (= 18), and 18 ÷ 2 = 9 as before. Similarly, too, the density of hydrochloric acid is 36·5 ÷ 2 (= 18·25); that of carbonic acid, 44 ÷ 2 (= 22); of ammonia, 17 ÷ 2 (= 8·5), and so on in respect of other compounds. The above law also possesses exceptions, but it is unnecessary to detail them for present purposes. Let us now ascertain what volume of steam at 100° C. we could obtain from, say, one litre of water, when the barometer stands at 760mm. We actually know that "1 gram of hydrogen at 0° C. and 760mm. = 11·19 litres"—that is, "1 gas volume," and that at 100° C. this will expand to 11·19 + $\left(\frac{100}{273\text{rds}} \times 11{\cdot}19\right)$ = 15·3 litres. We further know that 9 grams of water will, at 100° C., supply precisely this bulk of vapour. As the litre is equal to 1,000 cub. centim., our calculation becomes one of extreme simplicity, for, solving the question by proportion, we say:—

grms. litres. grms. litres.
9 : 15·3 :: 1,000 (= 1,000 cub. centim.) : x,

where x = (15,300 ÷ 9) = 1,700 litres. Hence we see that each cubic inch of water is capable of yielding nearly a cubic foot of steam, seeing that there are 1,728 cubic inches in a cubic foot. I have purposely confined myself to the estimation of the volume of steam liberated at 100° C., whereat the tension of the gas is such as exactly to sustain *in equilibrio* a column of mercury = 760mm. (nearly 15lb. on the square inch of surface); but it must be distinctly understood that water passes into vapour at all temperatures, even from ice itself. This effect may be observed by means of a thin bladder containing a little ice and ice-cold water. If it be placed under the exhausted receiver of an air-pump the elastic force of the vapour rising from the liquid will suffice not only to dilate the bag, but even to raise a small weight theoretically 1·5oz.) resting on its upper surface. Mercury also, placed in a massive oak trough *in vacuo*, will exude through and bedew the sides and bottom of it with bright globules of quicksilver, proving that it, like the water vapour, was previously held *in situ* by reason of the atmospheric pressure. The sole difference between these two cases is, that the steam is restrained by a downward, the mercury by a contrary, pressure on the part of the air. A short comparative sketch of "vapour tensions" may here prove of interest to some of my readers:—

The force of steam at	32° F.	= 1·5oz.	sq. in.
„	50° „	= 2·75	„
„	100° „	= 13·0	„
„	150° „	= 4·0lb.	„
„	180° „	= 7·5	„
„	212° „	= 15·0	„
„	250° „	= 30·0	„
„	272° „	= 45·0	„
„	290° „	= 60·0	„

Reverting now to our previous determinations in reference to the specific gravities of gases, let us examine a subject of considerable interest—namely, aërial flotation. Suppose that we have a circular balloon of, say, 35ft. diameter, what will be its ascensile power at ordinary temperature and pressure when filled with pure hydrogen? The capacity of such a balloon would be, in round numbers, 22,000 cubic feet.[*] Now at 0° C., and 760 mm. bar, water is 773 times as heavy as air; also at 15°·5 C. (= 60° F.) 1 cubic foot of water weighs 1,000 oz. (= 62·5lb.). It follows, then—disregarding the extremely slight expansion of the water between 32° and 60°, and taking the density of air for the latter temperature at 1-800th—that 22,000 cubic feet of air = 22,000 × $\left(\frac{1{,}000}{800}\right)$ = (22,000 × 1·25) = 27,500 oz., or 1718·75lb. (= 15·34cwts.); but as the specific gravity of hydrogen = 0·0691 (that is, the 1 – 14·47th), an equal bulk of this gas would only weigh (1718·75 × 0·0691) = 118·77lb. Then (1718·75 – 118·77 = 1,600lb., or 14·28 cwt., is the value of the ascensile power of the balloon. The weight then of 22,000 cubic feet of hydrogen is evidently = (118·77 ÷ 112) = 1·06cwt. From these simple facts we learn that were the balloon and its gaseous contents, together with car, ropes, grappling irons, the aëronauts, their apparatus and ballast, to weigh exactly 15·34cwt., the entire system composing it would be *in equilibrio* with the surrounding atmosphere, and would therefore refuse to ascend except ballast were first thrown out. The balloon and air would, mass for mass, possess a common density. But any nett weight not greater than 14·28cwt. would not only be supported, but even carried aloft. The foregoing subject is also of especial interest on account of the confirmatory evidence which it affords relative to the gaseous laws of Mariotte and Gay-Lussac, and I somewhat recently treated of this question in another publication.[†] Feeling that it would be difficult to treat at greater length concerning the gaseous state without entering too far upon the domains of chemical science, I deem it expedient to bring this portion of my subject to a close. Trusting that it may prove of interest, and perhaps slight service, to at least a few, I beg to intimate my intention of considering, in my next paper, the leading features by which the *liquid state of matter* is characterised.

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[*] Oxygen and hydrogen do not unite to form water-gas save when subjected to the action of an electric discharge or that of ordinary flame; when they do combine, however, a degree of heat is instantaneously generated, greater than that resulting from any other species of *chemical action.*

[*] Actually 22,458·3 cubic feet, because the contents of a sphere = 4-3rds of 22-7ths of the cube of the radius nearly.

[†] See "A remarkable balloon-voyage," *Echo*, April 23 of the present year, in which several effects bearing upon the gaseous state are more particularly explained.

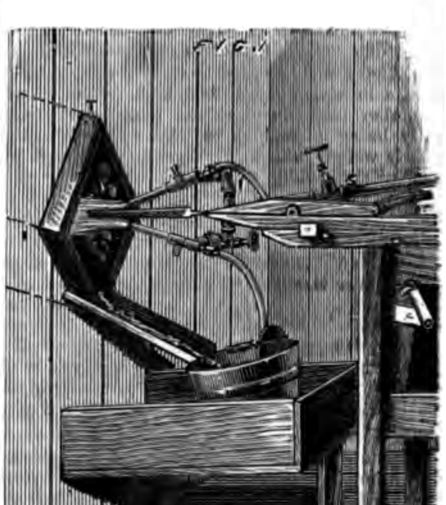
HOW TO CHOOSE (OR BUY) A PIANOFORTE.

THERE is perhaps no other class of manufactured goods the prices of which vary so much as pianos, and though it would be unjust to deny the intrinsic value of the higher-priced, it must yet be admitted that for all practical purposes another may be quite equal at perhaps one-quarter the price, but while, as a rule, the dearer article may be thoroughly depended upon, in the cheaper this characteristic is unfortunately the exception. As, however, with many the only option is between the latter or none, a few hints on how to choose a good one may not be out of place. There are no doubt makers who, hoping to become known, conscientiously turn out reliable work at low prices, and there are also others to whom fame is not so desirable, and who modestly repudiate their productions by adopting the trade-mark of a known though generally obsolete firm. A peculiarity of the last-named is a knack they have of making "second-hand" instruments to order. Numbers of these are advertised in the daily papers as having "been in use only for a short time," and, from a variety of melancholy causes, are "to be disposed of for one-half their original cost." It would certainly very much astonish outsiders if they could only see how large a number of these instruments the "widow" manages to dispose of in this way, notwithstanding the age and frequent exposure of this trick. Some, again, are sold as forfeited pledges, and others find their way to the lower-class auction rooms; and finally, as has been wittily observed, a majority of them go to—pieces. The intending purchaser will, therefore, readily understand how greatly it is to his interest to disregard these tempting baits, and to buy only of an established dealer or maker, who will be responsible for the quality of the instrument sold by him.

The chief points to be considered in the selection of a piano are its durability, tone, and touch. As to appearance, the buyer will, of course, please himself, but in the workmanship of the case much may be found that will help to decide its character. There is a saying that "the outside is of no consequence if the inside is good." This is no doubt true, but a good piano, like a good watch, is rarely put in a bad case; it will therefore be as well to notice closely the outside finish, and if any sign of rough work is perceived, not to risk becoming its possessor. I do not mean by this that it should be very elaborate, rather, indeed, the reverse, for a cheap piano covered with carving and of flashy appearance is, if anything, to be mistrusted. But, however plain it is, such work as there is should be good, and bad joints filled with cement and glazed over with polish may be taken as a sure indication of like defects in the more important parts of the interior. At the same time there is no reason why the eye should not be pleased as well as the ear, so that there is no need to go to the other extreme of supposing that it is only the ugly which is necessarily good, for, thanks to the introduction of machinery and division of labour created by the enormous demand for cheap pianos, such ornaments as perforated panels, carved cabriole legs, and mouldings are now turned out so cheaply as to form only a very small item in the proportionate cost. With regard to the important qualification of durability, it is impossible for any but the maker to pass any opinion. The buyer had better, therefore, place himself entirely in his hands, but in the matter of tone he ought to be able to discriminate, and here I would advise that sweetness be not entirely sacrificed to power, for if the tone is what is termed "brilliant" when new, it will speedily degenerate into harshness as the hammers harden by wear. A pleasing mellow tone, with well-sustained vibration, is that which wears the best, and will eventually develop into volume, which is the quality most to be desired. The next item, and one claiming serious attention, is the "touch," for on this depends in a great measure the pleasure and comfort of the performer. It is to be understood that we have at present the plain "hopper" action only under consideration, which, for hard work and simplicity of movement is perhaps to be preferred. The depth of the touch should not exceed 5-16ths of an inch to a hammer motion or "blow" of 2in. These distances are often increased, since by so doing the hammer acquires increased momentum, and consequently brings out more tone. But as this is at the cost of increased friction, the wear of the parts is greatly accelerated. The cutting of the hoppers and their respective checks may now be examined. To test the accuracy of the first, notice that there be no play between the top of the hopper (which, it will be seen, is blackleaded and burnished to reduce friction) and the lever immediately above. To prove the checks, press down quietly a few consecutive keys, and carefully watch the motion of the hammers. These should barely touch the strings, and then fall (in a line) about $\frac{5}{8}$in. from them. Particularly note, during this operation, that there requires no increase of pressure, as the hammers near the strings for this would indicate that the "stickers" were hinge-bound, the effect of a hard, inelastic quality of hinge leather. In pianos of a low price this fault is not uncommon, and its effects on the fingers of the performer are most unpleasant. It may be said that this will disappear with playing, and no doubt it sometimes does, but I have, on the other hand, known instances where it has been just as bad after many years' use, and found the only remedy to be an entire new set of hinges, so that it will be advisable to have it corrected before purchase. Finally, the method of stringing is worthy consideration In instruments of the class under notice I think a bichord is preferable, unless it may be for about one octave in the treble, principally because the tension and consequent fear of collapse is then at a minimum. Neither do I think, as is generally supposed, that a trichord is any improvement to the tone. At first sight it may appear unreasonable to doubt this, but it must not be forgotten that though there is an extra string to sound, yet owing to the further division of the blow each string is struck w'th less force. The effect, also, of extra weight on the vibration of the soundboard must not be underrated. In actual practice I have found that, other conditions being equal, a bichord has an equal volume, and possesses a purer quality of tone with longer vibration, while—and this is certainly of some consequence—it is easier, and less costly to tune.* **W. H. Davies,** Liverpool.

SHARPENING FILES BY THE SAND-BLAST.

A METHOD of utilising the sand-blast for the sharpening of files has been recently devised, and promises to become of no little value in engineering workshops. The patentee in the United States is, we believe, Mr. M. A. ichardson, of Bridgeport, Conn., but the invention is understood to be that of Mr. glumann, the original introducer of the sand-blast. Various methods of re-sharpening new files have been tried, including pickling in acid, but the only satisfactory method is to have them re-cut, and from an economical point of view it is doubtful whether any advantage is obtained by those who send files to be re-cut, over those who either sell or utilise them for other purposes when worn out. In Fig. 1 the general arrangement of the sand-blast re-sharpening process is shown, the bench table or carriage on which the file is secured, and which supports the gear for moving the file to and fro, and at the same time imparting side to side motion, being omitted. S is the steam-pipe connected to the branch supplying the injectors, which draw up the sand from the pail and force it against the file held in a clamp, as shown. The steam, sand, and water received in the tube, T, shown passing through the partition or wall, whence they fall down to the pail or other receptacle. The sand ine, and is specially prepared for the purpose by washing. It is mixed with sufficient water to form a very thin mud, and after a e must, of course, be entirely renewed. Before describing the results of experiments made with the process, it will be advisable to examine a file as a cutting instrument. No process has yet been devised for cutting the teeth of files theoretically perfect, the tools employed for the purpose invariably producing a burr or backward curve in the teeth, which speedily wears or breaks off in the rough work to which a file is put. Figs. 2 and 3 show the form of teeth actually found in files, and that which is theoretically perfect. In Fig. 2, which is slightly exaggerated, the cutting faces of the teeth instead of looking straight to the point of the file, appear to be studying the ceiling, as if afraid of looking at the piece of iron they are called upon to scratch. In Fig. 3, on the contrary, the teeth face the work, and are evidently strong-backed. It will be readily understood the teeth of Fig. 2 are more liable to break than those of Fig 3, but it is not so obvious why the impinging of a jet of sand upon the teeth should improve even a new file. It might be supposed at first sight that the sand would abrade the teeth equally all over, and so leave the file in much the same condition as before; but those who have worked the sand-blast, and know what a very slight covering serves to protect glass from its influence, will readily understand that the angles at which the particles of sand strike the file and the elasticity or resistance of the latter are important conditions in the satisfactory working of the process. The jet of steam and sand is directed against the backs of the teeth at an angle of from 10° to 15° from the face of the file, and the effect is represented with but little exaggeration in Fig. 3, the tops of the teeth being cut away, leaving a sharp firmly-supported edge. The wear of these might be represented by drawing a straight line just below the points or edges of the teeth, and it will then be easily discerned that the effect of a second application of the sand-blast will be to remove the metal from the backs of the teeth until the flat places have given place to a sharp edge. Many workshops in New England, especially in Connecticut, have adopted it, and at least one large manufactory has obtained a license to apply it in the finishing of their files. In a trial of the cutting power of the sharpened files, as compared with the ordinary tool, one side of a 10in. bastard was used to file a piece of clean weighed wrought iron, care being taken to make the strokes equal in every respect. The number of strokes and the weight of metal removed were then noted, and the other side of the file, which had meantime been submitted to the sand-blast was employed to make an equal number of similar strokes. The result was that double the weight of metal was removed by the sand-blasted side. In further experiments, after several re-sharpenings, the one side of the file demonstrated its superiority by cutting as much metal as six sides of files to which the blast was not applied, cutting at the same time about half as fast again. A few seconds suffices to re-sharpen a newly-worn file; but as the file is successively worn down and re-sharpened, the duration of the sharpening process increases, until the blast fails to be effective. The file can then be re-cut in the usual manner. The new process has already attracted some attention, and we shall, no doubt, soon hear of its adoption in this country, with details of further experiments.



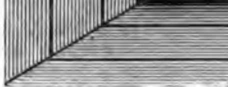


FIG. 2

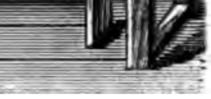


FIG. 3

THE ORGAN: A COMPREHENSIVE TREATISE ON ITS MANUFACTURE, PROCURAL, AND LODGMENT.*

By John Watson Warman,

Associate of the College of Organists, London.

PART I.—GENERAL TREATMENT IN MANUFACTURE.

i. Posit of Hand Blowers. We first consider the Lever Blower, and that of the Fixed kind only, as this may, perhaps, be regarded as the most common, and at the same time subject to a large amount of variation; bear in mind that in this description the term Front always means that face or portion at which the Claviers are placed.

j. When the main beam itself furnishes the Lever the placing of the latter will at once be determined, not only as to position of Beam, but as to which end of the latter is to be continued to form the Handle; for the Down-stroke should, of course, be the heavier, and to accommodate this one of the Feeders is larger than the other. But as the Bellows should always be designed with reference, among other things, to their convenience of Blowing, it will be as well here to point out the advantages of the various placings. There are three positions which the Handle may occupy while itself remaining the Main-beam of the Action; these are at Front, Side, or Back of Instrument.

k. The posit at *Front* is only *necessary* when no other point practicable; as in cases when Organ fits, complete, into a recess, and there is no chamber available beneath. An instance occurs at St. Margaret's, Canterbury (a lovely Instrument by Gray and Davison). The only practical advantage of this method is, that it makes the *teacher* really independent of the caprices of an "odd" or "chance" blowist; and even this ceases as soon as by enlargement of the Bellows the Handle is thrown sufficiently away from the Claviers: the left side is generally preferable if it be contemplated to have a Foot-blower as well. The placing at *Side* is often resorted to by reason of there being no access to back; there is no objection to it except that arising from obstruction or ill-appearance, perhaps involving curtailment of pews, use of Curtains, &c. (*see* u, *ante*). The Handle will be either projecting directly at, or sidewise from a break or *set in* of, Case. The placing at the *Back* will almost always be a simple projection *from* the back; it is practicable, as a rule, wherever the necessary room is allowed behind the Organ. Where the Handles can be beneath the Organ no exact practical directions are necessary, as the blowist is not then in any way barred from any desired point along the Lever, and the Screening him from view must, of course, be insured.

l. With regard to the Unfixed *Socket* Blower it is always under exactly the same conditions as preceding, the only difference being that the Slot in the Case will now only be required wide enough to admit the *shank* of the Blowing Handle.

m. The *Unfixed Elbowed* Blower will never attach at Front of Instrument, always either at Back or Side; it is obvious that the chief advantage of this method is that the Handle becomes reversible, as with the Socket kind. As with that form, however, it is desirable, though not necessary, that two Feeders be used. When the Elbowed Handle is placed at the back, and there is yet not sufficient space to allow the blowist to be stationed there, it must extend beyond the Case, and the shank of the Elbowed portion be formed into a Socket; the Handle itself being provided with a short Shank inserted into it and formed into a screw, so to insert firmly by screwing into the Socket of the Elbowed portion. When the Cranked Blower affixes at the side, the ordinary Thumb-screw and Elbowed fitting will always be sufficient; the object here is to provide a means of blowing either at Front or Back.

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* This paper will be followed by another on "How to [illegible] a Piano," with illustrations, finishing with advice tuning and casual repairs.

* All rights reserved.

m. m. It must always be remembered that where there are two Blowing-pedals, one for each Foot, the Feeders should be designed for the right foot to have the heavier stroke, and this should agree with positing of Handle so that down stroke is the heavier; of course this applies to regular Handle, not a mere occasional one (*see* 6, k.).

n. The posit of the *Winch* Blower is always very much restricted, as it may be considered essential that the Crank-shaft be in immediate connection with the Feeders; thus the latitude possible practically amounts only to a choice of either end of Crank-shaft; or as to the level of latter, which may obviously be either over or under Feeders, the length of the Connecting-rods being varied to any reasonable extent. The only other practicable departure is to place the Crank and Wheel (which latter now, remember, becomes necessary) so as to drive the Shaft by means of a Band; this arrangement, of course, *involves* two suitable Wheels, *besides* the Band, and the position of the Winch must still be confined to a line drawn at right angles with the Band-wheel on the Shaft.

o. In *summing up* with reference to posit. of Hand-blower the following may be laid down:—1. It is extremely convenient for the *teacher* to be able to give a little wind while close to the Claviers at which the pupil is performing. 2. But this position, or any portion of the Front, is inconvenient for the *regular* blowist; for, 3, the latter should be out of sight *without* necessity for putting up any screens, &c. 4. Where there are more than two Handles, and they be together (generally desirable, *see* on, q.), the Blowists should be also out of hearing, for chatter they will, as a rule. 5. That the blowist be spared unnecessary labour in reaching his work. 6. That he should be within proper hearing of the service. In SUMMARY it will be more fully laid down how these may be secured; it will be sufficient to observe here that the necessary conditions are best fulfilled by placing the *regular* Handle at back, near one corner, with a *supplementary* one at side of Claviers.

p. *More than One Handle.* It is now necessary to say a little about cases where there is more than one Handle. Of course this can only affect the regular Blowers; for, however large the Organ, the teacher's Handle, as I have termed it, can only supply a little wind, and if there be more than one Bellows, and they not connected, a portion of the Organ is all available; but this is generally quite sufficient, or, if not, the connection is a very easy affair. But the position of the two regular Handles demands more consideration. If they be together the blowists will often talk; and if they be apart no single person can actuate the two without much inconvenience; besides this there are sometimes practical difficulties in the way of placing the two together; then, again, the provision of communication (*see* 8, y.) will enable both Bellows to be supplied from one Handle.

q. Altogether, however, I am strongly in favour of placing both Handles together. Supposing there to be a *best spot*, as is, in fact, often the case, it is evident both Handles should obtain the benefit of it; talking can be prevented by proper discipline, and there remains the great advantage that a little wind can be supplied to whole of Organ by one person, without the necessity of connecting the Bellows, although he will have two Tell-tales to look at. It is true that the connection is a convenience to teacher's Blower, but that is in all cases a mere makeshift; for playing, in the real sense of the term, the teacher can obviously never supply wind, except in such an Organ as would not require more than one Handle. Then, as to the difficulty of placing both Handles together, that may generally be got over by proper forethought in designing the Bellows (*see* a little further on). When the Bellows remain always connected, no Valve being used (*see* Bellows, 9, a.), there will, in case of the wind being "let out," always be a doubt as to which is the real culprit, and either *this method or a* Valve becomes desirable unless *Handles be together.*

r. The best distance apart of the Handles will perhaps be 2ft.—that is, reckoning centre to centre; rather more than 1ft. 10in., therefore clear between handles: latter better of equal projection from case. Where there is difficulty in giving this amount—as often with Handles that lie parallel with the flat of the Case, being made to project from the side of the *set in* designed for the purpose (*see* 18, k,)—the matter may be completely got over by having the Handles close together (that is, 2in. clear between them), and one 1ft. 10in. longer than the other, the purchases of course proportioned accordingly: the two blowists will of course stand one behind the other; if but one be blowing, one hand will be on one Handle, and one on other. Observe in all cases where Handles are together the Bellows should, if possible, be so designed that the lighter actuator falls under the *left* hand of the single person blowing.

s. With regard to the Winch Blower not the least of its defects is the impossibility of ever conveniently placing two of its Handles close together. Thus they can be posited so that they, at their nearest points, be the minimum of 1ft. 10in. apart, and in such case may be tolerably well actuated by one Blowist, provided he turn them in contrary directions; and there is not as a rule any practical difficulty in arranging the Bellows, &c., with reference to this. But, then, when the second blowist comes, it is obvious that both Winches must be turned in one direction, or the two persons will be in each other's way, as they cannot possibly both operate in a space only 1ft. 10in. wide. And remember that though the Crank-shaft *can* easily be so placed as to admit of operating equally well in whichever direction it revolves, yet that this can only be done by having the stroke in both cases *diagonal* instead of (approximately) *square* with the Lug-motion (*see* ATTACHMENT, 17, k.). In other respects the position of the Winch is of course under same rules as the Lever Handles.

** HYDRAULIC ENGINE.

t. CONSTRUCTION. In this description is included any motor actuated by Water; it will be only necessary here to notice three kinds—viz., the Turbine, the "Hercules," and the Cylinder.

u. The Turbine may be at once dismissed, as its motion is so extremely rapid that an intermediary train of Band or Wheel-work will be required to furnish the desired comparatively slow motion, and then the noise of this and the hum of the Turbine itself will become insuperable objections. In addition to this there is the expense. The "Hercules" is described as an engine on the Turbine principle, but slower in its action, and particularly adapted for Organ-blowing; *see Musical Standard*, 1874, May, page 324: the London House for this Motor is 69, Prince's-street, Leicester-square. The size is 2ft. square each way. I have not been able to meet with an instance of its adoption for Organ-blowing. The "Brakell," a form with oscillating blades, may also just be mentioned; Patent No. 1,393; A.D. 1875.

v. The Cylinder Hydraulic is the most common and best known; it consists simply of a firmly fixed Cylinder, containing Piston, with, of course, suitable Ports or Valves for the proper admission of the water to the alternate sides of the piston—the whole, both in construction and action, being very similar to the Steam-engine; a Counter and train of wheels ought to be attached for the purpose of showing the amount of water used. For the purpose of Automatic regulation there is provided a Valve or Cock, which, being placed in connection with the Receiver, will close (or sufficiently nearly so) when the latter has risen high enough, and so cut off water.

v. v. It will be obvious that the Cock must be very light in its action, and this, if suitably constructed, it easily can; either the balanced or "opposition surface" form, or that well-known kind—acting with a simple thumb-screw tap—known as the "high pressure" will answer perfectly well; the common form consisting of a slightly tapered perforated revolving plug is obviously unsuitable, from its tendency to tighten: nevertheless, if accurately made and fitted, it is, n fact, often
used. The Motor may have either one
Cylinders, the latter, of course, preferat
Duncan, which is by many persons o
rience considered the best form of No
Hydraulic, has in all cases two cylinder
"Lea" is also highly recommended,
certainly very cheap, £10 the smallest
addresses, 41, 1); it has, however, no
attached—the "Duncan" has. The "
lately advertised in the ENGLISH M
may be also mentioned as being ver
price.

w. The Rotary Hydraulic differs in
crank-shaft added, so as to convert the
cating into a Circular or *Rotary* motic
name implies; and to accomplish this
it should have three Cylinders. The b
is said to be Brotherhood's patent (*see*
1), the next Ramsbottom's (*see* 41, 1); th
three Cylinders, and work with
smoothness, but both are expensive, th
particularly so. It may, I think, be co
laid down that the Rotary form of H
will only be required when it is not p
spare room for a Reservoir (*see* that Hea
and it is also impracticable to shift the
away from the Organ; nor does it fol
a Rotary will be absolutely *necessary* e
though *desirable*: and as it is ra
neither of the before-mentioned exped
be resorted to, it will easily be unders
very little used are Hydraulic Rot
Organ-blowing. And it must disti
borne in mind that there are many O
present driven by a "Duncan," witho
a Reservoir of any kind or the
farther from the Pipes than is quite u
may be mentioned here that a pressure
to the square inch will require a fall o

x. For other Hydraulic Engines *s*
BOUGHT PORTIONS, &c. (36, j.); also
MECHANIC for Sep., 1875, page 46. A
after in *Dep.* of PATENTS.

y. ATTACHMENT. The motion of th
being Reciprocal or oscillating; and the
the Piston also reciprocal, and at the s
continual, it follows that no Cran
absolutely required, the Piston th
directly connected with the Feeders—
say, with, of course, any Beams, Crank
&c., required to transmit the force
quired direction; care always bei
that the Piston motion correspond ex
that of the Feeder itself or intermedi
employed in actuating the latter.
going refers to Non-rotaries; Rotari
already stated, provided with a Cran
their own; for attachment in this
Engine-shaft must either be extende
carry the Cranks or Eccentrics which
Feeders, or Crank-shaft will be drive
Engine-shaft by the usual Band; t
method preferable if Fast-and-loo
desired.

z. For arrangement of Feeders,
Reciprocating (Non-Rotary) Hyd
BELLOWS, &c. (6, d. and on).

(*To be continued.*)

IMPROVEMENTS IN THE MA
TURE OF COLOURS.

AN improved process for obtainin
ultramarine has been patente
Johann Zeltner, of Nuremberg, and
be utilised in the production of other
is worth notice. The colour obta
according to the patentee, new, and is p
according to one method, in the f
manner:—Ultramarine blue or green pr
heated to 300° C. (572° Fah.), is subje
the action of chlorine gas to obtain
products of ultramarine. The ultram
first transformed by the effect of the
into a green substance, and by further c
tinued action into a dark red. The pro
thus obtained are then p[illegible] in water
solution of carbonic acid o[illegible] alkaline liqu
lye, and warmed. Then the [illegible]rine combi
with these products passes [illegible] the sod
into the condition of chlorur[illegible] alkali, an
the same time appears [illegible] new ultrama
combination—that is to [illegible] ultramari
violet, which contains [illegible] ed with
hydroxyl instead of chl

cisely analogous manner anhydrous
ıcid will produce on the ultramarine
ıbout 150° C. (302° Fah.), a sulphur
a red colour, which, when mixed with
:id, or a caustic alkaline lye, is trans-
o an isolated alkaline sulphate and
ed ultramarine violet. According to
nethod, the patentee modifies the
ribed process by taking blue or green
e and heating the same to 160° —
d then introducing into the mass
e chlorine (or other halogen), and
here will then be an immediate for-
violet ultramarine, hydroxide, and
sodium, the latter of which is re-
means of water. According to
odification in the method of pro-
colour, combinations of salts are
which, when heated in water, will be
l with chlorine or other substance or
, for example, as the nitrate and the
ammonia. Should blue or green
be mixed with either of these com-
for example, nitrate or chlorate of
nd heated in water and a compound
chlorine, and if this mixture is heated
ice with the second process above
an ultramarine violet hydroxide is
nd in transforming it by ammoniacal
et ultramarine amide. The corre-
lts which are formed are then re-
washing, and an insoluble violet
remains. According to the fourth
patentee takes blue or green ultra-
l heats the same to 160°—180° C.,
s it at the same time to the action
lowing bodies—viz., an acid, an
gent or water, either separately or
ion. The result of this process will
r less complete transformation of the
into a violet ultramarine.

NING AND TEMPERING.*

By Joshua Rose, M.E.

hardening of steel consists of first heat-
l then rapidly extracting the heat, it
this latter part of the process may be
herwise than by the use of water—such,
as by placing the article in a current of
if it is thin, by placing it between two
iron. In these processes, however, the
xtracted quickly enough to give a great
rdness; hence, cold plates are rarely
in cases where straightness and truth
y importance, and where straightening
be applied after hardening, are

eme hardness is required, it is not un-
quench the steel in mercury, which will
much greater degree than water.
e the efficiency of water, it is not un-
it, which draws off the air contained in
is no doubt that the superiority of water
en long used for hardening, is largely,
ther, due to its comparative freedom

erations which determine the most de-
of hardness or temper are whether re-
abrasion, the capability of sustaining
e upon a fine edge, or elasticity, are the
sought to be imparted.
ticity is sought, tempering is absolutely
cause the degree of hardness accompany-
is that represented in the colour test
of blue. But when the requirements
lement of strength (as is always the case
ols, and is sometimes the case in articles
resist abrasion), then the degree of
dified to accommodate the strength, for
d right out, that is, made as hard as fire
ning it) and water will make it, is some-
and comparatively weak, but it resumes
rength as its normal softness is restored.
utting tool is of strong section, it is, in
ctice, hardened right out, but if it was
he edge was, from excessive duty, liable
it would be tempered to a straw colour,
r, even down to a blue if the require-
ength demanded it. It is self-evident,
t since the cutting capability of a tool
ependent upon its degree of hardness
of the material to be cut, the harder a
made to stand the duty without break-
and the better duty it will perform.
is true, a great difference of opinion
to the propriety of tempering many
to a straw colour, especially in the case
ls for iron. Some of our most expert
ll temper such tools to a straw colour,
, equally expert, will give them all the water—that is, harden them right out, and not lower the temper at all. There is among them all, however, a common practice of using the full degree of hardness in the tool when the metal to be cut is hard, as is sometimes the case in even common unchilled castings, and, since the harder the metal the more force it requires to sever it, it would seem that a tool strong enough for the hard metal should be sufficiently so for the soft metal. On the other hand, the tool is sometimes made less keen for the hard than for the soft metal, and the difference in the tool shape may give as much increase of strength as the increase of its hardness tends to weaken it.

Here let it be noted that the difference of opinion referred to is not in any way due to a difference in the steel, for, of two men operating the same tools in the same machine and upon similar work, one will simply harden and the other harden and temper the tools. Let he who would excel, however, never use tools of a lower temper than that which he finds will safely withstand the strain, and never rest satisfied until, under equal conditions, he can use tools as hard as the best of others engaged upon similar work, for in most cases it will be found that an advantage of shape is the cause of being able to use a tool of increased hardness.

Under equal conditions, and under any given process, steel hardened with the outer or forged skin removed, will be harder, though tempered to the same colour, than if that skin remained, which appears an anomaly, since it is universally conceded that the forged surface is the closest-grained and most refined steel. An explanation, however, may be found in the probability that the forged skin, or scale, operates as a separating film or lining between the metal and the water, retarding the extraction of the heat from the steel; but, be this as it may, it must always be allowed for in tools in which the temper is drawn to give strength. Suppose, for example, the conditions require that a tool be filed to exact shape before being hardened, and that the proper temper for that class of tool, if hardened with the forged skin on, would be a pale straw, the temper with that skin off would require to be about a coffee-coloured brown; or if, in the first case, a deep reddish brown, then, in the second case, a clear reddish purple.

The surface of a piece of steel that is thoroughly hardened always appears white, provided that its surface was not covered with any substance during the heating process, and if any dark places or patches appear, it is an evidence that in those parts the steel is not so thoroughly hardened. For most colour tempering, except it be for springs subject to excessive duty in proportion to their size and shape, the presence of such dark spots upon good refined cast steel, such as tool steel, is not of sufficient importance to appreciably impair the value of the tempering. If shear steel, blister steel, machine steel, or any of the common qualities of steel are used, the whiteness of the surface is, however, a sure indication of the hardness of the steel, providing it was heated with its surfaces uncovered and quenched in water; but if the surface of any steel be coated with any of the substances sometimes used (and to be hereafter specified), to prevent decarbonisation, black or dark spots, will not be an indication of local softness.

In large bodies of steel, the heat is not extracted from the internal metal sufficiently quick to harden the interior to the same extent as the exterior. Furthermore, it is often necessary to have a free current of water in order to extract the heat sufficiently rapidly to harden the exterior, because the internal metal supplies heat to the external, thus partly counteracting the cooling effects of the water. In such cases, however, the coldest of water under pressure, and, if practicable, with salt added, may be employed.

In such sizes of steel as are used for cutting tools and instruments, it is not found that the internal metal is appreciably softer than the external, provided that the steel was heated equally all through.

In articles tempered to any degree not lower than a red purple under the colour test, it is not found that removing the surface after hardening alters the temper, or, in other words, articles not tempered (by colour) to a lower degree than a very light purple, appear to possess their degree of temper equally all through the metal; hence, subsequent grinding and polishing does not impair the hardness, unless the operation should heat them. But in all the degrees of temper represented in the colour test, the blue purples and blue, removing the surface of the metal after tempering, will sensibly reduce the temper; the amount of the reduction depending upon the depth to which the surface was removed. The difference, however, will be found to be less in the case of refined cast steel than when the quality of steel is that ordinarily used for springs. It is stated to have been found by experiment that the bare removal of the blue tint from a pendulum spring by immersing it in weak acid, caused the chronometer to lose nearly one minute in each hour. It is also stated as a well-known fact, that such springs get stronger in a minute degree during the first two or three years they are used, from some atmospheric change; while springs plated with gold, silver, or nickel, remain constant, though the covering or plating may be so thin as not to compensate for the loss of the blue surface removed for the plating process. Be that, however, as it may, certain is it that the elasticity of tempered steel is rapidly affected by various conditions. Thus the springs of engine pistons partly lose their elasticity in the course of time, whether from the heat or from rusting, it is hard to say. Springs operating under dry heat get harder, but whether this is not due to the crystallisation of the metal, is an open question.

It does not appear that the method of tempering affects the durability or elasticity, since the deterioration mentioned applies to springs tempered either on hot plates of iron, in sand, in heated fluxes, or by burning oil, or blazing as it is termed.

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* From the *Scientific News*.

ORIGIN OF SOLAR AND SIDEREAL HEAT.

By Prof. Daniel Kirkwood.

THE *Quarterly Journal of Science* for July, 1877, contains an able and interesting article by James Croll, LL.D., F.R.S., on the age and origin of the sun's heat. The theory of Dr. Croll may be regarded as a compromise between the mathematicians, represented by Thomson, Tait, and Newcomb, and the geologists of the uniformitarian school, represented by Playfair, Lyell, Darwin, &c. The principal points of this remarkable paper are:—

1. That, as had been estimated by Sir William Thomson and others, but twenty million years' heat could be produced by the falling together of the sun's mass.

2. That not less than five hundred millions of years have been required for the stratification of the earth's crust at the present rate of subaërial denudation, and hence that the gravitation theory of the origin of the sun's heat is incompatible with geological facts.

3. If we suppose two solid opaque bodies, each equal to half the sun's mass, to fall together in consequence simply of their mutual attraction, the collision would instantly generate sufficient heat to reduce the entire mass to a state of vapour. If, in addition to the motion resulting from their mutual attraction, we suppose the bodies to have had an original or independent motion towards each other of 202 miles per second, the concussion would produce 50,000,000 years' heat; a motion of 678 miles per second, together with that due to their mutual attraction, would generate 200,000,000 years' heat; and a velocity of 1,700 miles per second would generate an amount of heat which would keep up the supply at the present rate for 800,000,000 years.

4. The sun and all visible stars may have derived their heat from the collision of cold, opaque masses thus moving in space. The nebulæ are the products of the more recent impacts, and the stars have been formed by the condensation of ancient nebulæ.

5. This theory, while accepting the doctrine of the conservation of energy, indicates at the same time a possible supply of heat for several hundred millions of years, thus satisfying all moderate demands for geological time.

The mathematical correctness of the theory here stated will not be called in question. We shall consider merely the *probability* of the facts assumed as its basis. To the present writer the hypothesis seems unsatisfactory for the following reasons:—

1. The existence of such sidereal bodies as the theory assumes is purely conjectural, unless it be claimed that lost or missing stars have become non-luminous, of which we have no conclusive evidence.

2. But, granting their existence, we have no instances of stellar motion comparable with those demanded by the hypothesis, the velocity being in most cases less than 50 miles and in no case exceeding 200 miles per second.

3. If the two masses by whose collision the sun is supposed to have been formed were very unequal, as would be most probable, the amount of heat generated would be correspondingly less.

4. Such collisions as the theory assumes are wholly hypothetical. It is infinitely improbable that two cosmical bodies should move in the same straight line; and of two moving in different lines, it is improbable that either should impinge against the other. Comets pass *round* the sun without collision against it.

5. But, granting these difficulties removed, let us suppose that about 800,000,000 years ago two cold opaque bodies, each containing one-half the matter of the solar system, were approaching one another in the same straight line, each at the rate of 1,700 miles per second,* that on meeting their motion was transformed into heat, and that their united mass was at once reduced to vapour, the great question yet remains—How much of the period represented by these 800,000,000 years' heat can be claimed as *geological* time? The nebula formed by the collision would extend far beyond the present orbit of Neptune. The amount of heat radiated in a given time from so

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* This is the greatest velocity mentioned by Dr. C[illegible] An increased rate of motion would, of course, [illegible] more heat, but the hypothesis would be open to [illegible] objections.

vast a surface would doubtless be much greater than that now emitted in an equal period. No considerable contraction could occur until a large proportion of the heat produced by the impact had been dissipated in space. It has been shown by Trowbridge* that, with a temperature at the sun's surface of twice its present intensity, the solar atmosphere would be expanded beyond the earth's orbit. The conclusion seems inevitable that much the greater part of the 800,000,000 years' heat must have been radiated into space before the planets were separated from the solar mass, and consequently that the amount of geological time cannot, to any great extent, have exceeded the limits indicated by the researches of Sir William Thomson.

Upon the whole, it seems more difficult to grant the demands of Dr. Croll's hypothesis than to believe that in former ages the stratification of the earth's crust proceeded more rapidly than at present. The former, as we have seen, has no sufficient basis in the facts of observation. On the other hand, if our planet has cooled down from a state of igneous fluidity, the great heat of former times must doubtless have intensified both aqueous and atmospheric agencies in producing modifications of the earth's exterior.—*American Journal of Science and Arts.*

NEW FACTS CONCERNING THE TELEPHONE.†

AMONG the discoveries and inventions of Prof. A. E. Dolbear, who has been engaged for nearly two years in experimenting upon the telephonic transmission of sound, and whose telephone is today in constant use in Boston and New York, may be noted the following :—

Various substances have been used for making diaphragms for the telephone, and among others may be named paper. A telephone, very delicate in its action, has been constructed, the vibrating plate of which is of paper. To this plate is affixed an electromagnet, consisting of two cores and bobbins, which is in such close proximity to the soft iron poles of the permanent magnets that a piece of indiarubber tissue is of necessity placed between them to prevent actual contact. This construction proves beyond a doubt that the vibrations of the diaphragm are really those of sound, a point that has been disputed.

In 1861 Reiss invented a form of telephone which is regarded as the first one capable of transmitting vocal sounds by means of electricity. The essential points of his instrument were a vibrating membrane carrying a small metal plate, and a finger lightly resting upon the plate, making and breaking contact with it as the membane vibrated under the influence of sound. Introducing such a telephone into a circuit the electrical pulses will be synchronous with the vibration of the membrane, and pitch, not *quality* or articulation, can be transmitted. A sectional view of a telephone upon this principle, constructed by Prof. Dolbear, is represented in Fig. 1.

D represents a diaphragm of iron backed by a ring of wood, W. F, the finger, should lightly touch the diaphragm at D. A and B are screw-cups receiving the wires, A being connected with the diaphragm, and B with the finger. When the diaphragm, D, is caused to vibrate by a sound it alternately makes and breaks contact with F, closing or breaking the circuit in which the instrument is placed. Its tones, as made audible by means of a telephone of ordinary pattern, are of penny trumpet quality and inarticulate. If, however, *a single drop of water* be introduced between the diaphragm, D, and the finger, F, as is represented in the above figure, the instrument becomes a speaking telephone of great delicacy, and of notable simplicity, the receiving instrument being of the usual form.

This experiment is interesting, showing as it does how near to a speaking telephone was the telephone of Reiss—how nearly successful was the first effort in this direction.

Heretofore all electric telephones have depended for their action upon magnets or a circuit-breaking mechanism, but the "Water telephone," the latest curiosity of telephonic invention, has neither magnets nor coils, nor any of the contrivances so essential to other telephones. A section of one form of one of these instruments is represented in Fig. 2.

I and Z represent two discs or diaphragms of iron and zinc respectively, separated by a ring, W, which may be of paraffined wood, hard rubber, or any other suitable non-conductor of electricity. C then is a cell which may be filled with water or other solution, forming with the metals, I and Z, a galvanic battery, screw-cup, A, being connected with the iron, and B with the zinc. On the circuit being closed a weak current will constantly flow, which current will be modified by the vibrations of the discs when influenced by sound. These modifications will produce sound upon the diaphragm of any telephone of ordinary construction if placed in the same circuit, which sounds will be intelligible, although weak. If, however, a battery be introduced into the same circuit, the water telephone will modify its current when sounds enter the orifice of the instrument, and the receiving telephone will emit sounds proportionately louder than when no battery is employed. It is necessary, then, merely to supply battery power sufficient to overcome the resistance of the wire, and by means of this simple instrument we may talk one hundred miles, one thousand miles, or any distance we may choose. It is here that the electric telephone has thus far failed in practice. Its currents of electricity, generated by a limited vibration of the diaphragm, are limited in their results; the water telephone modifies currents generated by a battery, which may be so increased as to produce any desired results. Here, then, a new field has been opened for telephonic research, and a wide one. The instrument is at present only a transmitting telephone, but it is possible, without doubt, to so construct it as to make it speak as well as hear.

FIG. 1

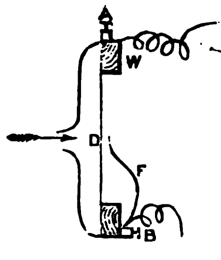
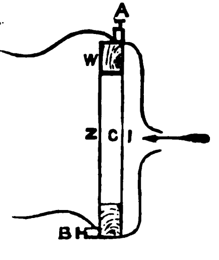


FIG. 2



A NEW PIANO-HAMMER.

THIS invention relates to the construction of piano-hammers, which is covered by two patents and issued jointly to Geo. C. Smith and Alvin O. Hall. This hammer has a felt-covered disc, adjustable by rotation. This is after one part of the hammer has become hard by repeated blows against the wire; by loosening the screw in the centre of the disc it can be turned, thus presenting a new soft surface. The change thus made restores, as to sound, the softness and mellowness of tone which is found in new pianos. Fig. 1 represents a hammer complete; Fig. 2 a section of the hammer head without the felt disc. A small washer of thin sheet brass under the screw helps to secure the disc to the hammer head; the strain of the blow is sustained on the circular projection, A, and also at B, on which the outward part of the circle of the disc rests. This hammer is so simple in its construction that any one of ordinary ability can, without calling in the aid of a piano-tuner, by simply loosening the screw and turning the disc, restore the piano to its original softness of tone.—*American Inventor.*

FIG. 1

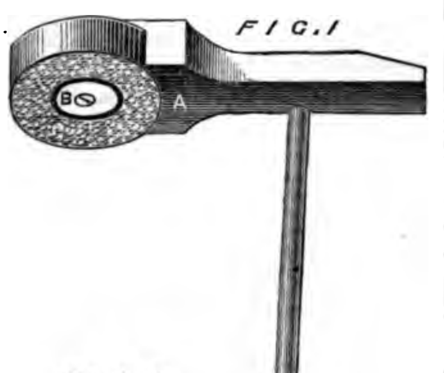
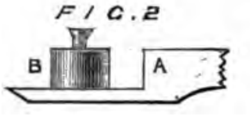


FIG. 2



The Desideratum Bicycle.—Messrs. Hinde, Harrington, and Co. are determined to leave nothing untried that will make their "Desideratum" bicycle the favourite of that portion of the public who cannot afford the higher-priced steeds. The wheels are of the spider type, the driver having from 50 to 60 spokes, which are fitted into the gun-metal hubs by nipples in preference to lock-nuts. The spokes and other bright parts are burnished by a new patent process, and are warranted not to rust. The bearings are on the roller principle, and appear to have been carefully designed after a consideration of all the bearings of that subject. Intending purchasers should send for a photograph of the Desideratum.

SCIENTIFIC NEWS.

THE 188th small planet was discovered by Prof. Peters, at Clinton, N.Y., on June 26th. No. 177, discovered on Nov. 5, has been named Irma; No. 180, discovered on Jan. 29, Garumna; No. 185, March 1, Eunike; and No. 186, April 6, Celuta.

The London Institution is not to be enlarged. It is to remain more of a club than an institution. The proprietors have the right to do what they please with their own, but we had thought that City men were advancing with the times. Within the past two or three years the London Institution has engaged eminent scientific men as lecturers, and given so many signs of life that about 600 new annual members have recently joined. Rooms have been provided for writing and refreshment, ladies have been admitted to them, and what with one thing and another, there is ample reason why the building should be altered and enlarged—at least, so thought a large majority of the board of management. The proprietors, assembled at a special general meeting, held a few days ago, Dr. De la Rue in the chair, decided that the proposed alterations and enlargements should not be carried out.

Dr. Clarence J. Blake, of Boston, in a letter to Mr. Preece, says that to prevent the scratching noise of the point of the phonograph, the cylinder may be covered with a thin layer of rubber tissue beneath the foil. The rubber destroys the resonating effect of the groove. Dr. Blake, to destroy certain overtones given by the reproducing disc, used a curved diaphragm of parchment, pressed into shape whilst wet. Between the embossing point and the centre of the diaphragm or disc he uses a light rod of pine, with a rubber pad at each end. The curved membrane is on the principle of the human drum membrane, and can be employed with advantage in embossing the foil, as well as in reproducing the sounds.

Mr. Thomas Bain has just sent home from Cape Colony a large collection of fossil saurians. There are amongst the bones 308 crania, some apparently new to science. Mr. Bain found the head of a saurian in the matrix of the coal within 2ft. of the seam. Amongst the known fossils are Dicynodon, Oudenodon Pariesaurus, Lycosaurus, Galesaurus, and Cynodracon.

The Trinity Board have determined to undertake the building of the new lighthouse at the Eddystone themselves, the tenders sent in being much above the estimate of the engineer. That is the wiser plan, as of necessity it must be a great risk for a contractor to run.

A very remarkable result has been obtained with the Iris, steel despatch vessel, in a series of trials made last week. It will be remembered that on her previous trial the speed attained was not by any means gratifying to her designers, but it was rightly surmised that the fault was due to the propellers. The two four-bladed screws, 18½ft. in diam., and 18ft. pitch, had therefore two blades removed, and the performance of the vessel was so much improved that new propellers were designed. They are four-bladed, 16ft. 3in. in diameter, and 20ft. pitch, smoothed all over, and with conical caps tapped to the bosses over the nuts holding the propellers on the shafts. Four runs at full power gave the following means: Horse-power, 7734·85; speed, 18·572 knots, or 21·3 miles, the fastest run ever made by a ship.

At the trials of the torpedo boats, however, No. 420 made a run of two miles, with tide, in 5 min. 19 sec., equal to a speed of 22·59 knots. The run against tide occupied 6 min. 47 sec., equivalent to a speed of 17·69 knots. The mean of the two runs was thus 20·14 knots, or 23·2 miles an hour, faster than many of our trains travel. No. 419, a sister vessel, made in two runs a mean of 21 knots—24·2 miles. The latter has a three-bladed screw, and No. 420 a screw with two blades, both 5ft. 6in. diameter and 5ft. pitch. Both vessels are 85ft. long, with a beam of 11ft., and draw, when equipped, an average of 3ft. of water. We shal [illegible] particulars of these remarka

The Branksome Hall l
21, and reached Bombay

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* Proc. Am. Phil. Soc., Vol. XVI., pp. 329—333, and *National Quarterly Review*, March, 1877, p. 292.

† *From the Science Observer (Boston, U.S.).*

of 26 days. Her homeward voyage occupied exactly the same number of days. Such speed and punctuality will before long induce an enterprising company to advertise that their vessels will call at Gibraltar at 10.30 a.m., and at Suez at 4 p.m., on stated days, with the certainty of being at least as punctual as some of the trains on suburban lines.

The Calais-Douvres has been an unfortunate vessel, her owners having had to pay some compensation to Capt. Dicey for alleged infringement of patent rights. Symington's steamboats were "twin," with a paddle-wheel between the two hulls. A twin steamer was built on the Hudson some years ago; but, after making a few quick voyages, she was wrecked. The facts mentioned may be useful to those who are thinking of "inventing" twin steamers.

The paper sheathing invented by Capt. Warren for preventing the fouling of ships' bottoms proves to be a success, as the Serapis, after a voyage to India and back, and two months in dock, was found to be quite clean, except where the jelly fish had attached themselves to portions of the cement from which the paper had been removed by abrasion. We gave an account of this invention on p. 152, Vol. XXV.

According to the *Whitehall Review*, some American gentlemen have brought to this country an invention by which a boat can be brought to a stop instantly from full speed! No information is given as to what becomes of the crew.

Some peculiar motions of the bubble in spirit levels formed the subject of a paper recently communicated by M. Plantamour to the Paris Academy. He placed the level in various places —on the massive table of his limnograph at the lake of Geneva, on the beton-covered ground beside it, on the ground in his cellar some distance from the lake, and elsewhere. The bubble was observed to be displaced, not only from day to day, but also in the course of the same day. The nature of these movements M. Plantamour indicates by curves in *Comptes Rendus*. In certain periods there was a gradual rising to the east, without perceptible return to the west, in others, horizontal immobility, while sometimes, again, there were oscillations from east to west and from north to south, more or less pronounced. Similar movements of the ground were testified to by M. d'Abbadie, from observations in Brazil in 1837, and others since, and M. Bouquet de la Grye has observed such movements in Campbell Island. M. d'Abbadie constructed a cone of beton 10m. high, having at the top a bath of mercury and a cross wire. A lens of 10m. focus gives, at the surface of the ground, an image of those wires, the displacements of which are observed with a microscope having a micrometer. According to his (more than two thousand) observations the vertical rarely continues fixed for 24 hours.

To give an idea of the mode of formation of owels and consonants in speaking, M. Schnee-eli lately devised the following experiment:—he current from a battery of two or three aniell elements is alternately interrupted and enewed by means of a tuning fork, and the urrents thereby induced in an induction oil are sent through a telephone. The one which the telephone gives is the ctave of that of the tuning fork, which, in e present case, gave 200 simple vibrations in second. This tone from the telephone was ery pure, and could be heard by a large audience. If the hand be now placed on the mouth the telephone, and the form of the hollow aried by opening more or less the slit between e thumb and the forefinger, the vowels *u*, *o*, d *a* are easily produced. And doubtless all e vowels may be given in this way if the oper forms be given to the hand. With a mall paper case having an opening into which cylinder could be pushed the telephone could so be made to give the vowels. Though the nsonants are quite different in their origin ey can also be imitated. Thus, by striking th the hollow hand against the telephone one oduces a sound very like *b*, moving the hand ntly to and fro on the telephone gives the M. Schneebeli hopes to prosecute ier.

A correspondent of *La Nature* describes a rustic hygrometer which he was surprised to find in the house of an old peasant up in the mountains. It consists simply of a thin branch of pine in the form of a cross attached by two nails, one at the point of crossing, another on one arm above. At the extremity of one horizontal arm is a kind of scale, on which are inscribed (coming upwards) *pluie, beau, très-chaud* (*i.e.*, rain, fine, very hot). The pine branch was not deprived of its bark. It was about 3mm. or 4mm. in diameter.

Wollaston's ingenious suggestion to utilise total reflection, as a means of determining the refractive power of bodies, was very imperfectly realised in practice. The idea seems to have been carried out more successfully by M. Kohlrausch, who has described to the Physical Mathematical Society of Würzburg an instrument for the purpose which he calls a total reflectometer. A description of it appears in the first June number of *Dingler's Polytechniches Journal.*

In view of the much-discussed question of adulteration of food it is well to provide the public with a means of self-help in the matter. For this purpose M. Griger, a mechanist and optician in Stuttgart, makes up an apparatus for examination of food, and he sells it for about 24s. It consists of the following things:—1 microscope, with case and pincers, 1 lactometer (Quevenne), 1 cream meter, 1 alcoholometer, 1 thermometer, 2 test-tubes, 1 flask each of tincture of iodine, lead, vinegar, fusel oil, and "seufgeist" (?); five preparations—trichina, wheat flour, pepper, cinnamon, cacao; and a *brochure*, giving directions for examination of various raw materials, preparations, and liquids.

A novel application of the electric light is proposed by Mr. Edison. His plan is to make a diminutive light apparatus, and inclose it in a glass globe of such size as to be easily swallowed! He will connect it with a suitable battery, and he expects to be able to witness the process of digestion, and to see with more or less distinctness the operations of the internal organs.

Two interesting experiments have been lately made by M. Gernez—one relating to decomposition of explosive liquids, the other to ebullition of superheated liquids. First he places under some very cold water, in a tube 1 metre long, a certain quantity of nitrous acid, then he causes the tube to vibrate by rubbing with a damp cloth, and finds that, when a musical sound is produced, the acid is decomposed with explosion. Repeating the experiment with methyl-chlorhydric ether, brought to the temperature of, say, 20° above its boiling point (−23°), he produces ebullition, which, however, ceases whenever the vibration is stopped. The difference between these two results is explained by simple facts of thermochemistry. Nitrous acid, as M. Berthelot has shown, liberates heat in decomposing. The vibratory movement ruptures the continuity of the liquid at a great many points, giving numerous free surfaces where decomposition may take place. The sudden consequent heating increases considerably the rate of liberation of gas, which, not finding exit quickly enough, projects the superposed liquid. In the other experiment the sudden transformation into vapour of a large quantity of liquid consumes much heat, and causes such cooling of the unvaporised liquid that its temperature may be brought near the normal boiling point.

For an electrode to be depolarised, it is essential (M. Lippmann has recently pointed out) that it be formed of the metal which is contained in the solution. Thus, copper is the only metal which is depolarised in sulphate of copper, while gold, silver or platinum is polarised in this solution. On the other hand, copper is polarised in sulphate of zinc, cobalt, &c. The author applies this to detecting the presence of a metal in a solution. Take copper —*e.g.*, put into the liquid to be examined a copper wire, as negative electrode of a weak current. It will be polarised if there is no copper dissolved; it will not be polarised if the solution contains 1-5000 of sulphate of copper.

In the south of Russia, with its abundant fertile black earth, and its few forests and scanty fuel of the better kind, the large quantities of cattle dung deposited in the meadows, steppes, and stalls are utilised as fuel. It is sold in brick form, and has the appearance of loose turf. Kisjak is the name given it. The manufacture dates from 1844. There are chiefly two kinds of these dung-bricks, made of horse-dung and sheep-dung respectively. The former contain considerably more carbon, hydrogen, and oxygen than the latter, which have more salts and earthy constituents. For manufacture of kisjak the dung is collected from the ground (where it has lain over winter), and after addition of water, is kneaded (by horses' hoofs) into a homogenous pap. It is pressed in wooden moulds, then dried in air. Sometimes the kneading is dispensed with. The dung-bricks are built up in pyramidal stacks, with air-passages. In heating effect kisjak stands low; it comes to a glow but slowly. In high winds it fills the peasants' houses with badly-smelling gases.

In a recent thunderstorm at Saint Reverien (France), the lightning disported itself in a curious manner. Striking a dwelling-house, it entered by the chimney a room on the ground floor. There it threw down several pieces of plate, and, oddly enough, perforated a piece of plate, passing from the first to the third, from the latter to the fifth, and so on alternately to the last. Finally, it disappeared by the window, breaking several panes. The lightning further reached the face of a young girl who was working at the threshold of the door: she experienced a violent agitation, which caused paralysis of the lower limbs, the use of which, it is feared, she will lose.

SCIENTIFIC SOCIETIES.

MINERALOGICAL SOCIETY OF GREAT BRITAIN AND IRELAND.

A GENERAL meeting was held at 116, Victoria-street, S.W., on Thursday, July 5th; Mr. R. H. Scott, F.R.S., in the chair. The following papers were read and discussed:—

"On a New Manganesian Garnet from several Localities in Scotland," by Prof. Heddle, of St. Andrew's; "On Cotterite, a new Variety of Quartz from Ireland," by Prof. Harkness, of Cork; "On Youngite and on the Artificial Production of Psilomelane," by Mr. J. B. Hannay, of Owens College, Manchester; "On Penwithite, a new Hydrous Manganesic Silicate from Cornwall," by Mr. J. H. Collins; "Notes on Cornish Minerals and Mineral Localities," by Mr. J. H. Collins.

The annual meeting was fixed for Wednesday, August 14th, at 2.30 p.m., to be held at Dublin.

Continuous Footboards.—Colonel Yolland has just issued his report on the fatal accident which occurred on the 3rd of June to a female passenger, named Gannon, at the Bishopsgate-street Station of the Great Eastern Railway, while travelling from Forest-gate to Liverpool-street. The deceased opened the door of the carriage while it was in motion, and while getting out fell between the train and the platform and was killed. The carriage was not fitted with a continuous footboard, but had iron steps outside each door. Colonel Yolland is of opinion that if the carriage had been fitted with a continuous footboard it is highly probable that, although the woman might have been injured from her own imprudence in getting out of the train after it had started, she would not have lost her life. "The Great Eastern Railway have, I understand," Colonel Yolland adds, "fitted somewhat more than two-thirds of the carriages which run in their suburban trains with continuous footboards, having arrived at the conclusion that these continuous footboards, if placed at a proper distance from the edges, and above the surface of the platforms, will materially tend to diminish the number of this class of accident. But I do not learn that this company have as yet recognised the necessity for substituting continuous footboards for these iron doorsteps on all the carriages that run on all their lines. It may be that the greater portion of the accidents of this class occur on the suburban traffic of the principal railways which have termini in London; but there is no doubt whatever that they do occur elsewhere, and I am not aware of any reason why these continuous footboards should not be affixed to all passenger carriages, and extend from the outer ends of the buffer castings at the end of each carriage so as to get rid of the open space between adjacent [illegible] fitted with long buffer rods."

LETTERS TO THE EDITOR.

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[We do not hold ourselves responsible for the opinions of our correspondents. The Editor respectfully requests that all communications should be drawn up as briefly as possible.]

All communications should be addressed to the Editor of the English Mechanic, 31, *Tavistock-street, Covent-garden, W.C.*

All Cheques and Post-office Orders to be made Payable to J. Passmore Edwards.

*** *In order to facilitate reference, Correspondents, when speaking of any Letter previously inserted, will oblige by mentioning the number of the Letter, as well as the page on which it appears.*

"I would have everyone write what he knows, and as much as he knows, but no more; and that not in this only, but in all other subjects: For such a person may have some particular knowledge and experience of the nature of such a person or such a fountain, that as to other things, knows no more than what everybody does, and yet, to keep a clutter with this little pittance of his, will undertake to write the whole body of physicks: a vice from whence great inconveniences derive their original." —*Montaigne's Essays.*

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WHO INVENTED THE MICROPHONE?

[14560.]—Inclosed I send a copy of letter I have just written to the American journals, relative to the most foul accusations of Mr. Edison against Mr. Preece and myself.

If you think it worthy of a place in your columns I should be happy that English people should have a chance of hearing what we have to say.

Mr. Edison, having made such a charge, I hope no technical discussion will be allowed between him and myself until he has proved the graver accusation. I know he will try to turn the discussion into another channel, knowing the utter want of truth of his charge, but he should be made to prove it or suffer the contempt which I cannot help but feel.

D. E. Hughes.

94, Great Portland-street, W., July 3.

HUGHES'S MICROPHONE.

Sir,—I notice with regret that Mr. Edison has been trying to make the American public believe that he also invented the microphone, and that simply because in his carbon telephone he made use of a button of carbon, the varying pressure of a diaphragm upon this producing a varying current of electricity. In all his attempts, as far as I can learn, he has never varied from this idea. He has made thin and thick diaphragms, tried many kinds of carbon, &c., but in all the principle remains the same. The use of carbon as a varying resistance, with varying pressure, did not originate from Mr. Edison. M. Clerac, electrician of the French Government Telegraph Department, supplied me with resistance tubes, founded upon this principle. in 1866—viz., a glass tube containing powdered carbon, the resistance of which was regulated by the varying pressure of a regulating screw pressing on he carbon. Mr. Edison claims this resistance tube as an original invention or discovery in 1873, or seven years after it was known in Europe, and he will find in the *Journal Telegraphique*, Berne, 1873, that the invention was claimed by a German; but on M. Clerac proving his priority (1866), it was freely accorded him. So much for the resistance carbon tubes of Mr. Edison, the principle of which he acknowledges he has adopted in his carbon telephone. As a coincidence, it is curious that the date, 1873, of Mr. Edison's claim to these resistance tubes, should be the same when the invention of 1866 was again brought prominently into notice by the remarks in the *Journal Telegraphique*. I am willing to believe Mr. Edison was ignorant of these facts until the present time, but he ought now to investigate this and give credit where credit is due.

The microphone, the principle of which I discovered, and after many months' incessant labour and study invented the numerous forms now in use, is entirely different in principle, form, uses, and results, to the carbon transmitter of Edison. There is no diaphragm, thick or thin; there is no mechanical apparatus by which the sounds are directed or concentrated upon the electrical conducting material; no arrangement to obtain a varying pressure, as we need really a constant one. There is not the slightest necessity for the use of carbon at the contact points, as all metals which do not oxidise act equally well. The sonorous vibrations are taken up by a piece of pine board or any resonant material, and if, on any part of this board, no matter how distant from the speaker or source of sound, two electrical conductors are placed under a very slight but constant pressure, these conductors vibrate exactly as the molecular agitation or vibration of the board, and of themselves, without any regulation, without any change of pressure, transform a constant electric current into waves in exact form with the sonorous vibrations. The effect is wonderful—so much so that the highest scientific intellects of Europe have been struck with surprise and astonishment, that such unheard-of effects could be produced from an apparatus and causes so apparently simple. In some of the forms of microphones, I use carbon at the contact points, and, if I believed for a single instant that Mr. Edison was the first to use carbon for electrical purposes or for contact points, I would use platinum or gold points, which are equal to, if not superior to carbon, though not so cheap; but as carbon has long been used in electrical batteries, electric light, resistance tubes, and relay contacts by myself, I see no necessity to abandon its use simply because Mr. Edison happens to use it in his carbon telephone in a totally different way, and for different reasons, from its use as contact points in the microphone.

The London agent of Mr. Edison, Mr. Adams, presented to the Post-office telegraphs, about eight weeks since, Edison's carbon telephone, and as it was publicly exhibited, I saw it in company with many others. It consisted of an Edison transmitter, and an exact copy of Professor Bell's receiver which he calls an Edison receiver.

The transmitter consisted of a diaphragm (same form and materials as Professor Bell's) pressing upon a button of carbon, the varying pressure of the diaphragm upon the carbon producing a varying current of electricity. It was complicated, required not only the use of batteries, but induction coils, and the results were not superior to those of Professor Bell's, against which it was tried in my presence. The Edison receiver was identically the same as Professor Bell's, the only difference being that the natural magnet was brought round so as to touch the diaphragm—in fact, it was so transparent a device to infringe Bell's patent, that the Bell Company at once said they would not permit its use. If Mr. Edison thinks there are points of resemblance between his carbon transmitter and Professor Bell's telephone, and anything I have done, it is quite a proper subject for discussion in the scientific journals, but quite unsuitable (being one of a technical nature) for discussion in public journals of general interest, and the technical part of the question must henceforth be discussed by those who, in full possession of the facts, are capable of judging.

As regards my heat-measurer, soon after my paper to the Royal Society, requiring some glass tube and not finding it, I used a quill pen which happened to be on the table; I found the quill very sensitive to heat, and some friends and journalists visiting me soon after, I showed them the remarkable sensitiveness of this ordinary quill to heat. The *Engineer* and *Electrician*, owing to my hurried explanation, having so many more important experiments to show, thought the effects were due as a thermopile, and gave it in a notice prominence it did not require. I thought then, and think still, that the matter was of no practical importance, as we have already such excellent and sensitive heat-measurers, each suitable for some special experiments. Mine has long gone in my waste experiment box, and if Mr. Edison has made a very similar one, and thinks it of value, he is welcome to his own and mine too, and I should recommend him to try a quill in place of the vulcanite I have lately seen described.

Mr. Edison has made publicly a gross personal attack upon the honour of Mr. Preece and myself, and this part he must prove as publicly as he has made it, or stand confessed a wilful slanderer.

His message to Sir W. Thomson, London, says: "Edison to Sir W. Thomson. Direct impact carbon telephone sent Preece two months ago, also publications and letters describing its use as heat-measurer, great abuse confidence, his part in Hughes' matter—I send you publications of proofs."

This message seems carefully worded, although it insinuates an abuse of confidence on Mr. Preece's part. The carbon telephone received through his agent, Mr. Adams, two months since, I have already mentioned; but I had already shown mine some weeks before its arrival at the Post-office, and had tried them in January and February at the Submarine Telegraph Company's in presence of its officers. There has been no secret as to the effects of my microphone since last January; but the secret of its action was divulged for the first time in presence of Professor Huxley, Mr. Norman Lockyer, Mr. Conrad Cooke, and Mr. Preece, on the 22nd of May last, when it was decided that I should bring my discoveries before the Royal Society, which was done the following week. Mr. Preece could see no resemblance then or since between my microphone and Edison's carbon telephone, and, consequently, had no confidences to make me, even if he possessed any, from Edison, which I do not believe he had; but even supposing he had informed me then that Mr. Edison was also trying to make a microphone, it would not have prevented me from at once presenting to the world the microphone I had discovered, made, and exhibited at the Submarine Telegraph Company's many months before. So it was a gratuitous insult to Mr. Preece and to myself to insinuate, that simply because he sent a carbon transmitter to the Post-office for trial, through his own agent, Mr. Adams, and that publicly, that I should have taken hints from such a failure as it proved to be, to improve that which had already been found successful months before. It bore no resemblance to the microphone in its objects and effects; the main object of Edison's telephone appeared to me to be to avoid Professor Bell's magneto-transmitter, by producing the same effects of telephony in a different way; the main object of the microphone is to render audible sounds hitherto inaudible, and thus to allow us to investigate a new and wonderful world—and a mere glimpse, or, in fact, a long study of Edison's carbon transmitter would not have helped the matter in the slightest. Had I been inclined to imitate, it would certainly have thrown me on the wrong track as it did him.

Mr. Edison, however, has gone still further. He has sent to the French journals, and published in *Le Figaro*, June 24, and *Correspondance Scientifique*, June 25, the following, which he declares that he sent to Sir William Thomson:—

Edison—Sir William Thomson.

"J'ai envoyé des microphones à MM. Preece et Hughes, il y a deux mois, et aussi des descriptions de cet appareil; il y a abus de confiance de la part de Mr. Hughes dans cette affaire; attendes mes preuves.—Edison, Menlo Park, June 1878."

Translation—Edison to Sir William Thomson.

"I have sent some microphones to Messrs. Preece and Hughes two months since, and also some descriptions of that instrument; there is an abuse of confidence on the part of Mr. Hughes in that affair; await my proofs.—Edison."

This will be seen to be very differently worded to the one really sent to Sir William Thomson, and states directly that he sent me microphones, and that I abused his confidence.

In answer, I have only to say that I have never received any microphones, any carbon telephones, any instrument, any description, letter, or communication from him, direct or indirect, at any time whatever.

This I state emphatically, and now call on Mr. Edison to prove the truth of his message I have just quoted from the French journals, and that no further technical discussion can take place until he furnishes such proof.

If he fails in proving the truth of the above message, as he surely will, his conduct will merit the contempt it will receive.—D. E. Hughes.

Abstract of a few of many affidavits which will soon be in print.

"I testify that Prof. Hughes has been constantly engaged experimenting on the microphone in our house since November last year.—G. Canton, 94, Great Portland-street, London, June 29, 1878."

"I claim the variable resistance carbon tubes which I have supplied you and others since 1866.—L. Clerac, Administration des Lignes Telegraphiques, Paris, June 19, 1878."

"I testify to your having brought the microphone to our office, and worked it in presence of myself and its officers, in the months of January and February. Mr. Preece knew nothing about it until long after.—F. Despointes, Superintendent, Submarine Telegraph Company, London, June 29, 1878."

THE MICROPHONE AND THE VIOLIN.

[14561.]—First, the microphone. I presume the carbon point when at rest is in an electrical state, bordering on vibration, so that the slightest motion sets it actually in motion, and by adding the sound of its own vibration to the sound caused by the prime mover the sound is thereby reinforced. Then, in the case of the fly, do we hear the tramp or the vibration of the pencil? Why, you say, the one magnifies the other. True; but you don't hear the pencil sound, yet the two sounds are there.

I take a soundboard fully strung, and place it in a horizontal position; then I balance a weight (piece of hard wood) over the edge of the soundboard, and leaning it thereon so as to act on it (like the carbon point) when put in a state of vibration, I find that the sound of certain notes are increased with the addition of a rasping noise caused by the motion of the weight acting or knocking against the soundboard. It remains for Mr. Edison or Hughes to discover a substance that may be induced into an electrical condition, and heavy enough to move with the strong vibrations of a strung soundboard, and moving also as softly as a thumb over a panel of wood. Not only would it be the means of reinforcing loud sounds, but the very vibrations would be a source of motion strong enough to drive small mechanisms, as clocks and watches, which would go for indefinite periods. I had the pleasure some time ago to present a problem of motion to our readers, and will revert to it again for their kind notice. I took a needle and thrust it in the end of a piece of wood, placing a small centred button to revolve at the free end; when I passed a fiddle-bow across the needle near the wood a sound was produced, and the little wheel moved round very quick indeed. Leaving out the argument as to whether the sound or the vibration moved the wheel, let us suppose the electric substance discovered that would put the needle in motion, and here we have a new motive power. I see many difficulties; but, au revoir, do the best you can.

Fiddler.

THE MICROPHONE AND THE TELEPHONE.

[14562.]—At the risk of repeating what has been done and published elsewhere by others, I venture to give a short résumé of some experiments I have tried in connection with the microphone and telephone.

First, I should like to expose what I consider to be a misconception in regard to the sounds heard by the microphone. It is said that by means of it we can hear the sound of a fly's footstep as he walks over the instrument; and at the first glance this seems to be a correct assertion, but a little closer examination will, I think, show that it is totally incorrect. An illustration will best show my meaning. I am sitting in my room; a horse, with heavy tread, passes along the street; I do not hear the tramp of his feet, but at each step the window-frame of my window shakes, and causes a rattling, which I hear plainly enough, but can I be said to hear the tread of the horse's feet? Again, sitting by the same window on a quiet day, I hear the frame rattle at regular intervals. It is the Portsmouth guns that are being fired; but am I correct in saying that I hear the report of the guns?

So, with the microphone. The fly as it walks shakes the soundboard, and this in its turn shakes the nicely poised piece of carbon or other substance, and it is the rattling of this upon its supports that is heard by the telephone. This may seem to savour a little of hair-splitting, but it really has an important bearing on the judgment we form as to any sound heard through the instrument. At least it appears so to me, and I shall be glad of the opinion of some of my fellow-subscribers, many of whom are more qualified to form a judgment on the matter than I am.

In support of this idea take the following experiments:—Let one wire of the battery dip into a tumbler of water, and the other be joined to the telephone in the usual way. Take hold of the wire leading from the telephone, and complete the circuit by dipping it into the water. At the moment of touching the water the telephone gives out a single distinct sound. On removing the wire there is the same sound at the moment the circuit is broken. Now, I contend that it is a gross mis-statement of facts to say that the noise we hear is the magnified sound of the wire touching the water. It is in fact nothing more than a repetition of a very old electrical experiment. It has long been known that when an electro-magnet is thrown into the circuit of a battery it gives out a musical note each time contact is made or broken. When the electro-magnet is placed on a resonant board, and a contact-breaker is employed to make and break contact rapidly, a musical note swells out. This note is high or low in proportion as the contact-breaker moves rapidly or more slowly. Here, in fact, are the essentials of the telephone. Had it struck early experimenters to arrange a contact-breaker that could be put into motion by air impulses, the telephonic problem would to a certain extent have been solved. All that would then have been wanting would have been the increasing of the sound by causing the magnet to act upon a plate capable of vibrating in response to the varying state of the attractive power of the magnet.

The following experiment shows this: I joined the wires of the battery, in the first place, to a small Rhumkorff coil, for the sake of the contact-breaker. Then, to the screws where the handles for receiving back are fixed, I connected the wires leading to a telephone, from which I had removed the vibrating plate. The noise of the contact-breaker was faithfully reproduced by the magnet, loud enough to be heard some distance from the ear. The sound was muffled, for the simple reason that the magnet is held tight in the telephone case; had the magnet been carefully suspended on a sounding board, in such a manner as to have had free power of expansion and contraction, we should have had the musical note obtained as above by the electro-magnet. To show the alternate attraction and non-attraction of the magnet I placed a strip of ferrotype plate across the telephone, first giving it a slight twist, so that it would not lie flat, but was capable of a rocking motion. On arranging matters as before, this strip of metal was set into the most rapid motion, the motion being, of course, very visible. I now screwed on the vibrating plate, and on making connection the rattle of the contact-breaker became clear in the telephone which could be heard across the room. On placing the finger on the plate it could be felt in rapid motion, and, although the pressure of the finger damped the sound, it could not altogether prevent it, and in spite of moderately strong pressure the plate could still be felt to be moving.

I may here mention a curious result of this experiment, and one which is, I think, worth recording. The loud note of the telephone caused by the Rhumkorff coil I found to be accompanied by harmonics, which gave it a quality distinct from the hum of the contact-breaker. On placing the blunt end of my penholder on the centre of the vibrating plate the loud note was immediately damped, but a higher and more musical one rang out clear and distinct. On moving the penholder slowly along the plate at a certain point this note stopped and another of a different pitch took its place. In this way I found there were four or five different notes corresponding to different parts of the plate. By moving the pen about over the plate the sound produced was highly suggestive of a musical box. In fact I think, with practice, I could manage to get a simple tune in this way. I think the experiment very suggestive in reference to the fact of the telephone giving out the quality or timbre of voices, as well as their pitch. It shows that the plate not only vibrates as a whole, but likewise in segments.

I now pass on to some simple experiments in relation to the microphone theory. From the time of my first experiment with this instrument I came to the conclusion that its action depended upon the same principle as the electro-magnet experiment above referred to—viz., that the sounds in the telephone were caused by the breaking and making of contact, more or less, of the movable piece of charcoal or other substance used in its construction. What confirmed me in this was the fact that when sounds were being made a bright spark was always visible at the point of contact.

Following out this idea, I cut a circular hole in a piece of deal board, and screwed over this a ferrotype plate. In the wood I fixed a piece of copper wire, which I bent over crane fashion, and turned up the end to form a hook, on which I hung a piece of very thin copper wire, so arranged as barely to come into contact with the plate. I then arranged wires so that the electric current would, after passing through the telephone, have to traverse the ferrotype plate, and ascend the copper wire in order to get back to the battery. On singing to the plate the tune could be distinctly heard in the telephone.

I next made one of the toy telephones by stretching some tracing linen over the end of a baking-powder box; in the centre of this I stuck a small square of zinc, to which I had previously soldered a thin copper wire. Then I took a strip of zinc, bent the ends at right angles in such a manner that it could be fixed over the drum-head at a distance of a ¼in. or so from the linen. In the middle of this strip of zinc I drilled a hole, through which I passed a mill-headed brass screw with fine thread, so that the point came over the small piece of zinc. By this means I could get the zinc and the point of the screw near each other to any degree of nicety. On making connections as before, and singing to the drum-head, I obtained a reproduction of the tune from the telephone, which, when it was held close to the ear, was unpleasantly loud, and at some distance from the ear could be heard above the direct sound of my voice. I was not so successful with words, but my apparatus was so roughly put together that I did not expect any great nicety. I shall improve upon it at my first leisure moments, and have little doubt that by this method all the finer shades of the human voice will be transmitted.

As far as my experiments go, I am led to the conclusion that the simple magnetic telephone will have to be discarded, from the impossibility of increasing its loudness to such an extent as to make its adoption universal; but, by employing battery power, I see no reason why the energy of the vibration of the plate may not be indefinitely increased, and consequently the sounds which it emits. **Edmund P. Toy.**

CONTINUOUS BRAKES—SANDERS' AUTOMATIC VACUUM.

To R. D. Sanders.

[14563.]—The whole object of R. D. Sanders' letter (p. 397) appears to be to find fault with a circular, which he states is "Mr. Westinghouse's own," in which a comparison of the Westinghouse and Sanders' brakes is made. If Mr. Sanders has any difference with the Westinghouse Company he should write direct to them. In his letter (14522, p. 397, line 10) he says, speaking of my remarks:—"From this fact your readers will be able to draw their own conclusions." I must ask what are the conclusions he wishes your readers to draw? From a private source I learn that Mr. Sanders would like to make them think that I have a personal or pecuniary interest in the Westinghouse brake.

At the risk of apparent tautology, I will repeat what I said recently, that "I am not connected with, nor have I any private interest, in any brake company whatever." My position with regard to the brake subject, and my reason for writing to the English Mechanic upon that subject, are clearly explained upon pp. 371 and 372, let. 14492. R. D. Sanders says my letter and drawing are merely a *réchauffé* of some circular. This is not the case. My drawing (p. 315) was made by myself from an official diagram of the Sanders brake as fitted to carriages upon the Great Western Railway. The description I gave from my own knowledge of the brake, supplemented by information I received from the railway officials, and also by information sent to me not long ago from the Sanders Brake Company. I have read over my letter (p. 315) again, and I believe that the engineering correspondents of the English Mechanic will agree with me that my description of the brake is more clear than that given by Mr. Sanders himself (p. 397), and he is unable to point out any fault in either my drawing or description. On the other hand, I will point out that the drawing (p. 397) is incorrect, as he does not show the release valve as well as giving no dimensions of the apparatus. Mr. Sanders also says that my "statement as to the time required to set his brake seems to have been copied word for word from Mr. Westinghouse's own composition." This is not the case.

At the meeting of the Institution of Mechanical Engineers, held on the 31st of January last, the discussion which followed the reading of Mr. Sanders' paper showed that there was great diversity of opinion upon the subject. I therefore decided that I would make some experiments to ascertain the real facts. The amount of air which has to move, and the time taken to apply the brake, as stated by me upon p. 315, are facts which I have myself proved in practice.

If the results obtained by me coincide, as Mr. Sanders says they do, with the statements of such an eminent engineer as Mr. Westinghouse, all I can say is that I am very glad that Mr. Sanders informed me of the fact. Two stops are given, said to have been made upon the Great Western Railway on the 27th of July, 1877, with the Sanders brake. I have searched the "Brake Reports," but cannot find those mentioned, unless they are two of the unreliable stops, which were not thought worth recording.

I would also ask with what brake the engine and tender were fitted, and also whether any speed indicator was used?

With regard to the inconvenience caused when an engine leaves the train, my statement is perfectly correct, as I have myself witnessed it—more particularly with the train which has for some time been running between Leeds and Birmingham, worked by two of the bogie engines, Nos. 1338 and 1311. How the disastrous accidents would be caused by the use of a tap instead of a blank coupling I am at a loss to understand, as the porter might as easily forget to couple the hose as to turn the tap. Even if the porter did forget to close the tap or couple the hose to the blank, all that would happen would be that the driver would be unable to create a vacuum, take off the brake, or start the train.

In conclusion, I would like to point out to Mr. Sanders a serious error in the description he gave of the Westinghouse automatic brake in his paper read last January. He stated that "there is no means of regulating the power of the Westinghouse automatic brake," and that "it must either be full on or full off." On the contrary, the fact is that it can be regulated to the greatest nicety from full power to the slightest touch, and upon some railways the brakes are not allowed to be used with more than half the full force, except in case of danger.

July 3rd. **C. E. S.**

METHYL AND ETHYLIC HYDRIDE—CHROMIUM.

[14564.]—Regarding letter 14426, page 314, I beg to refer my friend to pages 130-137 of Dr. Frankland's researches, in which he shows that methyl and ethylic hydrides are differently acted upon by chlorine in daylight. I will be glad to see Mr. Streatfeild's reply to letter 14518, as I scarcely understand what Mr. Pitt means, or how his equations relate to the question of the acidity of the dichromates. A very beautiful experiment with the spectroscope may be made by observing the absorption spectrum of $Cr_2O_3KO_2$ (which consists merely of the red and yellow), gradually change into the spectrum of chromic chloride or sulphate. For this purpose an acid solution of the salt, with a fragment of zinc, must be watched through the spectroscope. I think this would make a striking lecture illustration; but, of course, the electric light would then be necessary. **Wm. John Grey.**

Newcastle-upon-Tyne, July 4.

THE ORIGIN OF LANGUAGE.

[14565.]—With no extensive knowledge of languages, and without aspiring to be an authority on the subject, I should nevertheless like to make a few remarks on Mr. Toy's letter, p. 368, which interests me considerably. While freely acknowledging the force of most of your correspondent's reasoning I cannot quite agree with him that language has been formed arbitrarily by prehistoric man. There seems to be very frequently a resemblance, or at least a relation, between the sound of a word and the idea it represents. Of course in the "bow-wow" class of words—boom, buzz, puff, bang, and the rest—this is sufficiently obvious; but I would apply the statement much more widely than to these. I think, for example, that the full sound of the letter *r* suggests the idea of energy and motion, and that this is the reason why we find it in so many words signifying rapidity and energy. Run, rush, race, rend, rip, rack, ride, rasp, rapid, ring, wring, rub, rave, roll, and many others are instances.

Again, the sound of *sh*, to my ear, carries the idea of concussion and violence. Hence we meet with in such words as dash, crash, clash, mash, lash, gash, gnash, bash, rash, flash, and splash; while the slang-using public recognises the expressiveness of the termination by coining such words as bash, slash, and smash. By the bye, are such slang words as these arbitrarily invented, or do they boast of any derivation or descent?

I should like to know whether such associations of sounds with ideas, as distinguished from mere mimicry of sounds, is shared by others, or whether it is merely a fancy of my own? The theory would account for a very large number of our root words. It might be tested by comparing words belonging to different languages, which are recognised as not having sprung from the same stock; but, as I am unable to do this, I will leave the subject with the hope that we may see more about it in the future in the pages of the English Mechanic. **Amara.**

ORIGIN OF LANGUAGE—RATE OF INCREASE OF POPULATION.

[14566.]—The weak point of the theory that language has been arbitrarily formed is that it "presupposes language already, for how could men agree to name different objects without communicating by words their designs?" The imitation theory could supply only a few ideas, and beyond these the same difficulty would be felt. I must confess, though at the risk of exciting the risibility of some readers of the English Mechanic, that the sort of rudimentary instruction indicated in Gen. ii., 19., seems to me to meet the exigencies of the case. There are no data of any use for the purpose which "Os" intends his calculation to serve. You may, of course, assume an average rate of increase, and calculate accordingly. For example, assuming that population has doubled itself on an average every 200 years, starting from a single pair in 6,000 years the number would far exceed the present population of the globe. According to Dr. Farr at the present rates of increase, the periods of doubling in eight of the States of Europe would be as follows:—England and Wales, 53·3 years; Sweden, 61·1 years; Prussia, 64·3 years; Netherlands, 77·1 years; Austria, 86·0; Spain, 93·9; Italy, 100·5; and France, 361·3 years. From 1700 to 1850, notwithstanding her wars and revolutions, the population of France was increasing in about the ratio of 1-200 annually, so that the present rate of increase is exceptional. I look for a diminution of imprudent marriages among ourselves through the progress of education and other moral agencies. It is well to bear in mind that the ultimate fate of any nation which falls far below the average rate of fecundity must either be subjugation or extinction. **J. A.**

RATE OF INCREASE OF POPULATION.

[14567.]—In letter 14525, p. 398, "Os" says it would be interesting to know whether any calculations have been made to determine the rate of increase for the whole earth, and whether any of our friends have figures on which this calculation can be based. I have pleasure in stating that I have been, now and again, working at this and such like questions. Here follow a few results:—

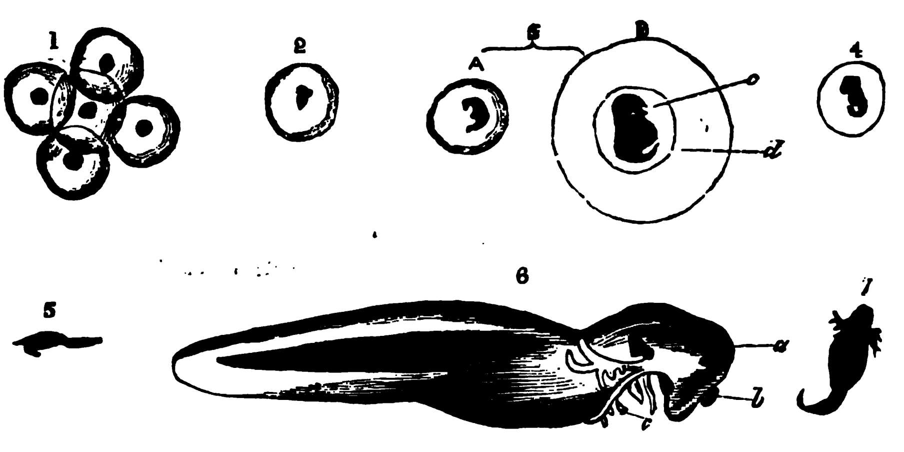
With the first term, 2, and the last term, 1,500,000,000, and the number of terms, 5,882, the years from our chronology, I obtain 1·0034 for the annual ratio per person. This ratio is lower than the ratio of England, which is 1·0211; but it is higher than the ratio of some countries—France, for instance, being very low; indeed, negative lately. The years I obtain from Ushur and Townsend, as given in the English translation of our Bibles. If I use the data from Hales and the Septuagint version of the Pentateuch, which is considered by modern learned men to be more trustworthy in such like questions, I obtain a lower result; but still reasonable enough. The high term given above is not widely different from various computations by German and English students of statistics. This may be considered the direct solution of the problem. A large error in the data becomes smaller in the result. The reverse of the problem is equally simple, but a small error in the data becomes larger in the result. The problem is: given any three of the above terms to find the fourth, and it is known as one of a transcendental character, because it involves the ratio raised to a high power. In the above question it is ratio ^{5882} = $1{\cdot}0034^{5882}$. **J. Steel.**

NOTES ON THE DEVELOPMENT OF FROG SPAWN.

[14568.]—Having frequently matured frog spawn I this year determined to note the progress of development daily from its deposition to the evolution of the perfect animal. With this object, I obtained on March 3rd a supply of freshly laid spawn. This was a very early date for the locality (Newcastle-upon-Tyne), but there had been no real winter, and the season was quite a month in advance of the average. This day also was very mild and genial and the batrachians proportionately active. The spawn was put into a shallow vessel containing water, with a liberal supply of aquatic plants, Nitella, Anacharis, &c., covered with a piece of glass and placed in the window of a room having a north-east aspect and without a fire. The blinds were kept undrawn so as to imitate natural conditions as closely as possible with reference to temperature and light. In the figures the natural size of the nascent tadpole is adhered to, excepting, of course, the magnified examples.

On divesting a freshly-gathered ovum of its gelatinous envelope and crushing it in water between two glass slips, the interior was seen under a ¼in. objective to be composed of squarish granules, irregular, however, both in shape and size, inclosed in a delicate integument (the vitelline sac), which, on being ruptured, lay in folds amongst the corpuscles. The larger of these measured the 1-2500th of an inch in diameter, and exhibited a faint nucleus.

Externally there was little apparent change in the conditions of the spawn until the 8th March, but the integument grew tougher daily until it became necessary to cut the ovum in order to liberate its contents. The granules were now aggregated into round pill-like masses, were apparently nucleated, and from the currents perceptible amongst them when examined in water, it became evident that ciliary action was in existence. A cleavage was now observed, and each ovum became unequally divided as in Fig. 2. The segmentation became rapidly more defined until on the 12th of March the appearance was as represented in Fig. 3. A enlarged at B where *a′* shows rudimentary external gills or bronchial tubes, and B′ the vitelline sac. Each day there was a perceptible change, the gills and tail especially enlarging, while the nostrils became conspicuous, and on the 17th of March motion consisting of a rapid energetic action in bringing head and tail together was observed (Fig. 4). The next day some tadpoles had emerged. These lay quietly for the most part on the gelatinous egg mass, but occasionally indulged in an active wriggle.



March 19th. Tadpoles all emerged and lay extended as in Fig. 5. The gills were now prettily branched in Fig. 6, magnified about 8 diameters; the tail is speckled with pigment cells, the nostrils (*a*) are well developed, and under the 1in. objective a rapid ciliary action was seen at the protuberance (*b*) (the immature mouth). The water seemed driven backward in a current to the gills (*c*), through which the blood now circulated vigorously. Fig. 7 is the dorsal aspect at this stage, slightly magnified.

March 23rd. The gills extend almost to the tail. I now remarked at the root of the tail and within the cuticle the starting point of posterior limbs. Up to this date the weather had been mild, but now a change occurred on the 24th. There was snow, and the cold lasted until the first week in April. In the interval tadpole development was arrested. There was little growth or motion, and all seemed dormant.

April 3rd. Weather springlike, and tadpoles active. They appear to feed upon the gelatinous portion of the egg mass now nearly gone.

April 5th. The eyes could now be distinguished, but as mere bluish specks, far too rudimentary for distinct vision.

April 9th. The growth has gone on steadily, and gills are absorbed. They now breathe by the secondary or internal gills, fishlike. The mouth is surrounded by a thick separated lip, within and upon which are several rows of black spines, pointing to the triangular mouth also fringed with them. Probably this organ exerts a combined scraping and sucking action upon the animal's food.

April 15. The blue filmy specks have now become perfect eyes. The tadpoles dive on approaching them. Their bodies are beautifully speckled, and the black pigment cells have assumed an irregular branched form. Excepting increased size and activity no great change was remarked until the 10th of May, when the membranous sheaths were projected from each side of the tail near the body, through which the posterior limbs are pushed.

May 20. The hind feet are now through the sheaths, and from their extreme transparency, together with the tail and margin of the body, exhibit the circulation to perfection. By covering up the tadpole in wet cotton wool, leaving the tail exposed, and placing it upon a glass slide, quietness is insured in the object without compression. I also found a zoophyte trough useful, especially in examining the internal organs with a frond of Nitella translucent in the same microscopic field. The animal and vegetable circulation could be observed side by side.

For the remainder of May the weather was cold and progress checked. They gulped air from the surface and the hind limbs lengthened. They did not attack animal food greedily—the aquatic plants appeared to afford all they required.

In the second week of June the temperature became warmer, and the tadpoles correspondingly vigorous and active, breathing from the surface and using their limbs in swimming. Those anterior now began to bud (I had previously remarked the toes underneath the cuticle), but, unlike the posterior legs, are not projected through a membranous sheath. They elbow their way out below the gill openings. The cuticle becomes attenuated, and is suddenly broken through, leaving the limbs exposed complete and free.

June 23rd. Those furnished with four limbs rest on the plants above the surface, and evidently want to leave the water, in which, if unable to make their way out, they would speedily become asphyxiated. They are not the largest nor apparently the strongest tadpoles which have completed their metamorphosis. First, the tail attains an extreme length and tenuity before the final change, which is rapidly effected, and tail, lip, gills, &c., become absorbed and the body shrunk to a frog shape suddenly—so much so that on the 27th June many tadpoles had developed into perfect frogs, thus occupying 117 days in completing their most interesting series of life changes. I am satisfied, however, that the period can be accelerated or retarded as required, by increasing or lowering the temperature. Light appears to be of most importance in stimulating the growth of vegetation and infusoria which form their chief food. With me they attained a wonderful degree of transparency, and although never put upon "water diet" exclusively, the details of the circulatory system could be followed with little difficulty. References to sketches:—Fig. 1, frog spawn as in situ; Fig. 2, cleavage in ovum, sixth day; Fig. 3, A, tenth day, enlarged at B, where C shows rudimentary external gills, and *d* vitelline sac; Fig. 4, 15th day, motion first observed; Fig. 5, 17th day, tadpole emerged; Fig. 6, same magnified about eight diameters, *a* nostrils, *b* miniature mouth, *c* gills; Fig. 7, dorsal aspect slightly magnified. **M. H. Robson.**

BOAT BUILDING.

[14569.]—There has been a great deal of information in the E. M. lately on boat and canoe building, but, so far as I have noticed, there has been nothing said on the method of getting the lines; I have, therefore, determined to contribute my mite of information, leaving for others more capable to take up the subject and enter more fully into it than I am able to do. I will describe the method I adopted in building a clincher-built boat, 17ft. long, 4ft. beam, 2ft. deep at head and stern, and 1ft. 1⅛in. at midship. Take four pieces of pine, 17in. long, 2in. wide, and ⅛in. thick, dressed up quite true, glue them together, and put two screws through them to hold them together; divide the length into six equal parts, and draw a line square across the top at each division. Then with a square draw a line down the side from the end of each line on the top, take out the screws, and cut the model of half the boat on the side not marked. Then place it in water to soften the glue, and take it to pieces and dry it, then draw a line across the top of each piece from the lines on the sides, number the divisions, beginning at the

stem, 1. 2, 3, 4. 5. and stern,
1⅜ 1⅞ 2 1⅛ 1⅜ 1⅝in.

as Fig. 1. My model was the respective breadths

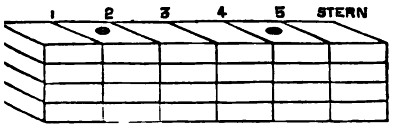


FIG. 1

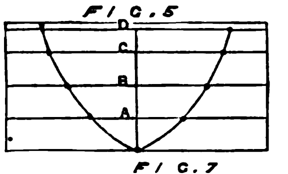


FIG. 5

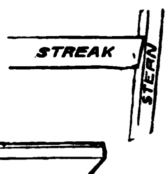


FIG. 6

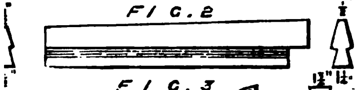


FIG. 2

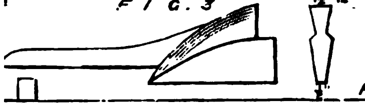


FIG. 3

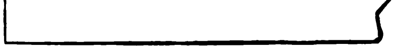


FIG. 7

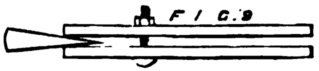


FIG. 9

FIG. 8

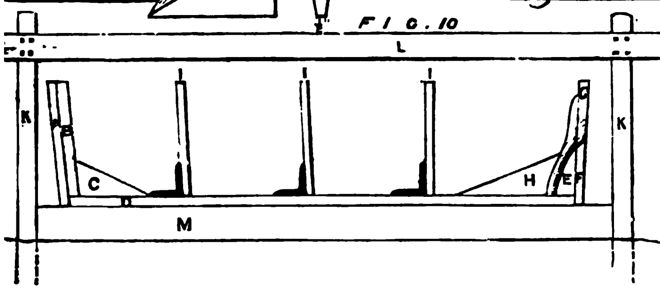


FIG. 10

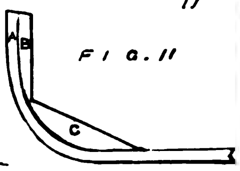


FIG. 11

m under each number of divisions. The joints re the pieces come together and the top may be ·ked A, B, C, D. The model is made upon the e of ¼in. to the foot. The first thing to make is keel. This may be made in different ways; it y be made of a board any breadth required, and ered off from midship to both ends, in which the edges are worked up so as to nail the kes to. The keel proper is nailed on this board n the boat is finished, or it may be made out of iece of wood placed edgeways, in which case a ove or rabbet is worked out on each side to nail first strake to. The stem is made from a piece of od, 3in. by 2in. at top, and 4in. by 1½in. at bottom g. 2), with a rabbet on each side for the ends of strakes to fit into, and a piece taken out at tom to fit on keel. The stern-post is made from iece of wood, 2in. thick and 5in. wide at bottom, 2in. wide at top (Fig. 3). A rabbet is taken out ach side for the ends of strakes to fit into from bottom to the part where the stern-piece fits on he stern-post. The stern-piece is cut out and ed to the stern-post, the shape being taken from model. A piece is taken out of the bottom of n-post, and stem and stern are nailed to keel. A or 1½in. board is firmly fixed edgeways on the nd, and the keel firmly fixed on the top edge screws, the stem and stern being firmly fixed perpendicular position. Divide the keel into as y parts as you have in the length of the model, make a mark square across. To make the shapes mplates to give shape to the boat take a piece oard for each template, and lay off three parallel s, the first 6in. from the bottom edge of the rd, and the others 6in. apart; mark the lines B, C. Draw a line in the centre of the board pendicular to the bottom edge. Take the model rt, and measure with a pair of fine compasses scale the width of the model at line No. 1, at t marked A; transfer this distance in inches to , A, on the board on each side of perpendicular , and make a mark; then measure the width of nd piece, marked B, and transfer this to line B, mark as before; then measure the top side of d piece, marked C, and transfer it to line C, and k. Repeat this with each of the other sections stern, then put the model together and measure flat side opposite each division and set it off nches on the perpendicular line of each tem- e and mark; draw a line parallel through this k and mark it D; set off on this line widths at 1, 2, 3, 4, 5, and stern, and mark e places on the line; draw a curved line through marks of the lines on each template, and cut hese lines; a piece of whalebone, a thin lath, or ece of stout crinoline wire is convenient to draw curves with. The templates are numbered to espond with the divisions on the model, and fixed with an iron angle or otherwise to the on the line corresponding with their numbers, are firmly fixed with stays. It is very imant that the centre of stem, stern, and centre of the templates should be in a line; it is ons that the model may be divided into any ber of divisions that is convenient, or if a el-built boat is required a division may be made each rib. If greater accuracy is required the el may be made with 6 ¼in. pieces instead of 3 pieces for the three lower pieces, and the lines apart on the templates. The midship section or plate may be divided into a number of unequal ts on the outer edge, according to the number of ribs. Where the section is flat they may be der, where round narrower. The stem and stern ay be similarly divided. Now take a lath and fix it on the marks at stem, stern, and midship, and mark the edges of the other sections. This will give you an idea of the width and shape of the strakes. To get the shape of the strakes get a thin board about 3-16in. thick, 6in. wide, and 12 or 14ft. long. This is called the curve board. Also a piece of wood 1in. square and 12 or 14ft. long. Chalk the curve board and rub it down with a cloth. lay it on the boat where you require the strake; being light it will easily bend and fit. Fasten it with clamps, then mark with a pencil along the edge of the keel or strake as the case may be, inside. Take off the curve board, lay it on the board from which you intend to cut the strake, pencil mark on top, provide a number of bradawls, and put them through the centre of the 1in. lath, about 15in. apart. Lay the lath on the curve-board close to the low side of the pencil mark, and stick the bradawl through the curve-board into the wood to form the strake, bend the lath to the line, and stick the other bradawls through until it is so fixed the full length, then pull out the bradawls from the wood and curve-board, but leave them in the lath, place the curve-board on one side, and stick the bradawls into the holes made in the wood; then, with a pencil, mark the opposite side of the lath to the line on the curve-board. This will give you the shape of the strake with one inch lap for nailing. Cut the other edge of strake according to judgment, cut out another piece the same size and shape for opposite side, and dress up. It is easier to put the strakes on in two pieces than all in one piece; if done in this way the piece at stern must be put on first, say two-thirds the length of the boat. The end of the strake must be fitted into the recess formed in the sternpost, then cut the other end square off with a fine saw, lay on a try square and mark with a pencil the width of the blade on the outside of the board, with a broad firmer chisel cut off from this mark to an edge on the opposite side of the wood, thus forming a wedge-shaped splice. Make a pencil mark 1in. from the top edge on the outside, and another 1in. from the bottom edge inside; with a spokeshave dress off the top outside edge at stern from the line to the opposite edge, coming off to nothing about 18in. from the end of the board, Fig. 5. The next strake will have to be dressed off in a similar way at the bottom to fit on this. These two pieces may now be steeped in water, steamed, or put on as they are —it is best to steam them; if not convenient steep them in water as long as you can, then fix and nail them in their places; get the forward part of the strake in the same way, making them a little longer than required, fit the front end to the stern. In fitting the end of the strake bevel to fit the stern rabbet make the bevel greater than apparently necessary, as it is reduced in bending (Fig. 6). Fix the strake in its place with clamps, and make a mark across where the other piece of the strake joins it; take off the strake and lay the blade of the square close up to the line, and draw a line on the other side of the blade. Cut off by this line, and with a broad chisel cut off the wood from this line to the opposite edge of the board. If carefully done this will make a good splice; it may be nailed with 1in. nails. Make lines 1in. from the edges, as in the first place, and dress off top edge same as for stern. In making the next strake let the splice be one-third from the stern, so that the splices cross each other; proceed thus until all the strakes are put on. In the parts where the mould of the boat is nearly straight nothing will be required to be done, but where it is round the outside of the lower strake is to be dressed off (Fig. 7) with a spokeshave, to get the necessary shape, how much or how little may be judged from the edge of the template. Nothing is to be taken off the top strake at bottom edge, but at the ends where the two boards are fixed to stem and stern. A useful kind of cramp for boat building may be made of two pieces of hard wood, 1in. thick, 2in. wide, and 14in. long; a ½in. hole is bored through 6in. from the end, and a ½in. bolt put through long enough to give a little play, 3½in. or 4in. long, and a wedge to drive in between them to tighten them up (Fig. 9). Having got all the strakes on take out the templates, and fit in the ribs, which may be made of oak, ¾in. wide and ½in. thick. These may be steamed and bent into their places and nailed fast, putting the nail-heads outside. Take two strips of wood, 1½in. or 2in. wide and ½in. thick, nail one outside the top strake along the gunwale, the other outside upon the top of the ribs. On each side of the boat a solid block must be inserted where the rowlocks come, and an iron plate put on with a hole in it for the rowlock to drop into. This hole may be 12in. abaft the after edge of the thwart. Next, the rising, which is a piece of wood 1½in. wide and ½in. thick, nearly the length of the boat, is fixed inside and following the gunwale of the boat, and about 5in. below it for the thwarts to be fixed to. It is nailed to each rib, and the thwarts are laid upon this, and are long enough to butt against the strake on each side. A knee is put in at each end of the thwart, butting against the strake and coming 6in. on the thwart. It is now ready for the ceiling or floor, which consists of one board down the middle, 6 or 8in. wide in the middle, and tapered off at each end to fit the boat. To make it lie level and firm cleats are nailed on the underside, across it, and a board, sometimes two boards, nailed on each side of it. They are 3 or 4in. wide, and ½in. thick. The centre one is left loose. I have used cut clout nails 1, 1¼, and 1½in. long, heads outside, and clinched inside, 2 to 2½in. apart. If found brittle they may be softened by putting in the fire and left till the fire goes out. A convenient steaming box may be made of four boards, 1½in. thick; two may be 12in. wide, and the others 4in. wide. The narrow ones may be firmly nailed between the others, forming a box, any length required, 4in. by 9in. One end may be nailed in, the other fit loose, or, when steaming, a tuft of hay may be put in to close the end. Get a kettle and fit a wooden lid to it tight. Make a hole in the centre, and fit a wood pipe in it. The other end of pipe must be fitted to the under side of box. Bore a hole in the lid and fit a plug, place the boiler under the box a little way from the ground, put in water, and insert the plug. Make a fire under, and when steam is up put in the article and close the end until steamed sufficiently.

The stem is sometimes made of two pieces. That part to which the ends of the strakes are nailed is called the apron, and is sometimes made separately, and nailed to the stem proper. There are two blocks fitted into the angle of the stem and keel, and stern and keel. These are called respectively the stem dead wood and the stern dead wood, Fig. 10. When the apron is made separately the dead wood is fitted up to the stem, and the bottom of the apron fitted upon that; but if the stem and apron are made from one piece the dead wood is fitted to the apron. It will be easier for an amateur to fit the dead wood in after one or two strakes are on. The stem can be made curved, if required, instead of straight, in which case it is better to make the apron separately, as shown in Fig. 11.

I have lately seen a very light canoe, 14½ft. long, 30in. beam, 12in. deep, stem and stern, carvel built, with a very flat bottom, no keel except about 2½ft. or 3ft. from stem and stern, the sides cambered in at midships. The ribs were 6in. apart, the strakes were ⅜in. or ¼in. thick, as near as I could tell, and were put on in three strakes on each side, nailed to the ribs where the strakes joined. A piece of wood, 1in. wide and ⅜in. thick, was fitted in between the ribs along the joint, and nailed along the edge of each strake. The stem and stern were made like a wedge, and the strakes were carried beyond the edge and nailed together. A narrow iron strut was carried along the joint, and 2ft. under the keel a good block was put in at bow and stern about 2ft. long, and four stays fixed across from gunwale to gunwale. A 1in. half-round bead was fitted round the gunwale.

References to letters in Figs. 10 and 11. A, the stem; B, the apron; C, bow dead wood; D, keel; E and F, stern-post; G, stern-piece; H, stern dead wood; I, templates; K K, posts; L, scantling to stay to; M, the stocks. The dark lines in Fig. 10 are angle-irons to fix template to keel.

Parry Sound, Ontario, Canada. R. Cooper.

AMERICAN OYSTERS.

[14570.]—"Hematopus" (14555) complains of the toughness of the American "canned oysters." So far as my experience goes, I have found the "oysters" in a minority, or, at any rate, if oysters at all they possessed the foot and sometimes the byssus of a mussel in those specimens I have dissected. On reference I find the foot is present in spondylus, lima, and the scallops, all branches of the oyster family. C. J. R. W.

PROPERTIES OF NUMBERS.

[14571.]—As there appears to be an interest taken in the formation of the so-called magic squares, perhaps a few examples of these curious mathematical structures may not be without a charm to the workers in dry figures.

From what I can gather these squares date from the commencement of mathematical knowledge, and appear to have exercised the ingenuity of arithmeticians even up to the present week. The reasoning wherefore these squares exist is too long for this present letter; but if your correspondents like, I can give them formulæ for the construction thereof later.

8	1	6
3	5	7
4	9	2

is the simplest and smallest form of square, and permits of no permutation.

17	24	1	8	15
23	5	7	14	16
4	6	13	20	22
10	12	19	21	3
11	18	25	2	9

a square having 5 for root; this is one permutation out of many hundreds, and I purpose shortly to give you a formula whereby any figure may be made to occupy any square.

30	39	48	1	10	19	28
38	47	7	9	18	27	29
46	6	8	17	26	35	37
5	14	16	25	34	36	45
13	15	24	33	42	44	4
21	23	32	41	43	3	12
22	31	40	49	2	11	20

A similar square to the last, only one of which there are more variations. This has 7 for a root; it is formed on the same lines as the last, and an inspection of the two will enable any one to detect the mode of construction. Squares having for roots 9, 11, 13, &c., may be constructed ad. lib.

The figures composing these squares may not all be in arithmetical progression. For instance—

128	1	32
4	16	64
8	256	2

These figures are in geometrical progression, and the product is 4096. This class may also be produced ad. lib.

Further, so long as the figures are in arithmetical progression—2, 4, 6, 8—3, 6, 9, 12, &c.—they can be arranged in a square. Also the numbers need not be consecutive, as shown in the two following squares:—

51	72	3	24	45
69	15	21	42	48
12	18	39	60	66
30	36	57	63	9
33	54	75	6	27

20	28	1	9	17
27	5	8	16	19
4	7	15	23	26
11	14	22	25	3
13	21	29	2	10

All these squares are capable of an almost endless permutation when arranged by the certain formula; but the method used in the above construction is the easiest to remember. The number of different squares constructable with the same figures, having a radix of 7, is, I think, about four hundred million, but I have never constructed that number myself.

Squares having an Even Number for Root.—4 being tha smallest number capable of being thus squared, we have—

1	15	14	4
12	6	7	9
8	10	11	5
13	3	2	16

This square adds up to 34 every way. Careful inspection of this square will show how it is made. For instance—

1	0	0	4
0	6	7	0
0	10	11	0
13	0	0	16

from which certain figures are omitted. These figures are formed into another square, commencing at the bottom.

0	15	14	0
12	0	0	9
8	0	0	5
0	3	2	0

These two squares, superimposed, form the top one; like the odd squares, the figures forming them need not be in complete succession. To wit—

1	63	62	4
60	6	7	57
8	58	59	5
61	3	2	64

Here we have 1, 2, 3, 4, 5, 6, 7, 8, 57, 58, 59, 60, 61, 62, 63, 64, commencing at the left hand top, and then working from right-hand bottom. This is easily re-numbered.

29	7	28	9	12	26
32	31	3	4	36	5
23	18	15	16	19	20
14	24	21	22	13	17
2	1	34	33	6	35
11	25	10	27	30	8

1	63	3	61	60	6	58	8
56	10	54	12	13	51	15	49
17	47	19	45	44	22	42	24
40	26	38	28	29	35	31	33
32	34	30	36	37	27	39	25
41	23	42	21	20	46	18	48
16	50	14	52	53	11	55	9
57	7	59	5	4	62	2	64

Above are two examples of squares having 6 and 8 for roots; in the latter may be seen the system applied to the square of 4, but more fully expanded. These even squares are capable of considerable permutations, and the formula similar to the odd squares, but more complex. In both cases they are formed of two squares, which, being added together, form a third or magic square. The figures in one square are arbitrary, the figures in the other square are the balance required to make up a certain number. From this it will be seen that any figure may be made to fall on any space.

The formula for these I will send if your correspondents are not already tired of the subject.

A variation on the common square has been devised—viz., one having a border, of which the following is an example:—

1	35	34	5	30	6
33	11	25	24	14	4
28	22	16	17	19	9
8	18	20	21	15	29
10	23	13	12	26	27
31	2	3	32	7	36

Each band makes 111, and the inside square is magic, and makes 74. This also is subject to variations. The first 10 and last ten figures have been reserved for the border, and the remaincder have been disposed inside the border after the rule of 4 squares; the border then simply requires dodging, so that the opposite figures shall count 37.

A further form of square of squares is shown below:—

1	63	62	4	9	55	54	12
60	6	7	57	52	14	15	49
8	58	59	5	16	50	51	13
61	3	2	64	53	11	10	50
17	47	46	20	25	39	38	28
44	22	23	41	36	30	31	33
24	42	43	21	32	34	35	29
45	19	18	48	37	27	26	40

These squares add up independently to 130, or straight across to 260; they are easily formed. To make the 1st square, take the first 8 and last 8 of the figures; the 2nd square is the second 8 and last-but-one 8; and so on—each square containing exactly one-fourth of the sum total of the 64 numbers. Therefore, they must add up to the same; each square is then made magic by the formula given before.

A square containing nine magic squares may be constructed by taking the mean of one-ninth of the sum of 81 numbers, and then arranging the nine squares magically; and so on to any size.

I will now bring this letter to a close with the description of a properly magic square, which should be copied by everybody who believes in their talismanic properties.

First.—The sum of the 16 numbers in each row, vertical or horizontal, is 2,056.

Second.—Every half column, vertical and horizontal, makes 1,028, or one-half of 2,056.

Third.—Half a diagonal ascending (64 to 52), added to half a diagonal descending (77 to 65) will make 2,056. This half diagonal may start from any side or any square, sideways or downwards.

Fourth.—The four corner numbers added to the four central numbers, equals 1,028, or half a band or diagonal.

Fifth.—If a square hole be cut in a piece of paper just large enough to admit of the view of 16 small squares, the sum of these squares will be 2,056.

200	217	232	249	8	25	40	57	72	89	104	121	136	153	168	185
58	39	26	7	250	231	218	199	186	167	154	135	122	103	90	71
198	219	230	251	6	27	38	59	70	91	102	123	134	155	166	187
60	37	28	5	252	229	220	197	188	165	156	133	124	101	92	69
201	216	233	248	9	24	41	56	73	88	105	120	137	152	169	184
55	42	23	10	247	234	215	202	183	170	151	138	119	106	87	74
203	214	235	246	11	22	43	54	75	86	107	118	139	150	171	182
53	44	21	12	245	236	213	204	181	172	149	140	117	108	85	76
205	212	237	244	13	20	45	52	77	84	109	116	141	148	173	180
51	46	19	14	243	238	211	206	179	174	147	142	115	110	83	78
207	210	239	242	15	18	47	50	79	82	111	114	143	146	175	178
49	48	17	16	241	240	209	208	177	176	145	144	113	112	81	80
196	221	228	253	4	29	36	61	68	93	100	125	132	157	164	189
62	35	30	3	254	227	222	195	190	163	185	131	126	99	94	67
194	223	226	255	2	31	34	63	66	95	98	127	130	159	162	191
64	33	32	1	256	225	224	193	192	161	160	129	128	97	96	65

It is probable that among all the figures I have put down that some mistake may be made either by myself (as I have not gone through every addition) or the compositor; but I trust even the slight description of the method of constructing the squares I have given will enable its rectification to be easy.

There is another form of "square" wl circle; but as it would require a special w will not trouble you with it. 65 num arranged in 8 radii of 8, having one in th common to all radii. The concentric r equal, and the radii are equal. There ar eccentric circles—the figures included in ea equal. The formation of such a circle w easy after making such a square as the last d

Sidney Jews

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SPRING STEP FOR BICYCLI

[14572.]—The idea A. A. Watkins gives 1 14486) is good, but I am afraid the slo weaken the backbone considerably; besides would be infringing on Dedicoat's patent w make use of his step. Concerning the said of which A. A. W. is evidently unaware, th ing particulars may be useful:—Dedicoat ring to the backbone, just above the ba through which a stout 9in. rod passes; aro rod is a stout coiled spring, which is fastene top to the above-mentioned ring, and at the to the lower end of the rod. The top of th fitted with a hinge, on which the large ellipt works, the back of which is provided with Its action is precisely the same as that of A. the catch being disengaged by the action of in mounting, and the spring raising the rid same time enables him to reach the saddle e

56in. Su

ON THE SALTS OF NITROUS O

[14573.]—Whilst making some analyses iron, an experiment was made to ascertain fusion with nitre and carbonate of soda woul yield the phosphorus in the form of an phosphate. If the operation be properly out a bulky yellow precipitate is obtai nitrate of silver, which it is impossible to r phosphate; the possibility was suggested might be the salt obtained by Dr. Divers action of sodium amalgam on nitrate ("Proceedings of the Royal Society," Vol and subsequent precipitation with nitrate o Several analyses of the salts were made, and lowing are some of the results obtained:—

Analysis of the Silver Salt.

The silver was estimated by dissolving acid, and then precipitating as chloride, an substance taken = ·6625 grammes. On boil nitric acid a little silver chloride existing as remained undissolved; this was collected on fused, and weighed, that adhering to the filt being burnt into metallic silver. The am silver chloride found, including the metall calculated to chloride, = ·092 grammes when substracted from the amount of origi stance taken, leaves ·5705 grammes of t silver salt. The solution in nitric acid w precipitated with hydrochloric acid. Th chloride was then collected on a filter pape and weighed; the amount of silver chloride fo ·599 grammes, which = 78·17 per cent. o A second analysis was made in a similar n the amount of substance taken was ·175 g The silver chloride found as impurity w grammes, leaving ·161 grammes of the pu salt. The amount of silver chloride obtai the nitric acid solution was ·167 grammes, 78·01 per cent. of silver. A third analysis following results: The amount of substan was ·3510 grammes, the amount of silver ch impurity was ·0804 grammes, showing th grammes was the amount of pure substanc The amount of silver chloride obtained fr nitric acid solution was ·283 grammes, whic 78·72 per cent.

Analyses of Silver Salt.

	Pure substance taken.		Silver chloride found.	
I.	·5705	...	·5990	...
II.	·1610	...	·1670	...
III.	·2706	...	·2830	...

Mean = 78·45.

The amount of silver found therefore agr the formula AgNU, and also with the ans Dr. Divers. Experiments were then made, sodium nitrate was substituted for the p salt; furthermore, the admixture of carb soda at first used was next left out, and was satisfactorily prepared by the simple iron filings with sodium nitrate. Regar best temperature for the operation, exp were made with a Bunsen burner, a Go furnace, a coal furnace, and a charcoal f the best results being obtained with a char nace. The silver precipitate is very bu when dried it shrinks greatly; the silver s duced slightly at 100° C. It is best to d vacuo over oil of vitriol, whilst taking care tect it from the action of light.

Preparation of the Sodium Salt.

prepare the sodium salt iron filings were fused sodium nitrate in an iron crucible over a char- furnace, lixiviated with water boiled, filtered the oxide of iron, evaporated down to a small , and left to crystallise. White needle-shaped als were deposited, having the composition O + $3H_2O$. In order to obtain the best yield e salt, the crucible ought to be kept at a red for about an hour, after the deflagration has place; otherwise the sodic nitrate will not be rly converted into hyponitrite, and crystals be got with great difficulty.

Analysis of the Sodium Salt.

e sodium was estimated by conversion into ate:—

Weight of substance taken.	Sodium sulphate found.	Per cent. of sodium.
·4815	·3105	20·90
·478	·313	21·19
·3995	·2615	21·20
·468	·299	20·68
·1555	·1045	21·73
·3309	·2215	21·39
·2205	·1455	21·35
·254	·170	21·67

Mean, 21·26.

water of crystallisation was next determined ying at 100° C. in the water bath until a con- weight was obtained, which is generally about or four hours.

Weight of salt taken.	Loss.	Per cent. of Water.
·202	·1025	50·74
·122	·0615	50·39
·442	·240	50·43
·662	·350	50·62

Mean, 50·54.

itrogen was then estimated by burning with lime and passing the gas through standard ric acid, also by precipitating as ammonio- ic-chloride. The following are some of the s which where obtained.

mount of substance taken.	Ammonia obtained.	Nitrogen per cent.
·466	·077129	12 95
·524	·0872175	13 70
	$(NH_4)_2 PtCl_6$ obtained.	
·3625	·740	12·80

Mean, 13·15.

be seen that the mean numbers of the several es agree well with the formula, Na NO $3HO_2$.

	Found per cent.	Calculated per cent.
=	21·26	21·49
=	13·15	13·08
=	50·54	50·46
=	15·15	14·97
	100·00	100·00

ments were then made substituting zinc for the reduction of the nitre, but the reaction o violent, and there was not the slightest ion of the salt being formed. The sodium very soluble in alcohol and ether; it is y efflorescent, and was found to lose water ulphuric acid. I have not yet succeeded in ng crystals of the potassium salt. An s solution of the sodium salt was found to e following reactions with some of the metals: copper sulphate a turquoise blue precipitate, in acetic acid; with sulphate of manganese e precipitate, soluble in acetic acid; with ic sulphate a white precipitate, soluble in acid; with nitrate of bismuth a white preci- insoluble in acetic acid; with sulphate of white precipitate, soluble in acetic acid; uminium sulphate a white precipitate, insolu- cetic acid; with baryta a white precipitate, in acetic acid; with calcium bi-chloride a precipitate, soluble in acetic acid; with ic chloride a whitish yellow precipitate, fterwards became brownish red, dissolved in acid, leaving a white residue; *with cobalte* a mauve precipitate, soluble in acetic acid; ickel sulphate a whitish green precipitate, in acetic acid; with protonitrate of mercury precipitate, apparently metallic mercury at om, and whitish yellow suspended matter at insoluble in acetic acid; with gold chloride l was reduced; with acetate of lead a white ate, insoluble in acetic acid; with stannous a white precipitate, insoluble in acetic

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ical Laboratory, King's College, London.

PURIFICATION OF SEWAGE.—V.

[14574.]—I WILL now discuss the third process of dealing with sewage—namely, by filtration or intermittent downward filtration. Mr. Bazalgette, in his paper has dealt with this process almost wholly in its relations to pounds, shillings, and pence: he has not touched on it from a sanitary point of view, nor did any of the members of the Institute of Civil Engineers, during the discussion, touch on its most important division—namely, its power of purifying sewage, either by causing a nuisance on the farm during the application of the sewage to the land, or without causing any nuisance during the process of irrigation. Why was the sanitary effect, or the question of nuisance caused by irrigation, wholly ignored or neglected for the secondary and subordinate one of profit and loss? I think it was a tacit acknowledgment on the part of Mr. Bazalgette and the Institute that they were wholly incapable of dealing with the question in any other manner than that of pounds, shillings, and pence. The one all-important question of purification was wholly shoved on one side, to show which system or farm produced the most profit, or which had cost the most money per acre or per head of the population. I think this is a very unsatisfactory manner of dealing with the subject. The best method of purifying the sewage ought to be first settled, and then the profit or loss question could be dealt with after. The Institute appeared to think that all that was necessary to be done was to spread the crude sewage over a farm and let the crops and land deodorise, clarify, and purify the sewage if it could, no matter about there being a nuisance on the farm so long as the farm was far enough away from a town or gentlemen's residences.

That is not the way in which such a vital question should be dealt with. If sewage is a nuisance in a town it must also be a nuisance to the residents and workers on a farm where it is applied in its crude state. Unless it is deodorised and disinfected previous to spreading it on the land it must be an intolerable nuisance.

I will now give my opinion on some of the sewage farms which have been often quoted as favourable examples of sewage irrigation. The Tunbridge Wells sewage farms—north and south—I made a particular examination of these farms for ten days in 1871. I again visited them in 1875, and I found that the tanks, the carriers, and the land smelled as bad as anything that could be conceived—in fact, the smell from these farms had a disagreeable sickening effect on any one approaching them, especially near the precipitating tanks, and were, at the times I visited them, a great nuisance. I collected some of the effluent water from several of the drains, and found it had a sickening smell, showing that irrigation as carried on there did not deodorise, much less purify, the sewage, although I found the sewage much easier to deodorise and clarify than London sewage. In 1871 and 1874 I examined the sewage farm at Earlswood for several days, which, at that time, received the sewage of Redhill, and was intended to take the sewage of Reigate. During my visits the smell from the carriers and ditches was very disagreeable, and a great nuisance. I found the sewage, as it flowed from the main sewer into the "extractor," of a character that was most remarkably easy to deodorise and clarify—in fact, it was five times easier to purify than London sewage. Notwithstanding that fact, the effluent water as it ran off the land smelled very strongly, and was far from being purified.

At Beddington, which I also visited, the smell was not so strong as at Earlswood. I took no samples, nor did I test the sewage at Beddington, but I think the smell from the carriers was sufficient to constitute a nuisance. The Eaton sewage farm I have visited several times in five different years, and I think the smell arising from that farm is something very disagreeable, which could not be tolerated near a town. The chief merits of the Tunbridge Wells and Eaton farms are, that they are situated well in the country, not near any town or highway; but the Earlswood farm, which takes the sewage of Redhill and Reigate, lacks the recommendation of being retired in the country. It abuts on a highway on two sides, and is too near to the asylum; there are also many cottages near it, and building operations are approaching nearer to it every year. For these reasons, I consider that it is a public nuisance which ought not to be tolerated. The effluent water runs off into a small stream, a tributary of the Mole, by the side of a highway, in a very impure state. It is all very well for the inhabitants of towns to get rid of their sewage by sending it away two or three miles from their own doors, but I hold that they have no right to annoy the public or travellers by the stench of this sewage being spread over a piece of land alongside of a highway. Boards of health have no more right to pollute the atmosphere by a sewage farm to the annoyance of any one than they have to pollute a river.

I was engaged making observations on Breton's farm for upwards of eight months. That farm takes the sewage of Romford, which Mr. William Hope, V.C., leased for seven years. Mr. Hope, during the seven years he farmed that land, demonstrated that the process of irrigation on a well-drained farm, as carried out at Breton's, thoroughly purifies sewage. The effluent water from that farm was at all times of a very pure character, but the sewage reservoir and the carriers were at all times a great nuisance, and the smell arising from the reservoirs in certain states of the weather was of a sickening character. Therefore, notwithstanding the pure character of the effluent water and the large crops produced by the sewage irrigation, as carried on at Breton's, the process could not be considered as of a satisfactory character so long as the reservoir of sewage and carriers continued to smell so badly.

With regard to Mr. Bazalgette's inference tha sewage has no more value than pure water for irrigating purposes, it is sufficient to say that the sands in the neighbourhood of Craigentinny, when watered with sea water or with rain water, never produced a crop, but when these barren sands were watered with the Edinburgh sewage they produced crops worth £30 per acre. Whether the crops take up any of the nitrogen of the sewage or not I cannot undertake to prove, but I will undertake to prove that sewage will produce a crop where water cannot.

It would be as reasonable to say, that if a farm was spread over with pure sand it would be as efficient as to dung it with farmyard muck, as to say that pure water is as efficient as sewage for irrigation.

"Intermittent downward filtration." I quite agree with all Mr. Bazalgette has said on this system. Its claim to be a new invention is quite ridiculous. What would they call the filter beds at Chelsea or East London Waterworks? Are these filters not good examples of "intermittent downward filtration?" The only difference between them and the Troedyrhiew filters is, that at Troedyrhiew the crude sewage of Merthyr Tydfil is filtered, whereas the Chelsea and East London filter beds filter sewage very much diluted, or call it water slightly contaminated with sewage; still these filters are good examples of "intermittent downward filtration," and they were established long before Merthyr Tydfil filters, or before Dr. Frankland proposed that system for purifying sewage. I think I can throw some light on the Troedyrhiew filters that was wholly overlooked, or probably quite unknown to the disputants—viz., the ease with which the Merthyr Tydfil sewage can be cleansed, in comparison with the sewage of many other towns. 2nd. The very great purity of the diluting water which mixes with the sewage effluent in the drains. I was engaged for eight days in January, and again for nine days in July, 1872, examining the filtering process at Troedyrhiew; during that time I took gaugings and samples every two hours during the daytime, and twice I devoted 24 consecutive hours to watching and noting the effects of the sewage on the land, so that I was able to judge of the efficiency of the system from my own undivided observations. From these observations and experiments—1st, I found that the sewage of Merthyr Tydfil was three and a half times easier to deodorise and clarify than London sewage which I take as a convenient standard. I cannot enter upon the question of the number of inhabitants contributing to the sewage; I only know the quantity and quality. 2nd. I found the filter beds, 20 acres in extent, passed the sewage at the rate of about one million gallons in 24 hours during dry weather, but during that time the lower portions of the beds, frequently choked from the deposit of suspended matters from the sewage, which caused the water to rise and accumulate in pools, then the sewage had to be turned on to other portions, which gave time for the water to filter through the soil, after which the soil had to be stirred at those portions that had been clogged before the sewage was again turned on. 3rd. I found the effluent water passing from the effluent drain at the rate of about 2,060,000 gallons in 24 hours; the effluent water was completely deodorised and clarified. 4th. I found that the water which diluted the effluent sewage came partly from the river and partly from springs of very pure water which issued from the side of the hill beneath the canal on the east side of the filter beds. I dug some pits and found some strong spring issuing from the ground at a higher level than the effluent drains or in the river. I collected a sample of this spring water which was pronounced to be "beautifully pure" by an experienced analyst. Well, a large quantity of this beautifully pure water mixed with the effluent sewage in the drains. I was rather surprised at Dr. Frankland stating that the effluent water was purer than the subsoil water without trying to explain why it was so. Did the fact that the effluent water being purer than the subsoil water not make him suspect that pure water must be getting in somewhere and mixing with the effluent? It raised my suspicions, at all events, and I traced the source of the pure diluting water to springs above the level of the river. If Dr. Frankland supposed that the filtered sewage entered direct from the filters into the drains provided for the effluent water, he made a mistake. The filtered sewage in penetrating through the soil mixes with the subsoil water all over the farm, and I have no doubt the subsoil water which Dr. Frankland states was not so pure as the effluent sewage, was actually mixed with the filtered sewage, and that pure spring water was at the same time mixing with the effluent sewage in the drains. The subsoil water taken above the level of the drains where the sewage water could not get into it, was at all times much purer than the mixed effluent water, and part of that pure spring water at all times found its way into the drains, and mixed with the effluent water, which accounts for the effluent being purer than the subsoil water taken from ground in close proximity to the drains. 5th. I found the soil at Troedyrhiew was of a character peculiarly well adapted for purifying sewage by filtration, but I think very few towns could get the advantage of such an excellent filtering medium, so that it could not be taken as a standard for the average required of other sorts of soil to purify any given quantity of sewage. There cannot be the slightest doubt that the filter beds at Troedyrhiew cleansed a large quantity of sewage in a short time, and I think Mr. Bailey Denton, C.E., is entitled to credit for having demonstrated that fact. Still that does not alter the fact that the sewage smells strongly in the carriers, and causes a great nuisance before it passes through the filters.

Wm. Burns.

(*To be continued.*)

TWIST AND RACK WHEELS.

[14575.] — Calculations on "twist" and "rack" wheels are to be found in almost every work on cotton-spinning, and it is a generally acknowledged fact that if you want to change your "hank stubbing" or "roving," these two wheels will also have to be changed. Moreover, you are usually told that by squaring the wheel you have on, multiplying the result by the hank you are now making, and dividing this latter result by the hank you wish to produce, you will, by extracting the square root of the quotient, arrive at a suitable "twist" wheel. For "rack" wheels the process is the same, except that instead of multiplying the result obtained after squaring your wheel by the hank you are now producing, and dividing by the hank you wish to produce, you multiply by the hank desired, and divide by the hank you are now making.

So far so good. Every manager and overlooker, as well as every book on the subject that I have come across, agree that this is the right method of procedure; but from no source whatever can I obtain a mathematical reason for so doing. A suspicion once crossed my mind that perhaps some speculative individual found out by a series of experiments that results obtained by proceeding as above answered well in practice, and that therefore this mode has been held up as a standard to go by ever since (?). But surely there must be some deeper seated reason than this. Probably our friend who gave us a hint or two a few weeks back on "Strap-piercing," can enlighten us on this subject. If not, any of your readers' opinions on this point would greatly oblige. **Xylon.**

MICROSCOPICAL.

[14576.]—Lately I have been studying the foot of the common fly, and, though my remarks may not be new, they may prove interesting; and, at any rate, I hope the pugilistically inclined will, if they hit, hit me softly, for I am but "a little fellow" in this science. In the first place I watched flies walking up a window pane, by my standing outside and looking through a strong lens; this lens was strong enough to distinguish the pads, two to each foot, and the projecting claw; but not being satisfied I made a glass cell, deep enough to allow a fly to walk about, but shallow enough to prevent his turning over; getting this on the stage with a 1¼in. objective, I could see the hairs on the foot-pads, and also that each pad had a slit in it.

I have not seen "Mr. Hepworth's interesting articles on the fly's foot in the second and third volume of the *Microscopical Journal*" referred to in "Davies on Mounting," but from what I have seen *au naturel* I certainly do not (*at present*) believe in Dr. Hogg's "tenent hairs." Next, I put on a ¼in. objective, and, after waiting very patiently until my fly walked into the field of view, I at last got his foot in a splendid position; there he was clinging to the glass cover upside down, and each of the pads was slit in the centre, to all intents and purposes an ordinary sucker; one foot raised off the glass was a rounded pad covered with hairs; but the pad on the glass had opened in the centre, so that a smooth surface (doubtless damped sufficiently to create a vacuum) adhered to the cover, and by this means I presume flies, &c., are enabled to move about upside down.

The above was done in the day time, but in the evening ("when the lamps are lighted") I took the same "live" slide and proceeded with the examination. I noticed that the two pads on each foot were independent of each other—that is, the fly moved one pad a little apart from the other without taking his foot off the glass, and, in so doing, the "*pocket*" *of the pad closed up* when lifted, and expanded when put down. When a fly stands a little while in the same spot, the pads are seen to expand a little more at intervals with a jerk. This, I imagine, is either a fresh damping of the under surface, or, as a boy would do to a leather sucker about to loosen, put his foot on it and spread it out for a new vacuum. Shortly afterwards I killed this fly, and every one of his pads were tightly closed, so much so that I could not trace a resemblance to a slit anywhere. I don't know that I have given anything new in the above, but I have not seen these facts in print, and this must be my excuse for sending them.

In examining the eyes of insects one is struck with the beautifully arranged hexagons; has any use been scientifically acknowledged for them, and their being in such numbers in a single eye? I think it is universally agreed that most, if not all, these insects see in the dark. Has not this form of eye something to do with it? If so, were a glass carefully cut in the same manner, should it not answer a similar purpose? I made a beautiful slide of a small butterfly's wing feathers in this way:—Put the wing on a blotting pad and take a dry clean slide, place it over the wing, and rub the slide briskly with a small pad of brown paper, lift the slide, put a cover over the part with the feathers on, and fasten it round the edges. My idea was to attract the feathers to the slide by frictional electricity, and it was successful.

Sydney, New South Wales. **E. C. H.**

CIRCULAR MOTION.

[14577.]—Old readers of this useful magazine, who have become accustomed to see letters every now and then from people who imagine it has been reserved for them to discover some gigantic error under which the whole scientific world has till then been lying, will pass over letter 14515, p. 395, without surprise. As I do not fully comprehend the greater part of Mr. Pinnington's letter I shall confine myself only to a few points in it. He will not employ the word force in its usual sense, but insists on speaking of a body as under the influence of a force when it is moving with uniform velocity in a straight line. Passing over the advisability of using words with the same meaning as other people use them, I would ask Mr. Pinnington if his method does not lead to confusion, for it is to say that the body is under the same influence with respect to the line AD as to the line AC. Now, if the force towards D did not act the body would move to C with a constantly-increasing velocity, but if the force towards C were to cease it would move to D with a uniform velocity; therefore when he uses the word in its first sense he means that which produces motion, but in its second sense that which does not produce either motion or anything else—*i.e.*, nothing. It is not usual when a body, free to move, remains at rest, and does not change its state, to say that it is under the influence of a force, and it would be equally absurd to say that a body in motion, when it does not change its state of motion, was under the influence of a force.

FIG. 2

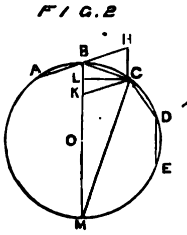
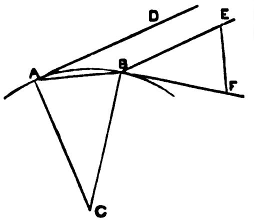


FIG. 1



In the very simple proof of the law of variation of gravitative force quoted by Mr. Pinnington from a "modern writer" he finds three errors:—(1) "The error of accepting a measure of the circular path as a measure of velocity." From which it would appear that he does not regard velocity in a curvilinear path as the distance divided by the time of describing it. (2.) "The gross error of dividing the squares of the radii by the squares of the times, instead of the squares of the circumferences by the squares of the times, in order to get the squares of the velocities." Mr. Pinnington does not seem to see that it is only with proportions, and not absolute magnitudes, that the writer he quotes is dealing; or, if he is aware of this, he cannot have taken the trouble to acquaint himself sufficiently with arithmetic to know that, when the numerator and denominator of a fraction are divided by the same quantity, its value remains unchanged. (3.) The error of supposing that the centripetal force $= \frac{V^2}{r}$, instead of $\frac{V^2}{2r}$. A few lines further down he gravely informs us that it is equally correct to use the first of these formulæ when we know the value of f; but if we do not know it, then we must use the second. So that, if he does not admit that the mental act of knowing affects the value of centrifugal force, the only alternative is the admission of the equation, $1 = \frac{1}{2}$.

Some of your readers who have onl
knowledge of dynamics or mathematics, o
learners not yet advanced beyond the r
might like to see the following proof of th
for centripetal force. It is modified from
and is more direct than the one given
p. 29.

Force is that which changes a body's
motion or rest, and is measured by the m
or quantity of motion it produces in a uni
When a force acts across the direction
which a body has at each instant, it produ
tinuous deviation, and if the force and th
its direction be constant the deviation is
The deviation in unit of time, or rate of de
the change of the body's state of motion
therefore the measure of the force.

At A (Fig. 1) the body is moving in the
A D. Take A D = v, the velocity. At B
moving to F, with the velocity B F = A
B E equal and parallel to A D. The mot
may be considered as compounded of B E
in direction A D) and E F, the deviation.
A B, is described in a small interval of tin

$$\text{Arc A B} = v\,t,\ \text{chord A B} = v\,t,\ \frac{\text{chor}}{\text{arc}}$$

and B E F are similar isosceles triangles; t

$$\frac{\text{EF}}{\text{AB}} = \frac{\text{BE}}{\text{CB}},$$

$$\text{or EF} = \frac{\text{AB}\,.\,\text{BE}}{\text{CB}} = \frac{v^2 t}{r}\,\frac{\text{chord}}{\text{arc}}.$$

This is the amount of deviation, and t
found by dividing by the time, t, during
takes place; and, therefore, the approxin
of f is $\frac{v^2}{r}\frac{\text{chord}}{\text{arc}}$. But this is only approxim
as t is a finite interval. The smaller we
nearer we approach to the true value of
in the limit when t vanishes do we actuall
it. But as the chord, A B, is taken sn
smaller it becomes more and more equal t
and when it is infinitely small it is equal
Therefore, $f = \frac{v^2}{r}$. It may, perhaps, be w
adding the demonstration in Ganot, a
above. Suppose an intermittent force at
to cause a body to describe the regular
A B C D, by giving it an impulse, $f\,t$, at e
angles, A B, B H is a prolongation of A
A B, and it is easily seen that H C is
B O, and, therefore, B H K C is a para
and B C, a side of the polygon, is its dia
the resultant of the velocity, B H, and th
B K = $f\,t$. C L is perpendicular to B M s
being an isosceles triangle, B L = B K.
similar triangles, M C L and B C L, we
: B C = B C : B L, or $2r : vt = vt : \frac{1}{2}$ (ft
fr, or $f = \frac{v^2}{r}$. **Charles W. H**

[We shall insert no more letters on th
—Ed.]

DOUBLE STARS.

[14578.]—Mr. Seabroke has called my
to Mr. Burnham's letter (14416) in you
June 7, and, as he is away on business, ha
to reply. I fear it is a mistake not wh
error of the press. The ¾" is a mispri
which was a description from recollection
distance of the faint companion. My ow
of this companion, made in 1874, may be
to Mr. Burnham. They are: position a
distance, 59·7". It is plain that this i
spoken of in the next sentence in the boo
tion. **A. Percy**

Temple Observatory, Rugby, July 1.

NOTES ON OUR SATELLI

[14579.]—Vitello, Lee, and Doppel
In my recent letter (14505, p. 393) there
great many blunders, which I am totally
account for. In the first place, the
Vitello, is printed Vitruvius. In the sixth
the diagram ζ is printed ς, and in the nex
printed χ. The diagram comes next: I
ridge ι, connecting A and Doppelmayer,
marked, so is the central mountain γ of
whilst its W. boundary, ζ, is marked ς.
ν, enclosed by θ, κ, ι, η, is likewise not m
the last line but five ζ is again printed ς.

Further study of the diagrams of this r
to point to θ, κ, and ι as portions of th
upon whose walls the rings, A, Doppel
Vitello, have subsequently and success
formed—the results of later volcanic dist

Mare Nectaris. — Upon 1878, J
shortly after 11h., I noted that "the e
seemed much brighter than formerly."
be satisfactory if any other observers
have seen it would publish their observ
formerly, as it may be remembered, paid c
attention to this mare, but on the date
was struck by the additional brightness of
portion. **Frank C. D**

10, Terminus-terrace, Southampton,
June 29.

NEW SOUTH WALES.

]—Thinking that a few remarks in
by a native white man, may not be out of
l would, on the other hand, be interesting
lk of your readers, I venture to send the
:—The population of New South Wales is
t about 650,000 persons, scattered over an
11,000 square miles, or, say, three times as
England, Scotland, and Ireland put
Sydney, the capital, is approached by a
which is proverbially beautiful and wonder-
distance from the entrance to the city is 6
ıd it is one dissolving panorama of bays,
c., though, after passing the town, the
still runs up a long way. The city itself
2,000 acres. The railway line open for
nsists of 629 miles, and does not come
wo miles of the Circular Quay, where the
and other vessels load and unload. Botany
re Captain Cook landed, is on the southern
ven miles from Sydney. Newcastle, the
, 75 miles north of Sydney, exports on an
70,000 tons per annum, this amount being
per cent. of the total coal output of New
ales. The variety of minerals found in this
nsists of iron, tin, silver, platinum, gold,
ntimony, kerosene, shale, coal, diamonds,
, limestone, marble, meerschaum, man-
lumbago, quicksilver, salt, and slate. With
to the gold-fields, I may mention that the
Sydney is 130 miles away, because, lately,
gentleman arrived here, and when his
asked him "what he would do after
?" He replied, "Oh, I think I'll stroll
e of the gold-fields and be back to lunch."
roos are peculiar to Australia, and now, I
n export in skins is beginning. The leather
as one of the best, softest, and most
nd when I think of the fact that as many
have been destroyed as pests in one week
on, I am surprised that this trade is not
ward. The number of sheep now in the
24,600,000; horned cattle, 3,100,000; and
70,000. The last three seasons have been
—that is, droughty ones, thousands of
lying weekly; but we are now entering on
period, the cycle being reckoned as 19½
t is very singular that so few tube-wells,
pumps, and such like are in use in this
he only reason I know of being that the
not push them sufficiently. In summer
rage) maximum heat in the shade is
, and in winter the minimum cold is 46°—
Sydney.
ve our share of "vermin," such as mos-
ornets, tarantulas, scorpions, snakes, &c.,
vage wild beasts (this, perhaps, accounts
lness of the aboriginal brain), the native
a very furry harmless creature that men
shoot, because, if wounded, it cries so
like a baby. The laughing jackass is "a
snakes." Some of these birds sit up in
ee opposite this house and laugh by the
together, but woe to the snake it sees! It
ptileship by the back of the neck and up
the air in no time, then lets the snake go,
ll is generally sufficient.
oned the railway, and I should like to say
rds on the zig-zag. This wonderful piece
ering is 90 miles from Sydney on the
line, and is constructed on a gradient of
The train, say, from Sydney, on arriving
-zag, runs on to a shunt, and then reverses
next decline on to its extension, and back
n the next. When you are at the top you
e bottom rails directly underneath you, at
f about 600ft., which appear to be a foot
al gauge 4ft. 8½in. The line just here cost
er mile. The lowest on our lines is 32ft.,
ighest 3,658ft. above sea level. In conclu-
pend a few names of towns in this colony—
lemen might fancy them for their cottages:
ng, Bulgandramine, Coonabarabran,
lla, Ginninderra, Goorangoola, Jembai-
Pallamallawa, Tooleybuc, and Woomar-

E. C. H.

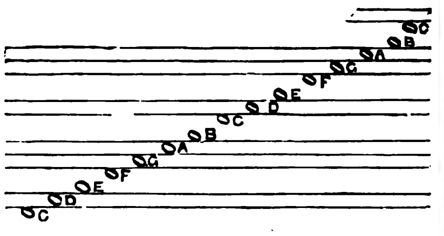
OR 9th OR DIMINISHED 7th?

—I deny that the chord G, E, C sharp, B
lair's "Suite for the Violin" is, as your
lent, A. Coates (let. 14513), asserts, a
and, on the contrary, I affirm that it is a
l 7th. Had it been a minor 9th in G, the
ld have been G B D F and A flat, whereas
here are G E C sharp and B flat, of which
mes are, as I affirmed, the two last—
ediate notes, E and G, constituting an
of minor thirds, being necessarily taken on
as Leclair has written them. Ordinarily,
is placed on the leading note of the minor
as this music modulates into the mode of
of which A sharp is the testing note, a
ion, with an enharmonic transition, gives
es A sharp, C sharp, E natural, and G
so a chord of the diminished 7th, and the
e require to introduce us to the mode of
which the music conducts us.

Isaac Fowler Ballard.

NEW MUSICAL NOTATION.

[14582.[—I have read the letters which have appeared in your pages with much pleasure. Now, I think that a perfect staff would obviate the use of sharps or flats in the signature. What is desired, then, is a staff that will answer these conditions, and also at the same time be a guide to the eye; or, as your correspondent (letter 14440), Mr. Robert Wark, says, it should have "landmarks." The staff of which he gave an illustration requires a good memory to retain it, from the fact that it has not sufficient "landmarks." I inclose a staff of my own construction, upon which I should like the views of your readers. I do not claim that it is perfect, but certainly think it is more easily learnt and remembered than the staffs of the old notation. The principal features of it are—(1) It represents the keyboard with which all players of the piano or organ are acquainted, the lines representing the black notes, or sharps and flats, and the spaces the natural notes; the broader spaces show the position of the semitones between E and F and B and C. These are its chief landmarks. (2) The distance of one note from another is easily found; and (3) the position of the octave at once seen. I shall be glad to hear what Mr. Wark has to say upon my proposed new staff and its practicability for general use.



Cello.

MUSICAL TONES.

[14583.]—My reply to the question proposed by "H. C. K." (let. 14467) is, that the note A♯, in the passage quoted, is intended for one that is higher than the B♭, and I think it probable that, as produced by the best performers, it is an upwards inflected tone between the B♭ and B♮. But as "H. C. K." has more to say to any person who replies "higher," and a further question to ask, I conceive that this reply is all that is required until we have got what he has in store for us.

June 29. Fred. J. Jackson.

TELEPHONIC.

[14584.]—The following phenomenon may be of interest to some of your readers:—When the two instruments described below are put in connection with each other, and a weak galvanic element (I used a Menotti), and placed on a table, if the latter is slightly shaken the telephone gives out notes which sometimes last for hours at a time, during which period the note given out varies suddenly without any apparent cause; but if the telephone is removed from the table the sound stops, and no amount of shaking will induce it to continue until it is replaced. These notes are so loud that they can be heard from one room to the other with ease. Perhaps some one can explain this occurrence. A, two wooden supports; B, two pieces of wood screwed to A, which hold C, the diaphragm, at two ends only; D, a weight to regulate the pressure of the carbons; E, a wire fastened to the horizontal carbon, along which D slides; F, an upright wire which supports the horizontal carbon by being passed through; G, hole in the carbon. E. C. B.

FIG. 1

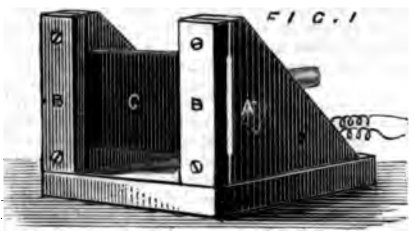
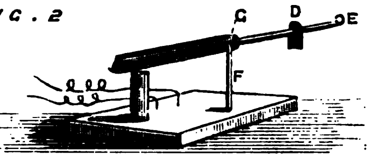


FIG. 2



THE CASSEGRAIN REFLECTOR.

[14585.]—Will "A. N. H." (14416) forgive a tardy reply? I have been very busy. He is right in supposing that when I thought of mounting so large a mirror as 18in. I would cling to my favourite form—the Cassegrain—not only as I still prefer it to all others, but I think I have discovered some other cardinal advantages attaching to this form, if mounted as mine is, which greatly increase its convenience.

When asking Mr. Calver to figure the 18in. I made it a condition that the mirror should be parabolic, for two reasons—firstly, I was anxious to be able at any time to use it as a Newtonian, as described in a former letter; secondly, I knew of no certain method of testing any other figure, whether the section of an ellipse or a sphere. The latter was to me the far more important reason, for although I had been able with some success to examine the figure of my 8½in. (With) mirror by Foucault's process, it ceased to give me any certain results when afterwards applied to the larger aperture; other things entered into the calculation which were hardly apparent before (such as atmospheric disturbance, flexure, &c.), and destroyed all certainty. I had not the place to attack so difficult a problem; it should be encountered under ground. This, I thought, might probably happen, and it influenced my request to Mr. Calver. No doubt for those who would not undertake the patient labour and trouble required in matching a secondary to so large a mirror it might have been better to say:—"Make for me and mount the best Carsegrain reflector you can," and to leave the choice of the figures to the person selected to construct the telescope; but for me it was most necessary to know the curve, as I meant to set about the figuring of the convex. I only do Mr. Calver bare justice when I say he did his very best for me, and I am very much pleased with his work. The figure is as nearly as possible parabolic, with the least trace of outstanding spherical error, which came to my assistance when fitting the secondary mirror. When I got the mirror last August I was just in time, using it as a Newtonian, to catch four glimpses of the satellites of Mars—two of these were afterwards confirmed by a reference to the ephemeris which appeared in *Nature*; of the other two I am in some doubt. Since then I have been using the very few good opportunities which come to us in this climate in matching a convex to it. I have ground nine of these, doing three at a time. The first three were of too small diameter, the outer edge was slightly degraded and the definition spoilt. The second three were of too short focus, but one proved an excellent match, and gave splendid definition on 15in. of the large mirror. The third three which I have in hand at present are likely to supply a good match. The grinding and polishing of these has taught me many lessons—above all the great advantage there is in bringing the glass up to the very finest possible grain before polishing, if a really good figure is desired.

If it should be thought a long time to complete this work I would ask your readers to remember the very few evenings we have suitable for such work, the inopportune occurrence of good nights for one who has other duties to perform, and perhaps the fastidiousness begotten by the constant watching of such good work as the 8½in. (With), and my admirable 3¾in. (Cooke and Son's) can accomplish. In testing thus two mirrors one soon learns to guess what is wrong, but how to correct the error is a very different thing. As regards "figure," I am coming more and more to the conclusion that evenness and equality of curve have more to say to good definition than the character of the curve. "That is a good figure which gives a good image" (Herschel). Delicate definition seems largely to depend on a good polish and uniformity of surface. The kind of polish on the silver film, too, is very important; nothing but the black polish will do really good work. All these considerations tend to explain the curious circumstances I mentioned in my last letter, that one segment of a mirror performed better than the rest, although it is very difficult to trace this variety of performance to its true cause. It may be that the portion of the mirror exposed is better silvered, or better supported at the back, or that the perpendicular strain agrees better with it, or that it looks out through a less troublesome stratum of air in the tube, or that the portion of the flat it employs is more perfect, but the fact remains, and any one can test it for himself. My tube is of spiral latticework, wood, after the pattern of Great Melbourne, and I find a good difference in the steadiness of definition from this cause, especially when using it as a Cassegrain.

A word as to the powers of a Cassegrain telescope. It is often objected that they are high, and that it is impossible to keep them down. Perhaps those who make this objection do not realise the fact that there is a limit of power below which it is not possible to employ the whole aperture of any telescope. If the pupil of the eye be considered as 2-10in. wide (the usual estimate) it will not be feasible to use a lower power than 5 diameters on a 1in. object-glass, and have the benefit of the full aperture, for with any lower power the emergent pencil of rays from the eyepiece will be of greater diameter than the pupil of the eye, and some be lost. Keeping this in mind it may very well be taken as a rule (as Professor Newcomb, in his recent work, has shown) that the lowest power an object-glass or mirror will bear on a star, if the whole aperture is to be employed, may be found by multiplying the number of inches in the aperture by 5. This would give the least power on a 4ft. mirror as 240, which, I find, is the lowest supplied with the Great Melbourne by Mr. Grubb. It is obtained by using with the secondary mirror a field lens of 1ft. 4in. focus, no very exaggerated focus when compared with the focus of the Great Speculum, 30ft. 6in.

By the way, why does Mr. Fennessy (14502) call the sky of Australia "pellucid?" I have read that it is a singularly troublesome climate for observation, the scorching sun raising a turmoil in the air not soon quelled after dark, and filling it with a cloud of microscopic dust so all-pervading that it shuts out objects near the horizon from view, and so deleterious that every bearing in the great telescope has had to be provided with a special shield to prevent a grinding process going on where it is least of all required. After this is the rainy season, when everything is saturated and dripping with moisture, and the very penknives rust in the pocket. It is not certainly like either Italy or Egypt.

It surely was most unfortunate that this splendid telescope, the most perfect reflector ever made, should have fallen, in its early life, into such unskilled hands. The reckless treatment to which its delicate specula were subjected after its arrival in Australia tends largely to explain the small results which, until lately, have been obtained from it. It is pleasing to know that one now guides its movements who will soon make its excellence known.

But to return to the powers which are possible on large telescopes. The lowest power (according to the above rule) which could be employed on a 6ft. mirror, similar to Lord Rosse's, is 360, whether it is used as a Newtonian or Cassegrain, and it would be no difficult thing to obtain this power on a mirror of that aperture, mounted as a Cassegrain, by using a convex of about 10ft. focus, and a field-lens of about 2ft. focus. It has often struck me, too, how much more convenient the Cassegrain form would have proved (pardon the audacious conception) had the late Lord Rosse selected it as his model. Supposing the present mounting, or something similar, to remain, the observer would sit on a low chair underneath the great speculum. The telescope should, of course, be supported on one side, and not as now, on a ball and socket joint under its centre—moving only at intervals—as the eyepiece travelled from him in its short arc, and completely sheltered from the cold. How different this would be to his present position! Mounted in a cage sometimes 50ft. from the ground—poised in mid-air a prey to every hostile gust—always moving—with a sense of endless chains and pulleys ever moving around him.

My 18in. is mounted on this principle. The telescope is hinged to a pivot immediately under the lower edge of the mirror, and is suspended in altitude by a system of pulleys and counterpoises, with quick and slow motion, which work admirably. The observer sits below the mirror, and need hardly move at all, for the reason stated above. The movement is altazimuth, but to avoid the frequent use of the two handles when the object is within 20° of the meridian, the telescope is constrained into a parallactic course by an arrangement excellently described in an early volume of your journal, and subsequently at a meeting of the Royal Astronomical Society by Lord Lindsay.

"A. N. H." is quite right about the focal length; every foot added saves much time and pains in matching the two mirrors; but he is quite wrong in his interpretation of Sir J. Herschel's words relating to the convexity of the small mirror, the fact being, the longer the focus of both (making the focus of small 1·5th to 1·6th of large), the easier will be the adjustment.

As to the reason why so few mirrors are ground or polished to be used either in the Newtonian or Cassegrain form, I can only suppose there are some mechanical objections to it—perhaps a change in grinding or polishing tools to avoid degradation at the edge of central hole (this is only conjecture), or it may result from the absence of demand; but of this I feel confident that the Cassegrain is the reflecting telescope of the future. I am still further strengthened in this assurance by the knowledge that Dr. Henry Draper, of New York, after many years' experience with the Newtonian form, has mounted his last and most perfect production in this manner, and has now one of the finest Cassegrain reflectors in the world of 28in. aperture. It would be interesting, indeed, to know from him the reasons of this choice, and the experience he has gathered from its construction. **Hyperion.**

TELESCOPIC APERTURES AND MYSELF.

[14586.]—Like Mr. Dennett, I was not aware *that he had given more* than one extract from Dr. *Kitchiner's "Economy of the Eyes,"* but I gave two, which, with his one, make the three I mentioned. I thank him for the date of the Vol. I. he quotes from, and I suppose the book I have, "The Economy of the Eyes," Part II., which relates to telescopes, and is dated 1825, is a second edition, or reprint of the one he has. I am sorry I overlooked "the wondrous changes," &c., but Mr. Dennett must remember I have not a 2¼in. telescope to observe them with; however, I ought to have written, after on p. 433, of Vol. XXV. of the English Mechanic, something like this, "as to amount of detail shown." The resolution expressed by Mr. Dennett, at the end of letter 14511, is, perhaps, a wise one. **8½in. O.-G.**

[This controversy ends here.—Ed.]

MR. DENNETT'S CAUTION TO YOUNG OBSERVERS.

[14587.]—The appearance to which I referred of craters appearing like hills, and vice versâ, I did not see as Mr. Birt thinks, and as "Mac" describes, over the whole moon. I have never seen it so; it has always affected small objects only, objects of much the same size as those Mr. Dennett mentioned. That made me think it was the same appearance as that which he observed. I have never seen it with a large crater, such as Theophilus, as Mr. Birt has; it has only affected certain small objects without affecting others in their neighbourhood. One instance is the hills on the N. border of Fracastorius; I have often seen them apparently concave. Mr. Birt's explanation of it by libration makes it quite clear, and I think what I have seen must be due to that cause. **Brickwall.**

Erratum.—Letter 14556, page 423, line 13, for 10^1 read 10^{16}. **Wm. John Grey.**

USEFUL AND SCIENTIFIC NOTES.

Ornamenting Zinc.—A chemical process for covering zinc with coloured coatings has lately been described by Dr. L. Stille in the *Engineering and Mining Journal.* The articles of zinc are first brightened by vigorous scouring with quartz sand, moistened with dilute muriatic acid, putting them quickly in water and then wiping dry most carefully with white blotting paper. To insure success, however, it is necessary to employ zinc as free as possible from lead, and to have it bright like a mirror. When these conditions are fulfilled, the metal may be coated with a variety of most beautiful colours by immersion in a solution of alkaline tartrate of copper for a shorter or longer interval of time, depending on the colour that is desired. The solution is made by dissolving three parts of air-dried tartrate of copper in caustic soda lye containing four parts of hydrate of soda to 48 parts of water. If the zinc is dipped in that liquid at a temperature of 10° Cels. (= 40° Fahr.), it appears violet after two minutes, takes a splendid dark brown in three minutes, changes to green in four and a half, to golden yellow in six and a half, and to purple in eight and a half minutes. If the liquid be employed at another temperature than that given above, the appearance of the different colours will also vary in other short periods of time. If the zinc be left longer than eight and a half minutes in the copper liquid at 10° C., the last-mentioned purple colour disappears, being replaced by one or another of the preceding hues, depending on the time; but then they are never of the same brilliancy, and will continually diminish, until after some days' immersion the zinc is covered with a miscoloured suboxide of copper. For this reason the articles are removed from the bath as soon as the desired colour is fairly developed, and rinsed immediately in water. After careful drying, the metal may be coated with a good varnish, to make the colours more durable. Silvering and gilding zinc: A direct silvering of zinc, according to Ebermayer, is not practicable, for although the zinc covers itself speedily and nicely with silver as well as with gold, yet this coating becomes dull and unseemly after a short time. The cause of this may be that the covering is too thin to perfectly cover the zinc. There is no other means left, therefore, but plating the metal first with brass or copper. It not being sufficient, however, to merely cover the zinc by simple immersion, it is necessary to produce a good, durable precipitate, which may be accomplished by using the galvanic battery and a solution containing cyanide of potassium. A process has of late been published in Germany to copper-plate zinc articles by simply suspending them on zinc wires in a solution of blue vitriol and caustic potash, which, to prevent a precipitate being thrown down, is mixed with tartaric acid or glycerine. Ebermayer further remarks that all articles made of sheet zinc are better adapted for plating with brass than castings, because the latter, if not most carefully handled, are liable to be disfigured with black spots.

REPLIES TO QUERIE

**** In their answers, Correspondent
spectfully requested to mention, in each
the title and number of the query asked.*

[32269.]—**Systematic Memory.**—Mr.
Temple may perhaps find something to his
the following examples from various su
show that a *memoria technica* may be
suggest a considerable number of fact
having recourse to a "large number of a
mental pictures:"—*Example* 1, from Trig
—Sin a mol·t is sa cot mol ca sit. This li
tractions being expanded becomes: Sin *a*
less t is sin *a* into cos *t more or less* cos *a* i
—*i.e.*, Sin $(a + t)$ = Sin *a* cos *t* + co
Example 2, from Astronomy.—The follo
gives the names of the twelve signs of the
order: Ar-ta-ge, Can-leo-virg, Lib-sc
Capric-aquar-pisc. *Example* 3, from
"Ethics."—Eight reasons are given by A
show that virtue has to do with pleasure
They are suggested by the following lin
pleasure, actions, and pim πιμ, choice,
pleasure, and θυμος. *Example* 4, from Ge
The angle at the circumference standing o
is the *demi-arc.* and the angle in a semi
right-angle. This may be put in the
jingle: Rim-angle on arc is arc-demi, and r
angle on semi. *Example* 5, Ecclesiastical I
The first three general councils, with the
the Popes who convened them, the reigning
the heresy condemned, and the dates. are
the following line from Gray's "Memo
nica:" — Nic-Sil-Con-Ari-tel: Co-Da-The
Eph-Ce-The-Nes-*fib.* *Example* 6. Di
Calculus.—A function can only have a ma
minimum value if the first-derived function
not vanish is of an even order. This m
membered by the following lines: *Max-n*
can be when the first valid derf is
then, if the even be *pos* we have *mini*, but
maxim. For the mode of applying
memory to the learning of foreign language
refer Mr. Temple to any of the books of B
which may be seen in the British Museum.
add that the above examples, with the exc
Nos. 3 and 6, are taken from Gray's "
Technica," or Kirkman's "First M
Lessons."—Old Oxonian.

[32614.]—**Sailing Boat.**—A boat 20ft. l
taken to pieces should have strong doub
inserted where it is proposed the division
made. These frames must be wide enoug
them to be joined together by ⅜ or ½ bolts
a thin washer being placed on each bolt be
frames, so the frames shall not quite to
may otherwise be built in the ordinary
when completed the bolts connecting th
frames removed, and the skin sawn throu
open ends of the parts must be planked over
the frames, and the connection of these l
kelson, bilge, and gunwale, strengthene
brackets or knees. Six bolts to each f
enough, two near the keel, one about th
each side, and one near each gunwale.
of sole leather must be interposed between
of the bolts and the frames, and also unde
to prevent leakage through the bolt ho
may also be well smeared with a mixtu
wax and tallow. But if "Irishman" is a
and proposes to build his own boat, he l
make his first essay on a smaller scale. A
long and 4ft. beam, in 3 compartmen
accommodate him and two or three frien
easily built by an amateur carpenter, and
pleasure send a full specification and d
Gimcrack.

[32693.]—**Chemical Reaction** (U.Q
much as nothing is known as to the nat
colouring matter in crude palm oil, excep
destroyed by oxidising agents, the firs
asked for in this query cannot be giv
chloride occurs native, forming beds in
nesium limestone or chalk. Potassic dic
obtained by roasting chrome iron ore in a
tory furnace with chalk and potassic
oxygen is absorbed and potassic chroma
This is dissolved in water and nitric a
which converts the normal salt into d
thus:

$2CrO_2Ko_2 + 2NO_5Ho = Cr_2O_5Ko_2 + 2NO$
389 126 295 20

With respect to the reactions of the vitrio
"Derby" had best consult some good
chemistry, and if he meets with any diffic
be glad to help him.—Wm. John Grey.

[32701.]—**Pony Bicycle** (U.Q.).—Th
all that it professes to be. A book is p
Tinsley, of the Strand, entitled "The Rise
lopment of Bicycling."—J. E. Oxill.

[32727.]—**Ochre.**—This query has no
answered, and, as I have a query of the
I will engraft it on to this one. I hav
ochre 6ft. thick; a portion of the seam
and the other portion brown. Can a
chemical friends inform me how I can
yellow colour more bright? I can make
of a deeper shade by roasting the ochre.

yellow brown or red by the same process, nt to know how to make it a brighter An answer will oblige.—More Light.

nd 33361.]—**Welding Steel (U.Q.), and ıg" Steel.**—Many people profess (on lo this; but I much doubt if it is possible st "smith" to weld three out of four heats st steel. I am only an amateur, and but nith at that; but I once did weld two Wardlow's hard tool steel, ½in. square, by tead of sand, a mixture of 4 parts borax t sal-ammoniac, pounded, well mixed, and plumber's ladle, and then pounded fine Try it, and report if successful; it is worth —Finem Respice.

—**Electro-Magnet.**—Having read in No. 21, Mr. Weisendanger's instructions for Daniell's cells, I procured the necessary , and made three; but I can only get suffi- tricity from them to ring an electric bell y. I may add that I did not soak top and porous cell in melted paraffin, and made on of copper sulphate by crushing it, and in water. I do not want the battery for r purpose but to ring an electric bell tion with a telephone. Could I trouble endanger to say whether the battery he would be strong enough for this purpose. t. can I alter it in any way to make it so? LEYARD.

—**Hooks and Eyes for Catgut Band.**— doubt that "J. K. P.'s" plan of paring or band is very good for large bands. My only ¼in. in diameter, and I find they fit out any paring, as the latter causes the ıy or peel off from joint. When I pur- first pair of hooks I sent the gut to the and this plan answered so well that I now d either hooks or gut, as the case may be, ıgh I have obtained them from different result is always the same. The gut is, of t so large as the external diameter of the this does not matter so much for a small it is better than having the gut peel away. an emergency, tried paring the band, but was not, to my mind, satisfactory, as the e did not seem to give as good a hold as lazed exterior of the gut, in addition to eeling away. I clean out the thread with ent wire. As I said before, I have not r than ¼in. bands. Large bands will tand paring better, as the individual larger, but for ¼in., or any smaller size, dently recommend such a band as will ly into the hook without any reduction ave a little shaping at the extreme point. e any tallow or grease, and should not o, but it may be requisite and useful with s, the hooks for which have larger threads, her harder to screw on. I do not like per. Some are made the same diameter so) throughout, and I prefer them. I reatest respect for "J. K. P.'s" opinion, , every old reader of the English must have, but I give the result of my r what it is worth.—Os.

-**Gas Holder.**—I would not attempt to ith weights unless you want a very small gas; in which case, collect it in a bell- water. Take your Winchester quart off the bottom; put a cork in the neck, he cork a ¼in. or ½in. gas tap. Extem- eumatic trough (I expect you know what ce your bottle in the trough; you can he air out at the top, and as you do so, will fill with water from the bottom. filled with water, turn the tap. You can gas in at the bottom. When you wish gas, fasten a piece of rubber tube to the ork, but you must provide water to fill n place of the gas. Get another bottle same size, cork it, and through the cork s tube. Fill this bottle with water, and the side of the other, so that the end of st dips into the water in the trough. Now, eaves the first bottle, and the water rises ilar quantity of water will bubble out of bottle, and preserve the level in the Then you are about it, get larger bottles hester quarts. You can easily procure t will hold a gallon. The whole thing nore than half a crown.—Os.

Plaster of Paris.—If "Etna" wishes e plaster of Paris actually to powder I dge-runners would be more satisfactory ng rolls, if ground wet or dry, but I do 00 bushels could be ground per day by f one machine alone could do the quantity nd I know of no maker of mortar mills to nd. Mortar mills, or edge runners, are ading cement.—Novus Homo.

Rate of Interest.—I perceive that your nt, "A Fellow of the Institute of in giving his answer of 4·278 per cent. on n gets it from tables of interest. I can e accuracy of this answer, having got ame answer, or 4·28 per cent. by approxi- d without tables; but, if I remember gave 222 per cent. as the interest charged ey. If the answer was to be the rate per nnum compound interest, then I differ as, instead of multiplying the interest upon the payment of £5 per year for 10 years for the loan of £40 by the number of weeks in the year—that is, 4·278 by 52—we ought to find the 52 power of 1·04278—that is the amount of £1 at the rate per cent. in the year, or find the log. of 1·04278, and multiply that by 52, get the natural number that corresponds to the product, from that deduct £1, and you will have the compound interest on that amount per year at 4·278 per cent per week, multiply this by 100, and you have the rate per cent., which is 783, and not 222 as stated.—B. Riley.

[32955.]—**Moths.**—Will "N. Sirch" favour me with the publishers of the book noticed by him on May 31, 1878, p. 299.—F. C. Smith, Librarian, Bridgeport Library, Bridgeport, Conn., U.S.A.

[33021.]—**Bleaching Glue.**—Glue can, I believe, be decolourised by passing the hot liquor through animal charcoal, and it can be rendered tolerably waterproof by the addition of a little bichromate of potash when it is about to be used.—S. M.

[33022.]—**Hominy.**—"G. L. T." does not say whether he wishes to make hominy, or merely to cook it. I cannot give him "one or two simple recipes;" but he should soak it all night, and then boil for three-quarters of an hour, taking care it does not burn.—Momus.

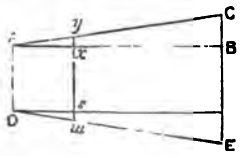
[33024.]—**Oil.**—Why not run the oil through strainers?—Video.

[33029.]—**Electrotyping in 15 or 18 Carat Gold.**—I did not exactly misread this question, but took the liberty of thinking that the querist had made an error. I beg pardon for so doing. The deposition of alloys is not an easy matter at the best of times. I have never tried it, but the only method of doing it will be to make your solution in the ordinary manner, using 15 or 18 carat gold, with an anode of the same. I should prefer gold alloyed with copper only, or with silver only. Dissolve in nitro-muriatic acid, evaporate to expel the excess of acid, dissolve in water, and precipitate with cyanide, of which add sufficient to re-dissolve the precipitate. About 2dwt. of gold will make a quart of solution. All gold solutions must be used hot. The bath can be placed in a pan of water over a gas stove. Do not let the vessel containing the gold solution touch the bottom of the pan. If you require any further information which I can give I shall be happy to afford it, but you will have some difficulty in finding any one who has had much (if any) actual experience in such work. The working will not differ from gilding, but the articles or moulds will require to be left in the bath for a longer time. Guttapercha or wax will, of course, not do for moulds.—Os.

[33034.]—**Staining Wood Sections.**—What does "A. T. J." want to stain wood sections for?—Nemo.

[33036.]—**Mensuration.**—If "Omicron" (see p. 400) will read (instead of the continued product of the length) the continued product of the following quantities—viz., the length, the difference between the breadths of the ends, and the area of the part to be cut off, extract the square root of the sum, from the result, deduct the product of the length and narrow end, and divide the remainder by the difference between the breadths of the ends, that will give him the answer.—B. Riley.

[33036.]—**Mensuration.**—"Omicron" is quite right in surmising that I inclosed a diagram with my reply to his query; but it never reached the editor. However, the accompanying figure will explain to "Omicron's" satisfaction the meaning and use of the italic and capital letters to which he refers. I am sorry to see he misunderstands the rule I gave for solving problems similar to the one he sent, but if he will just look over my reply again (p. 349), he will see at once that the words "continual product" (in connection with the remainder of the phrase, and which "Omicron" does not quote), were used in a perfectly intelligible sense. "To the square of the product of the length and narrow end, add twice the continual product of the length, the difference between the breadths of the ends, and the area of the part required to be cut off," &c. The latter part of this rule is simply explained, thus:—(288in. the length) × (8in. the difference of the end) × (2,880in. the area of the part to be cut off, or, in other words, half the area of the board in square inches) × 2 = 13,271,040. In the working out of the remainder of this query nothing difficult can present itself to "Omicron."—Bernard M'Guire, Liverpool.



[33041.]—**Boiler.**—Apply to one of our model-makers, or else get an engineer to make you a strong vertical of copper, with plenty of cross tubes, so as to heat it by gas.—Stoker.

[33045.]—**Hydraulic for Blowing.**—Steel on cast iron is perhaps the best, both having very highly-polished surfaces; but such a valve is a bad one for a water engine. It should be on the principle of a three-way cock.—Motor.

[33051.]—**Carriage Mileage Indicators.**—All made on same principle. The revolutions of an axle are communicated to a train of wheels, calculated to show the distance travelled or the number of revolutions made. See the description of Mr. Striffler's on p. 424.—E. P.

[33065.]—**Indiarubber**—Can be "moulded" into a ball by cutting it into that shape. Then dissolve the cuttings in mineral naphtha, and paint on until the rubber is returned. To soften it would require a powerful masticator and steam.—Vulcaniser.

[33067.]—**Tuning Forks.**—The Rev. T. G. Driffield, of Bow, has a tuning-fork formerly the property of Handel, so that "tuning-forks" must have been known more than "fifty years."—S. M.

[33078.]—**London Conservatory of Music.**—I, too, should like to know what this institution can be like. It does exist, for it has a "chemist." Is it at South Kensington—a sort of new cole-hole?—Musicus.

[33081.]—**How to Make a Photo Print in Five Minutes.**—Try common salt and nitrate of silver as the sensitising medium, and fix with hyposulphite of soda.—E. K.

[33084.]—**Electroplating Extraordinary.**—If such a statement was made in *Cassell's Family Magazine*, the editor of that paper should be applied to for his authority.—Video.

[33085.]—**Bleaching Human Hair**—The peroxide will produce a golden colour. I do not think it will turn hair quite white.—M. P.

[33088.]—**Link Motion.**—Try Colburn's or Clark's works on locomotives and railway machinery.—Tim.

[33102.]—**Wire Joints.**—I have no great faith in the rosin doctrine, and have never myself found any injury that I should refer to the flux. I always add sal-ammoniac to the chloride of zinc solution. Rosin is more troublesome, but would work easily if care were taken to thoroughly clean the copper, and to have the bit well tinned. The real objection to the flux is the carelessness of people who do not wash it thoroughly off after the soldering is effected.—Sigma.

[33110.]—**Steam in Small Boats.**—In answer to "Aquarius" I will send him the information he asks for within the next issue or so of the English Mechanic. I would advise him not to entertain the idea of paddles, as they are not so effective or convenient for small launches. They are inconvenient for several reasons. It is impossible to run them up close to a pier or landing-stage; in passing fore to aft the paddle-shafts are a great obstruction, and they are more expensive, and liable to breakage. I should think, from the description of his boat, the draught of water will be from 24in. to 26in. at the stern, which is not a very deep one for a shallow river.—Black Witch.

[33111.]—**The Spider and the Fly.**—Mr. Lancaster is of opinion that spiders act by feeling and not by seeing. How is it with a kind of spider that may be seen on walls, palings, gooseberry, and currant bushes, that makes no web, and is grey in colour, and about the size of a small house-fly, with very short legs? This kind of spider, when he meets with a chance, begins to sidle about, and then seizes his prey and all is over. I was once walking through a hop garden about this season of the year when my attention was drawn to a spider and a fly on the path. The fly was certainly the aggressor, and about the size of a house-fly, but sharper built, and very brisk. The spider seemed quite on the alert as the fly kept prancing round and about, and now and again attempting to fly on the back of the spider, which ultimately he succeeded in doing, and then away went fly and spider too out of my sight. The spider looked nearly double the weight of the fly.—G. B.

[33159.]—**Locomotive.**—I am sorry I can't give you any information respecting the first paragraph or the second, for I fail to conceive how the word [diaphragm] is applicable to a locomotive. I should be glad if W. H. Salford would make it more explicit. I can give you some dimensions of a locomotive with two pairs of cylinders, two smoke boxes, two funnels, &c., and I have no doubt it is the same engine you have seen—viz., an engine constructed on Mr. Fairlie's system, called the "Little Wonder," which has been at work for some time on the Festiniog Railway, a line in Wales constructed to a gauge of 1ft. 11½in., or what is known, in round numbers, as the 2ft. gauge. The boiler is double, having two fire-boxes united back to back, with two distinct barrels and sets of flue tubes, and consequently a chimney at each end. A bogie is placed under each barrel, and each bogie has two pair of wheels coupled together, worked independently by a pair of steam cylinders to each bogie. Thus a total wheel base of 19ft. 1in. in length is covered by the bogies. Each bogie has a 5ft. wheel base, and the distance between the centres of the bogies is 14ft. 1in. The four cylinders are 8 3-16in. diameter, and have a stroke of 13in. The wheels are 2ft. 4in. in diameter. The combined grate area is 11 square feet, and the heating surface 730 square feet. From the results of a series of well-attested trials of the "Little Wonder," made in Feb. 1870, on the Festiniog Railway, the following may be selected for example. The "Little Wonder" left Portmadoc with a train of 72 waggons, [illegible] length, as follows:—

	Tns.	c.	q.
Loaded waggons (slate trucks) weighing	138	17	2
Empty waggons weighing ...	43	13	0
Passengers weighing	4	0	0
Train weight	186	10	2
Engine weight	19	10	0
Gross weight of engine and train	206	0	2

The engine started with a steam pressure of 170lb. per square inch, and drew the train up a gradient of one in 85, at a speed of 5 miles an hour. The train, when it was started, stood partly on a curve of 4½ chains radius, and partly on a reverse curve of 8 chains radius. The weather was fine, with a strong cold head wind. The rails weighed 30lb. per yard, and were not finished.—A. BROADBENT, Manchester.

[33164.]—**Properties of Matter.**—Your query contains its own answer. "Divisibility refers to aggregations of atoms, and impenetrability to the atoms themselves." The very word atom means that which cannot be divided. On the other hand. impenetrability, in a certain sense, is a property of atoms only, for when a vessel is quite full of water a considerable quantity of salt may be added without the liquid overflowing, the explanation being that spaces exist between the atoms of the water.—AMARA.

[33181.]—**Life of a Watch.**—The answer to this query given on p. 401 does not seem to me to give a fair idea of the time that a really good watch will last. I have known numbers of watches which have lasted very much longer, but can only give particulars of two. One is a silver Geneva watch, which I bought exactly this day 34 years ago (1st July, 1844). It was a first-class one, costing £6 6s. It has had very hard usage, and some very heavy falls. One fall it got knocked off the spindle of the second hand, and smashed the spring, wkich threw the back open, but did not in any way injure the works. The only expensive repair it ever wanted was when the cylinder was broken by another very heavy fall. It, of course, has had several new mainsprings, and an enormous number of glasses, but has still the original hairspring. It has been going the entire time I have had it, and went as well as ever up to a day or two ago, when the mainspring went; and I expect it to go well again when I get a new one in. The engine-turning has been entirely worn off the case many years ago, and the ring of the handle worn out. The second handle is now worn rather thin. The name on it is Badollet. The other watch is in my family. It is a lady's gold half-capped lever, by Sharp, Dublin, and is at least 10 years older than mine. Some years ago it for the first time got out of order, and caused some trouble, something being wrong with the ruby pin; but, on being properly repaired, it went well again, and is going very well still. I have known a great many watches which have lasted as long as these, though I could not name another Geneva watch which has lasted as long as mine. The gold watch which I have mentioned cost at least £20, and, I believe, £25. Two of those watches were bought at the same time. The other, when last I saw it—about 4 or 5 years ago—was quite good, and, I believe, is so still. Of course silver watches bought for £1 15s. or £2, and gold for £3 10s. or £5, cannot be expected to last like first-class ones.—G. J. H.

[33202.]—**Algebra.**—A subscript figure, such as the 4 in x_4, or the 6 in y_6, shows that the number to which it is appended is the fourth or the sixth of a certain succession of similar numbers. For example, in the expansion of a certain expression in ascending powers of x, the coefficients of the successive powers of x may be denoted by $a_1, a_2, a_3 \ldots$ &c., thus:— $a_0 + a_1x + a_2x^2 + a_3x^3 + \ldots$—AMARA.

[33207.]—**Capital Investment.**—If "An Engineer" will apply at the National Debt Office, Old Jewry, he can obtain a pamphlet gratis containing much information relative to the granting of annuities either for single or joint lives. During the last month, on the advice of an experienced broker, I have invested in securities—English and Indian—to pay an average 3¾ per cent. per annum. War or no war, my money is safe, and I have no trouble either on the score of principal or interest. An investment beyond 4 per cent. ought not to be recommended to a small capitalist. Remember, annuitants are usually long lived. Do not be over anxious about those who come after you, except they be your own wife and children. The greatest injury that can be inflicted on a working man is to leave him an unfettered £100.—PENANCE POINT.

[33212.] — **Prussiate of Potash.** — Perhaps "J. M. W." will kindly supplement his answer (p. 402) by saying whether leather from old shoes is ever used in the production of this salt; and, if he is practically acquainted with the process, give some details of quantities used; whether the parings, &c., are much cut up, or washed, before using; and method of purifying the crude crystals. If old boots are used there are plenty of them knocking about in most houses to make the trade of collecting them, if wanted in any great quantities, worth the attention of the "rag and bone" men. What degrees of heat is required, and is there any danger of decomposing the salt by over-heating? Must the iron crucible be closely covered? By the way, "J. M. W." has not mentioned iron filings or scraps as one of the ingredients. Does this equation represent the reaction?

$$\begin{array}{ccccccccc} 2K_2CO_3 & + & Fe & + & Cy_6 & = & K_4FeCy_6 & + & 2CO_2 \\ 276 & + & 56 & + & 156 & = & 368 & + & 120 \end{array}$$

How much skin, &c., will give this 6CN?—DAGHBERT.

[33217.]—**Converting Bicycle.**—Take out back axle and wheel, and get a duplicate of the latter. Get a new axle made, and fitted to the hind fork. This axle will require to be made about 18in. long, and must be fixed to the end of the fork by two caps, or in any other convenient manner. It must have adjustable cones at each end suited to the twin wheels, thus (Fig. 1.). The adjusting screws to be one right-handed, and the other left-handed, to prevent unscrewing when the machine is driven. Remove the brake, and substitute a double one, made thus (Fig. 2). If "Junius" keeps the original axle and brake he can at any time reconvert his machine into a bicycle. My machine was converted by the original makers, Singer and Co., of Coventry, but any other machinist could easily make the alteration (see No. 684, May 3, let. 14274).—ALDERLEY EDGE.

FIG. 2

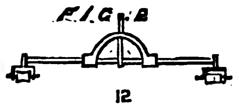
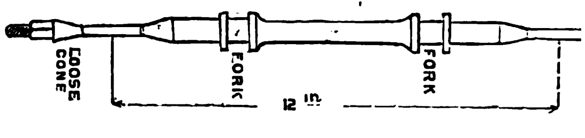


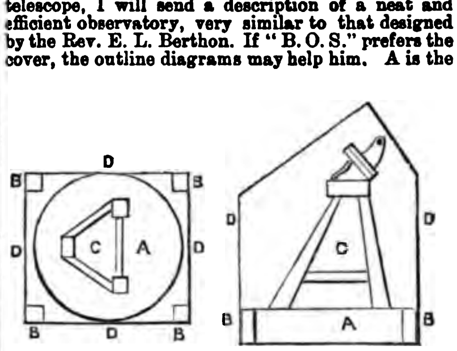
FIG. 1



[33228.]—**Adulterated Carbonate of Lead.**—Mr. Menke recommends hydrochloric acid, but surely nitric would be preferable, as lead chloride is barely soluble in water. "Bunsen's flame" would be better than "Bunsen's burner."—F. W. WOODMAN.

[33234.]—**Flute.**—I would recommend J. Colling to get one of Carte's patent flutes, the transition from the old fingering being very easy, and, at the same time, the facility with which various passages can be played is much greater. The difference between wood, ebenite, or metal is one of tone, some persons preferring one to the other.—G. A. P.

[33238.] — **Observatory for Reflector.** — "B. O. S." may certainly have a cover for his telescope stand; but, if he will take my advice, and can afford it, he had much better have a cheap observatory building, it is so much more comfortable to observe indoors than out. If he chooses to have an observatory, and will tell me the focal length of his telescope, I will send a description of a neat and efficient observatory, very similar to that designed by the Rev. E. L. Berthon. If "B. O. S." prefers the cover, the outline diagrams may help him. A is the stone block upon which the stand, C, is placed; B B B B are four low wooden posts, fixed firmly in the ground, and about level with the top of A. These posts are square cornered, and occupy the corners of a square rather larger than will contain the circular top of A. D D is the cover, which may be either well-painted canvas or zinc on a wooden strongly-made frame. This is taken off during observation, but is replaced afterwards, and may be fastened to the posts by small bolts.—F. C. DENNETT.



[33243.]—**Silver-like Polish on Brass.**—Like "R. G. L.," I, too, have been unsuccessful with the solution for silvering recommended by Alexr. Watt. I could never make the precipitate re-dissolve, and, after several repeated attempts—each attended by the same unsatisfactory result—ultimately consigned the solution to my "waste" bottle. "Nomdeplume" might try the following:—Mix 1 part of dry chloride of silver, finely powdered, with 3 parts of pearl-ash, 1 part of chalk, and 1½ part of common salt. This is to be rubbed on the surface of the brass to be silvered with a wet cork or leather.—E. J. MARSHALL.

[33246.]—**Chemical.**—Many thanks for Mr. Menke's answers to my queries, but I did not ask for the name of Fe_2O_3 (as I know what that is the symbol for), but for that of Fe_2o^{vi}, which, according to Frankland, is the symbol of a compound radical, supposed to be present in ferric salts of oxygen acids, as ferric sulphate, $Fe_2, 3SO_4$, or

$$\begin{array}{l} SO_2— \\ SO_2—Fe_2o^{vi.} \\ SO_2— \end{array}$$

In a chemistry I have by Meldola the equation I asked for was given thus:—

$$2CaF_2 + 2H_2SO_4 + SiO_2 = SiF_4 + 2CaH_2(SO_4)_2,$$

which is clearly wrong, and I must thank Mr. Menke for kindly giving it to me correct.—F. W. WOODMAN.

[33250.]—**High Pressure Horizontal**
—If you bushed the cylinder with a liner
I think you would be troubled by the expa
contraction of such a lump of metal. I h
lined cylinders of 10in. diameter with a
thick, to remedy blow-holes in casting, wi
difficulty from unequal expansion. Po
steam may pass the piston, and the valv
admits steam the whole stroke by your
much as 16lb. coal per h.-p. per hour. Y
not to exceed 4lb. The best modern engin
exceed 2lb. per h.-p. per hour. I would a
(after making sure that the piston is steam
"cut off" steam at one-third of the strok
would give a theoretical economy of 49 o
comparison with full steam the whole st
turning forward the cam of eccentric on
shaft, and putting a liner on each end of sli
so as not to admit steam until the engine
centre. You do not give boiler pressure
data to calculate from. It is economy to u
steam pressure than is required, as low
steam is saturated with water, while high
steam is elastic and dry. Perhaps a part
trouble is in boiler, which should evaporat
than 6lb. of water per pound of coal. Som
boiler-makers (Davidson's, Glasgow) profess
rate 10lb. of water per pound of coal. If y
good supply of water, a condenser (without
or moving parts) by Morton and Thompson,
might answer your purpose, as the paten
mise to save from 25 to 50 per cent. of fuel.-

[33275.]—**Dispersion of Sound.**—I th
Davies for his reply to this query, and regr
has utterly misunderstood its meaning.
the word dispersion signifies the decompos
compound light into its constituent colours
divergence produced by a lens or mirror), a
to know whether, in experiments on the
of sound, anything analogous to this has
served? For instance, if a common chord be
by a lens, do its four component notes a
one focus, or is there a difference?—W
GREY.

[33276.]—**Blast Furnace Slags.**—The
and chemical composition of slags varie
methods of working the furnace; and as
ing conditions vary so will the character o
produced. From this statement it may be
that comparisons can only be made when
ing conditions are similar. There are w
black, blue, brown, &c., slags. In the ma
of grey iron the slags are usually white,
charge is increased and temperature dimi
slag is black. Generally speaking, if t
very fusible, white iron will be produced,
slag is refractory the iron will be grey.
gives 4 $(CaO, SiO_2) + Al_2O_3 3 SiO_2 = Ca_4$
as the most fusible silicate of calcium and a
which compound always forms upwards
cent. of slag, but generally upwards o
sometimes it forms even 90 per cent.
above formula it will be observed that
14 of oxygen in the silica and 7 in the
alumina combined, so that when the ox
bined with the silicon is double that com
the calcium and aluminium, the slag o
most fusible. Again, it has been found
ment that when the oxygen of the lime
oxygen of the silica as 1 is to 2 the bes
obtained. In this case, at a white heat in
and a half the slag is well melted. When
is in any other ratio the result obtained
satisfactory. The following is a table
from Dr. Percy's valuable work:—

No	Formula.	Rates between O of Lime and O of Silica.	Weight in Grains.		Pe Con
			Lime.	Silica.	Lin
1	$3CaO, SiO_3$	1 : 1	1,260	690	64·
2	$3CaO\ 2SiO_3$	1 : 2	1,260	1,386	47·
3	$2CaO\ SiO_3$	2 : 3	560	460	54·
4	$9CaO\ 4SiO_3$	3 : 4	1,008	736	57·
5	$6CaO\ SiO_3$	2 : 1	896	245	78·
6	$9CaO\ 2SiO_3$	3 : 2	756	276	73·
7	$CaO\ SiO_3$	1 : 3	840	1,380	37·

ɔn found that No. 1 at a white heat for ıs not melted; No. 2 at a white heat for rell melted (this slag is artificial wollastite). 3 after 2 hours melted; No. 4 after artly melted; No. 5 after 2 hours not Io. 6 after 2 hours not melted; No. 7 after not melted. Again, if magnesia is sub- or lime in the above table we find that ɔxygen of the magnesia is to the oxygen of either in the ratio of 2 : 3 or 3 : 4, the is greatest, so that the fusibilities of f lime and silicate of magnesia differ. he silicate of lime melts at a lower tem- from 2,100° C. to 2,150° C.) than silicate of (from 2,200° C. to 2,250° C.) And silicate a melts at a higher temperature (2,400° C.), silicate of protoxide of iron melts at from :o 1,832° C. Again, the silicate of lime and melts at a lower temperature (2,000° C.) silicate of either of these separately; and te of lime and alumina (of which blast lags mainly cousist) melts at a still lower ıre—from 1,918° C. to 1,950° C. The slags furnaces practically range between the $3\,CaO\,2\,SiO_3 + Al_2O_3\,2\,SiO_3 = Ca_3Al_2$ $l\,3\,CaO\,SiO_3 + Al_2O_3\,SiO_3 = Ca_3Al_2Si_2O_{12}$. rst the oxygen of the silica is double the ' the bases, and in the second they are equal. wing table, which I have extracted from on, gives an analysis of blast furnace slags:

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
...	38·48	43·07	31·46	27·68	42·96	61·06	40·95
...	15·13	14·85	8·50	22·28	20·20	5·38	8·70
...	32·82	28·92	52·00	40·12	10·19	19·81	30·36
t. ...	0·76	2·53	·79	0·80	19·80	3·29	·60
rot.	1·62	1·37	2·38	0·20	1·53	2·63	2·18
...	7·44	5·87	1·38	7·27	2·90	7·12	16·32
l. ...	2·22	1·90	2·96	2·00	1·32	—	0·34S
...	1·92	1·84	—	—	1·10	—	0·32
id ...	0·15	—	—	—	—	—	0·10

lysis is from Dowlais when making grey . 2 is from Dowlais produced with white). 3 is from Kirkless Hall, Wigan, produced Bessemer iron, and the slag disintegrates r on account of the large excess of lime ent.). No. 4 is the slag produced from l ores. No. 5 is from Cwp Celyn, S. Wales. rom Grosberg, Sweden; and No. 7 is from Styria, produced with grey iron. Bauer- ves the following as the maximum and limits of the chief constituents of blast lags:—

	Minimum per cent.		Maximum per cent.
... ...	20	...	72
ina	0	...	30
... ...	0	...	60
Protoxide	0	...	26
ganese Protoxide...	0	...	34
nesia	0	...	34
ta	0	...	8·2
... ...	0	...	11·3
sh	0	...	4·3

e of iron tends to increase the fusibility of l it imparts a black or dark green colour, ı be observed in the black cinders produced es working with an excessive charge of lux in proportion to the fuel. The slag is grey when the furnace is hot and working t burdens, and grey iron is made. Man- when present in ores, usually imparts an ine tint to the slag, particularly observed es smelting hæmatite. An opalescent or c character in the slag denotes the presence e amount of alumina. The fluidity and character of slags increase in proportion to tity of silica present. It is often found that slag, on being suddenly cooled or solidified, perfect glass, and when slowly cooled it porphyritic and dark, with crystals inter- hrough its mass. One of the principal be attended to when the ore is of good the production of the most fusible slags ntroducing non-ferriferous matter. When ining sulphur is used it is necessary to use amount of flux than is indicated by theory e S may be taken up by the slag instead of on. The power of slags to take up S is to them by the presence of lime or the of manganese. It is very important that consistence of slag should be obtained, so metal may not be drawn off by the slag, the particles of the metal should not be m coalescing by slags of a refractory , and thus become subjected to a long- heating, producing an assimilation of Si hich is not desirable. When the furnaces ing hot the slags are characterised as a uid flowing continuously, and passing from the fluid to the solid state; but slags pass at once from the fluid to the te without assuming the intermediate ndition. The manganic hæmatites produce vitreous slag, but the slag assumes a white ndition when the gases pass through it. e is present in large quantities, as it is in atite furnaces, the slag possesses a dull stony fracture, and crumbles on exposure to the moist atmosphere. The extraction of iron from the hæmatites and other oxides of iron would be a very easy matter if pure, but there are always other impurities, especially siliceous matters, and the silica combines with the protoxide of iron, forming a silicate. The substance generally added to prevent the silicate combining with the iron is calcic carbonate, which forms, with the silica and alumina, an easily fusible silicate of lime and alumina. The choice of the limestone is very important, as limestone containing magnesia, as was stated above, diminishes the fusibility of the slag, and fossil limestone is objectionable since it contains phosphorus. The purer the limestone or calcic carbonate the larger the percentage of iron obtained. In North Lancashire and Cumberland brown hæmatite containing a large amount of alumina or coal shale is added to the red hæmatite when smelting. I almost omitted to state that the lime and alumina are bases in the slag. From the above considerations it is evident that those engaged in smelting operations can give very shrewd guesses at the composition of slags from their physical appearances.—HUGH CLEMENTS.

[33279.]—**Composition.**—Gilder's composition, or "compo," as we call it, consists of glue, resin, oil, and water, with whiting quant. suff., as the apothecary says, in about the following proportions:—Glue, 2lb.; resin, 1¼lb.; linseed oil, ½-pint; water, ½-pint. By altering the proportion a little you can vary the quality. By increasing the resin you make it harder, but more brittle; more glue makes it tougher, but it takes longer to get hard, and will not take so nice an impression of the mould; more water, and consequently more whiting, makes it weak. Dissolve the glue in the water over a fire, constantly stirring, to prevent it sticking to the bottom or burning; dissolve the resin in the oil in another vessel (both had better be of iron), taking care that it does not boil over and catch fire; now, while both are boiling, or nearly so, pour the dissolved resin into the vessel containing the dissolved glue, which should be large enough to hold the contents of both. Pour slowly, and keep stirring. Having previously sifted, say, 7lb. of whiting on something convenient, make a hollow in it, and pour in some of the mixture; stir the whiting in with a stick until cool enough to handle, then work whiting well in with the hands until of a pleasant consistency and perfectly homogeneous. If you make more than you want to use, it will keep best in cakes about 1in. thick, and 3in. or 4in. diameter, under some sifted whiting in a box. When you want to use one of the cakes wrap it in a cloth, and put it in a steamer. When soft it will require a little whiting added; so the oftener it is steamed the weaker it gets. I have tried to make it plain to you, as I never recollect seeing a really genuine recipe given in our pages.—A. N. H.

[33283.]—**Scratch Brushing.**—"J. H. T." can use nothing better than beer.—G. A. P.

[33284.]—**Trigonometry.**—For the third stage "Student" had better get Todhunter's "Plane Trigonometry," price 7s. 6d. Instead of going further into plane trigonometry he may take spherical, in which case Todhunter's "Spherical Trigonometry," price 4s. 6d., will more than suffice.—WM. JOHN GREY.

[33284.]—**Trigonometry.**—Haughton and Galbraith's "Plane Trigonemetry" is a very good work; so also, is F. G. Hall's. Griffin's "Elements of Algebra and Trigonometry," and his "Notes" on same are two excellent works. But "Student" will find Todhunter's preferable to any of these, if he intends to present himself for examination, mathematics, third stage. "Student" should procure "Examination Papers" for the present year, which he can have by writing to the Secretary, Science and Art Department, South Kensington, price 3d. He will derive much valuable information from a perusal of these papers, giving him at once an insight into the nature of the problems proposed at the May examinations.—BERNARD MCGUIRE, Liverpool.

[33285.]—**Cutting Grindstone.**—The majority of grindstones driven by manual labour have the same fault as "H.'s." I should like to know the cause of this. The best way to true them is to mark the high part, then chop it gently with a small chopper; then turn it up, using an old round file for the tool.—THOS. CLARKE.

[33285.]—**Cutting Grindstone.**—It may be cut true by means of the end of a piece of bar or tool steel with a rest.—NOVUS HOMO.

[33285.]—**Cutting Grindstone.**—See that it is firmly fixed on axle, at the same time be careful you do not split the stone. Now put rest at the side, and with a sharp point mark as near the edge as possible, to avoid waste. Pack up firmly with wood blocks and wedges, and with sharp fine chisel cut from line. Having done this all round, get an old file and use the hank—same as a lathe tool. If you have not a treadle or a lathe get some one to give you a turn. This is the way I do mine, which I use in lathe. In fact I have seen many others done the same way.—W. R. S.

[33287.]—**Marine Zoology.**—The following is obtained from Beeton's "Dictionary of Universal Information," and answers in a general way the first part of "M. R. C. S.'s" inquiry:—"Porpoise, the most common of all the cetacea on the British coast. The porpoises swim in shoals, and drive the herrings, mackerel, and salmon before them, pursuing them up the bays with the same eagerness as a dog does a hare. In some places they almost darken the sea as they rise above water to take breath; they not only seek for prey near the surface, but often descend to the bottom in search of sand-eels and sea-worms, which they root out of the sand with their noses. They go up rivers in pursuit of salmon and other fish, and have been seen a considerable distance inland. In fine weather they leap, roll, and tumble, and appear heedless and blind to all danger. The oil procured from the fat surrounding the body of the porpoise is of the purest kind, and the skin, when carefully tanned and dressed, is used for wearing apparel, and for coverings of carriages. As an article of food its flesh was anciently esteemed, and in Henry VIII.'s time was even a royal dish, appearing to have been generally presented as a roast, with a sauce made of fine bread crumbs mixed with vinegar and sugar. At a later period the porpoise kept its ground on the tables of Roman Catholics on fish days and during Lent. Its length is from five to eight feet." "Dolphin:—This fish bears a great resemblance to the porpoise, but has a much longer and sharper snout. The teeth in both jaws are nearly conical, though some of the species lose those of the upper jaw at an early age. They are very voracious, and are said to prey not only on fishes, medusæ, &c., but also on the wounded and feeble of their own species. They live, however, in herds, which often delight the voyager in the ocean solitude by the gambols which they perform around his ship. They may be discovered, says a celebrated naturalist, at a great distance, as they are continually leaping from the surface of the sea—an action which, as it seems to have no obvious object, is probably the mere exuberance of animal mirth. When a shoal is seen thus frolicking at the distance of a mile or two, in a few moments, having caught sight of the ship, down they come trooping with the velocity of the wind. When arrived they display their agility in a thousand graceful motions—now leaping, with curved bodies, many feet in the air; then darting through a wave with incredible velocity, leaving a slender wake of whitening foam under the water; now the thin back fin only is exposed, cutting the surface like a knife; then the broad and muscular tail is elevated as the animal plunges perpendicularly down into the depth, or dives beneath the keel to explore the opposite side." It is said that in these gambols the dolphin has been known to leap out of the water to such a height as to fall on the deck of a ship.—RUBY.

[33289.]—**Fiji Islands.**—I am a carpenter, and have just returned from Fiji after a three years' residence there. I beg to offer the following for the information of "Young Scotsman:"—I cannot think what could have put it into his head to emigrate to this colony, where everything is at a standstill, and nearly everybody in a hopeless state of bankruptcy, where all have left except those prevented by *res angusta domi*, or fears of the vigilance of Australian detectives. Carpenters have but little chance of earning salt for their kail there. Most of the white inhabitants live in native-built huts, in which the only thing in a carpenter's line is the door. There are a few weather-boarded huts in the town of Levuka, but these, if not made or repaired by the occupiers themselves (who are generally what are called "handy men" with tools), do not find occupation for the carpenters already on the island. The Government work, such as bridges, culverts, and buildings, is executed by the Royal Engineers. There are several carpenters who subsist on the profits of hotels or shops who would only too gladly take employment at their trade. The chances of getting a situation at anything else are extremely small. One would require a knowledge of sugar, coffee, and maize-planting, besides, and above all, an acquaintance with the Fijian language, before one could get employed as an overseer to a plantation, which is, practically speaking, the only occupation open to a white man. The wages are, nominally, for a carpenter, 14s. a day. An offer of 10s. per day would be eagerly snapped up. The climate, though free from fevers and cholera, is very debilitating to Europeans. The present inhabitants are poor and inhospitable. Provisions are dear; clothes, tools, books, &c., prodigiously so. Meat, 1s. per pound; flour, 14s. for 50lb.; beer, 2s. per pint; tobacco, 6s. 6d. per pound; medicines, books, &c., 100 per cent. dearer than in England. There are two ways of getting to Fiji—one by way of New York and San Francisco, in which journey you travel 3,000 miles by rail; the other round the Cape of Good Hope to Sydney, and from thence to Fiji. The steerage passage to Sydney in steamer is £15, in sailing ship I think about £13. From Sydney to Fiji in steamer £9, in sailing ship £8. There would be some chance of working a passage to Sydney, though not much; but they give but a nominal wage, generally 1s. a month. From Sydney to Fiji the chance would be infinitesimal. My advice to a person about to emigrate to Fiji would be, "Don't."—KO VAVU, Sotia.

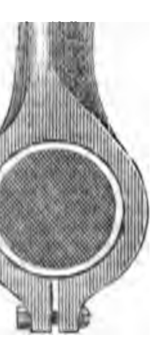
[33290.]—**Nodules in Limestone.**—A nodule is a more or less spherical body, composed of aggregated particles. A flint is an instance of a nodule formed in chalk (limestone), but a silicious one. Their origin is doubtful, but there seems a tendency in particles to gather round a central nucleus, like the bubbles in a teacup round a teaspoon. The oolite limestone is composed almost entirely of concretionary grains, and the pisolite, on the Cotswold Hills, has grain as large as peas, and if examined will be found to have a minute shell, or portion of shell, in the centre of each grain, round which the particles have arranged themselves.—NOVUS HOMO.

[33290.]—**Nodules in Limestone.**—The nodules that "J. Y." finds are, probably, silicious. Limestone is supposed to have had an organic origin, the sea during its formation, as at the present time, abounding with silicious-cased infusoria of a surprisingly prolific character. "A single one of these animalcules can increase to such an extent during one month that its entire descendants can form a bed of silica 25 square miles in extent, and 1½ft. thick." The silica thus rendered solid and diffused through the mass under formation, and of a different nature from itself, seems to have a tendency to collect together around certain points, and form nodules. Read about "Chalk Flints," in Lyell's "Elements of Geology," pp. 319 to 322 (6th Ed.).—RUBY.

[33291.]—**Organ Pneumatic Action.**—The atmospheric motors are governed by three way cocks in immediate connection with the drawstop rods. From these cocks tubes conduct the motors to and from a very simple pneumatic apparatus attached by a bell crank to the slides, which are opened or shut by the reciprocating action of the cocks, no effort being demanded of the performer to open and shut the slides. This tubular atmospheric system is applied as follows to the pedal organ:—Instead of a network of trackers a very short movement of this kind suffices to connect the pedals with a series of regular soundboards, having slides and escape and supply valves. The slides are covered by upper boards, but, instead of organ pipes, these tubes commence at these boards, and run in all directions to soundboards constructed for the pipes. On the depression of a pedal compressed air rushes along the tube, and opening a diaphragm stretched across round chambers cut in the pipe soundboards causes the pipes above to speak. No reasonable limit exists to the length of the tube, and it is noiseless and instantaneous in its operation.—J. E. B.

[33292.]—**Tour in Southern Europe.**—The approximate fare from London to Marseilles, viâ Paris, is, according to Bradshaw, for 1st class, £6 14s. 7d., for 2nd, £5 0s. 6d. Marseilles to Aden, by steamer, 1st class, £40; 2nd, £30; 3rd, £18, which includes food, with table claret to 1st and 2nd class passengers. Allowing for the return journey and hotel expenses, the cost of the tour, travelling 2nd class, would not be far short of £100, allowing yourself a month on land.—RUBY.

[33295.]—**From "56in. Superb."**—The fork ends in a circular flexible clip, as shown in accompanying sketch. The cylindrical bearing is slipped on the axle, and held firm by tightening the nut at the bottom. To take out the wheel all that has to be done is to take off cranks, and slip out the bearing, when it comes out of the bearing clips without the slightest trouble. The cranks are detachable in the ordinary way; they are recessed to cover the bearing, and so keep all dust from entering. My sketch was faulty, which made it appear peculiar.—56IN. SUPERB.



[33297.]—**Noise in the Ear.**—This most likely proceeds from accumulation of wax in ear. It may also proceed from small perforation of the tympanum, or from slight aural catarrh. Olive oil and glycerine each one drachm, 2 or 3 drops in ear every night. Use a solution of carbonate of soda 5 grains, lukewarm water an ounce and a half, injected with glass syringe every morning.—J. H. L., Surgeon.

[33297.]—**Magnesium.**—"Ignoramus" will experience considerable difficulty in storing up magnesium for use in a vaporous state, inasmuch as its boiling point is upwards of 1,000 centigrade. According to Dr. Frankland, illumination by magnesium costs about 15 times as much as illumination by coal gas. In this calculation the metal is taken at 10s. 6d. per ounce, and gas at 4s. 6d. per 1,000 cubic feet.—WM. JOHN GREY.

[33299.]—**Anatomical.**—There are two processes by which skeletons of animals may be prepared—the natural and the artificial. In the former of these the skin is first taken off, and all the entrails, together with the contents of the thoracic cavity, removed, care being taken not to separate the bones from each other at the joints, nor to cut or otherwise damage them. The bones are then merely cleaned by dissecting off the softer parts with scalpel, scissors, &c. During this process it will be found convenient at intervals to wash away any blood, *débris*, &c., by placing the subject, for a few days, in water, which may be frequently changed with advantage. After everything has been removed except the ligaments which unite the bones, the skeleton is fixed in the required attitude by means of suitable external supports, and allowed to dry in a place through which the air circulates freely. Skeletons prepared by this process, especially the smaller specimens, require to be handled with very great care, as the ligaments often become brittle with age. This process is generally adopted for small animals, such as rats, birds, fish, &c. Artificial skeletons are much more difficult to prepare, inasmuch as the bones are separately cleaned by "maceration," and then joined again by means of wire. In this process, as in the former, the skin, viscera, and as much as possible of the soft parts are removed first. The subject is then divided into several parts, the limbs being severed from the trunk, and if practicable put to macerate in separate vessels. Maceration consists in placing the bones in a vessel of water, the surface of which is exposed to the air, and leaving them undisturbed until the flesh is destroyed by putrefaction. This process naturally emits a disagreeable odour; it is therefore best conducted in the open air, water being added from time to time, to replace that lost by evaporation, but under no circumstances should it be changed. The time required to do this properly is only to be acquired by practice, since various causes, such as temperature, size of bones, &c., affect the process in different ways. When it is considered that this process is completed the water should be carefully poured off, and the bones taken out, care being taken that none of the smaller bones are left in the solid matter at the bottom; they are then to be transferred to a vessel of clean water for several days, which may at intervals be advantageously changed, and ultimately dried, preferably in the sun if circumstances permit. And now it is that the skill of the "articulator" is brought into play, for holes must be drilled in the bones in such a manner that when joined together by wire they (the bones) may have the same relative positions to each other as in the natural skeleton. "Vorticella" would, however, learn more in an hour by watching an "articulator" at work "wiring the bones" than I could tell him in double the time. But if he has access to an anatomical museum he might gain a general idea of the subject by noticing the manner in which they are there articulated.—E. J. MARSHALL.

[33290.]—**Anatomical.**—The skeletons of small animals are generally made by maceration. The animal is skinned, and the flesh as well as possible dissected off, the carcase placed in water for some time until the flesh becomes quite soft, and can be cleaned away with a brush. The bones are placed next in a solution of chlorinated lime or soda for some few days, to whiten them. The bones may be fixed together with clear Russian glue, mixed with a little fine plaster of Paris. In the larger skeletons the bones are drilled, and fastened together with fine copper wire, or, if the skeleton is wanted, flexible fine indiarubber threads. Another plan is by boiling the carcase until the flesh is soft, and can be picked off. Some knowledge of anatomy will be of use in articulating the different bones. When a boy I placed several animals close to an ants' nest, and found them help me well.—J. H. L., Surgeon.

[33302.]—**Brown Bronze.**—Any metal can be bronzed by first painting the article with a body colour and when the paint is nearly dry dusting on with a brush or piece of chamois leather copper bronze powder, which can be obtained at any good artist's shop. Afterwards, when the whole is dry, you may warm the article slightly, and either brush over pale lacquer or weak spirit varnish.—J. H. L., Surgeon.

[33307.]—**Geological.**—The rocks around Tunbridge Wells belong to the Wealden, a division of the lower cretaceous group of strata. Mr. Drew, of the Geological Survey, described this formation as it exists in the neighbourhood mentioned in the *Quarterly Journal* of the Geological Society, Vol. XVII. Lyell says, in his "Elements of Geology:"—"The picturesque scenery of the 'High Rocks' and other places in the neighbourhood of Tunbridge is caused by the steep natural cliffs, to which a hard bed of white sand, occurring in the upper part of the Tunbridge Wells sand, gives rise." Mr. Drew found this bed of "rock-sand" to vary in thickness from 25 to 48ft. Large masses of it, which were by no means hard, or capable of making a good building stone, form, nevertheless, projecting rocks with perpendicular faces, and resist the degrading action of the river, because, says Mr. Drew, they present a solid mass without planes of division. The calcareous sandstone and grit of Tilgate Forest, near Cuckfield, in which the remains of the Iguanodon and Hylæosaurus were first found by Dr. Mantell, constitute an upper member of the Tunbridge Wells sand, while the "sand-rock" of the Hastings cliffs, about 100ft thick, is one of the lower members of the same.—RUBY.

[33308.]—**Photography.**—You will require a temporary piece added to your camera, so as to have a greater distance between lens and dark slide, and then by putting camera near to engraving, you can make it as large as the camera will take. If a sliding body camera, you can easily make a piece to go between the two parts.—R. E. S.

[33308.]—**Photography.**—You require a greater length of camera. If a handy fellow with tools make a wooden "extension" same size as camera, to go between front and back (of camera), first ascertaining by experiment what length you require, and, if any cracks in it when completed, cover it with brown paper pasted on. It must be made to fit into camera front, and for the back of camera to fit into it. Use a small stop when copying.—FINEM RESPICE.

[33309.]—**Pocket Compass.**—No doubt the needles are made of soft, or rather not hardened, steel, and so rapidly lose their magnetism. Rub them with a common horseshoe magnet; start with the north pole of the horseshoe at the south pole of the needle, and go straight from end to end two or three times.—FINEM RESPICE.

[33309.]—**Repairing Pocket Compasses.**—These have lost their magnetism, and require to be re-magnetised in the ordinary way—viz., by rubbing the ends of the needles with the north and south poles of a horse-shoe magnet.—J. HARRIS.

[33309.]—**Repairing Pocket Compass.**—Most likely the pivot on which the needle oscillates is bent or become blunted. To remedy this you must take the compass to pieces, and repoint the steel pivot, then remagnetise the needle, and put together again, when the needle should point about 17° [illegible] of geographical north. When one is done, and [illegible] correctly, then do the other in the same way.—W. [illegible] LANCASTER.

[33310.]—**Varnishing Walking Sticks.**—[illegible] question has been asked and answered before. [illegible] paper sticks very clean. Use Stephen's [illegible] diluted to your taste; dry well, and varnish [illegible] white or brown spirit varnish in a hot room; [illegible] you can French polish them they will look very [illegible] —J. H. L., Surgeon.

[33312.]—**Engine for Boat.**—If "H. F." [illegible] kindly refer to the reply sent to "Aquarius" [illegible] there, in due course, have the information [illegible] quires.—BLACK WITCH.

[33315.]—**Distance Indicator.**—I intend [illegible] a mile indicator with a gas meter dial, and [illegible] can make it register about 40 miles by using the [illegible] gent screw. I will suspend with as long a [illegible] there is room for a lead weight, from axle of [illegible] and clamp the wheels to axle of front wheel, [illegible] screw parallel to axle, so that all will go round [illegible] the wheel. The weight, however, will remain [illegible] ing across and cause the screw to go a turn [illegible] revolution of front wheel and move the wheel [illegible] it one tooth. The wheels I have registered 100,[illegible] —54IN. DROMORE.

[33316.]—**Preserving Moths.**—Try [illegible] insect powder, or brush the under part of the [illegible] with a solution of corrosive sublimate and [illegible] J. H. L., Surgeon.

[33316.]—**Preserving Moths, &c.**—Let "[illegible] put all his insects into a box, impregnated [illegible] benzole, for a fortnight before placing them in [illegible] cabinet. When taken out of the box touch [illegible] bodies of each with a camel's-hair pencil dipped [illegible] solution of bichloride of mercury—6grs. dissolved [illegible] 1oz. of spirits of wine.—N. SIRCH.

[33316.]—**Preserving Moths, &c.**—Camphor [illegible] not, in my opinion, the most useful substance [illegible] which to preserve entomological subjects from [illegible] attack of mites. Indeed, in some instances, I [illegible] found it almost as bad as the mites themselves, forming a white sublimate on the glass of the [illegible] and, what is worse, on the insects also. I [illegible] not object to the smell so much if it would have [illegible] desired effect, but not only do I complain of [illegible] above defects but of its inefficiency to destroy [illegible] mites. I use in my cabinet a mixture composed [illegible] equal parts of oil of aniseed, oil of thyme, and [illegible] of wine. I should advise "Mike" to clean his [illegible] out, and, after replacing his specimens, pin a [illegible] pill-box filled with cotton-wool in one [illegible] Moisten the wool with a few drops of the [illegible] The cases will be filled with an aromatic odour [illegible] will be more than the bravest mite will stand; [illegible] if a few drops are put in the box occasionally [illegible] think "Mike" will not be troubled again.—T. J. [illegible] Bury.

[33316.]—**Preserving Moths.**—Camphor is [illegible] preventive, but will not destroy mites when [illegible] they have taken possession of the cabinet or [illegible] box. In this case the best thing to do is to [illegible] some pieces of blotting-paper in a strong solution [illegible] potassium cyanide; place these in the drawer, [illegible] ing them there 24 hours. To make perfectly [illegible] the drawer should then (having had the moths [illegible] porarily removed) be re-whitewashed, adding [illegible] quantity of corrosive sublimate (mercuric c[illegible] to the whitewash, taking care to put in a good [illegible] of camphor when the moths are replaced. [illegible] insure greater safety if the underpart of the [illegible] of the moths be touched with a weak solu[illegible] corrosive sublimate, by means of a small [illegible] before replacing them. Great care must be [illegible] to inhale the deadly poisonous fumes of the [illegible] —INQUISITIVE.

[33317.]—**Carbonate of Lead Manuf**[illegible] Which method of manufacturing this com[illegible] you refer to? In the processes I am [illegible] with the only other salt of lead likely [illegible] dentally present is a small quantity of ac[illegible] may readily ascertain whether this salt is [illegible] treating a portion of the sample with wa[illegible] and testing the filtrate for lead and [illegible]

would not cause the dirty white
ɪpeak of. Probably it is due to some
: re-agents.—T. J. H., Bury.

rneto-Electric Bells.—I am sorry
Zanni's magnetic bell is unknown by
ave been pleased to have given you
you ask. I never have seen one in
no reason why the current induced
of bobbins in front of a magnet
a bell ring, and I should think an
make such an apparatus to work
hould certainly prefer the ordinary
a good constant battery. I have
for seven years with but the least
tion.—W. J. Lancaster.

ures on Lens.—Your lens is similar
which have screw corrections. Thus,
s, mounted without the power of
d give one object well defined; but
a greater or lesser thickness of
s or balsam, would not be so well
to use the correction first, move the
line is opposite to the word un-
lace a slide on the stage, and focus
ntil the object appears well defined;
djustment until you can see the sur-
cover. Now refocus the microscope
the fine adjustment. Having done
ll be at its best on that particular
ould look at the number opposite
it upon a label on the slide. Thus,
7, then any time you wish to see the
the lens to 7, and you know that it
good plan is to have a label on top
to enter memoranda—thus, "cor-
half of proboscis very good, left eye
apping out the best parts of the
Lancaster.

ures on Lens.—Edgar Stone can
w to adjust his object-glass by look-
bjects, and seeing with what number
lots on the object look best. By
the number, he can at any time
out any further trouble, adjust his

and N. W. Engines.—Engines
ton; 1,517, Princess Helena; 1525,
nd those numbered about 1,670, have
24, and driving wheels 6ft. 6in. I
ella, belongs to the same class.
790, Hardwicke, have driving wheels
t 790 is of a later build, and coupling
ends. The number of Precedent is
., Prince of Wales, 7ft. 6in. driving
e engine in the Abergele accident,
.—R. N. H.

nd N. W. R. Engines.—In answer
I can tell him that the numbers
tion bars often refer to the engines
ars have at one time or other formed
metimes to the old number of the
they then are. The engine in the
n was 291 Prince of Wales. Those
accident were No. 850 pilot, named
No. 833 train engine, named Clyde;
driven by Shelvey, the latter by
was commonly known on the line
usion to the size of his nose, which
very like that of the Duke of Wel-
ough I have many times been in his
requently heard him spoken to, and
I never remember hearing him called
Precedent is No. 2,175; Alma, No.
, No. 2,183; Princess Louise, No.
Leopold, No. 857. The L. and
y Company was incorporated in
be puzzling to say how often No. 1
renewed since then, for this excellent
g after the incorporation of the com-
nt sections which had formerly been
es kept their separate lists of loco-
ver, I will set down what I recollect
o. 1 of the northern division, origi-
ction, was an engine called Saracen,
f Mr. Denrance's type, I have reason
was replaced in 1848 by another,
same as the engines 311 and 365.
say, "Murano" often sees, were
e rebuilt, and that gave way to the
ewhere about 1860, and she has been
No. 1 of the North-Eastern section
hester and Birmingham, blew up in
gsight, in 1853; her successor lasted
nation. No. 1 of the Southern divi-
high-domed Bury's engine, and was
at Harrow in 1840. She was twice
t last altered to a bank engine in
ow be seen, her running days being
water at Coalville. The engines for-
d 861-872 were large Fairbairn's
They used to work main line heavy
London and Rugby in days of yore.
any of them have been scrapped, but
ave been altered to 1,900 and odd, and
g on the South Stafford line chiefly.
main sizes of the coupled passenger
class, to which 830 belongs. Their
, are 6ft, and cylinders 16in.; but I
re. They are the type of the other
The 1,480 class is like them, but
r, which may be said also of the
which are to be reckoned 403, 790,
5, 6ft. 6in. wheel. 1,666 class is a little larger still. 2,150 class is more nearly the size of the first. I don't know that there are any particular class names for these; they call them large coupled and small coupled. I am sorry I cannot be more precise about their dimensions, but I can't get at them without a longer search among bundles of papers than I now have time for.—Itzaex.

[33322.]—**Cementing Iron Pipes.**—Sal-ammoniac. 2oz.; sulphur, 1oz.; cast iron filings or borings, 16oz. Mix well in a mortar, and keep dry. When a cement is required for use take 20 parts of iron borings, and mix thoroughly in mortar with one part of the prepared powder. Make this new mixture into a stiff paste with water, and you have it ready for use.—Ruby.

[33322.]—**Removing Rust from Iron Pipes.**—Disconnect the pipes near the boilers at one end. Take off bends, elbows, &c., at the other end, if any on. Connect on to steam pipes, after seeing all clear where the steam will exit. Turn on gradually till full. The result will soon manifest itself. I have done miles of underground pipes this way.—W. R. S.

[33324.] — **Walking Tours.— Tender Feet.**—Ordinary dock-leaves cut in strips and laid on the parts of the feet usually affected, and between the toes, will cure and prevent tenderness. Damp the leaves before putting them on. If carefully done this is infallible.—J. Harris.

[33324.] — **Walking Tours.— Tender Feet.**—Let "Walker" try a well-fitting sewn (not pegged, screwed, nor riveted) Blucher boot, and wear neither socks nor stockings. Bathing the feet in any and every cool running brook crossed, and if his way be by the sea, walking barefoot on the hard smooth wet sand will harden the skin. Tincture of iodine will do the same. It is friction rather than pressure which raises blisters, and the friction is aggravated rather than mollified by the interposition of any woven material between the skin and the shoe.—Gimcrack.

[33324.]—**Walking Tours.**—I have always found laudanum or proof whiskey very beneficial in the case of blistered hands, and I should think they would answer for the feet as well. Weston used whiskey. On no account use much of fuller's earth if you do not want corns.—Thos. Clarke.

[33324.]—**Walking Tours.— Tender Feet.**—For twenty years or more I have been in the habit of occasionally steeping my feet in a solution of alum (about 1oz. to a quart of warm water) for, say, 20min. or 30min., and though my feet are very tender when I neglect this (much more so, in fact, than any other of my "feelins"), I can by using it, manage a week's heavy walking without inconvenience. Some say it is injurious to health, but I have not found it so. I am, however, in robust health, and of strong constitution.—Finem Respice.

[33327.]—**Simple Instructions on Organ Stops.**—There is a catechism of the organ by Hiles, price 1s. which might be of some use to the querist. Though, of course, it is not to be compared with Rimbault and Hopkins. Most instruction books for the organ give directions as to the general kind of stops to be used in each movement, and "Brickwall" had better follow these directions till he has acquired sufficient skill to devise combinations on his own account. In doing this he must carefully remember that, though there are certain combinations, such as "full to fifteenth," "full swell," &c. (generally controlled by composition pedals), which are applicable to all instruments, yet, as regards more delicate effects, a combination which is pleasing on one organ cannot be absolutely relied upon to answer well on another. I may tell my friend that I compiled some notes on organ stops a short time ago, and, if he will advertise his address, I will lend him the book for a short time.—Wm. John Grey.

[33327.] — **Simple Instructions on Organ Stops.**—Get Dr. Stainer's "Organ Primer" at Novello's; it will give you all the information you require on almost every stop used.—J. E. B.

[33327.] — **Instructions on Organ Stops.**—Every beginner ought to possess a copy of Rinck's "First Three Months at the Organ," and in this "Brickwall" will find what he wants in a concise form, in addition to more than ninety invaluable exercises. He should get J. Bishop's edition, published by Cocks and Co., 3s. net. I should advise him also to get Nicholson's handy little book, "The Organ," published by Metzler and Co., price 2s.—Ne Sutor.

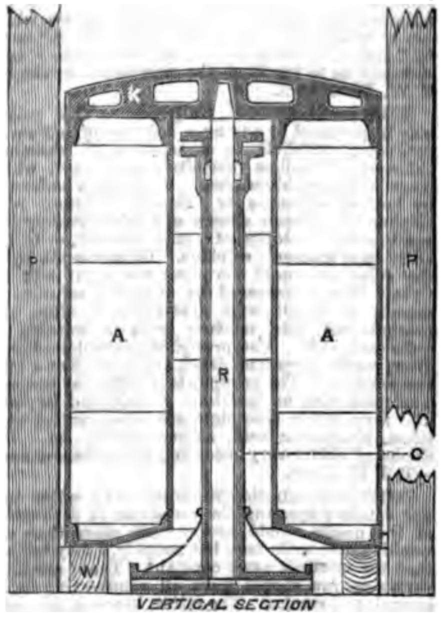
[33328.]—**Sign Language.**—I have been deaf since 1866, when aged 15 years nearly. The manual alphabet and signs employed in most of the deaf and dumb asylums is the only system of any use, and easily learned. When on a visit to France last year I could easily follow a conversation in the French language carried on between myself and a good-humoured curé while travelling by rail from Rouen to Havre. As I have never *heard* French (I know it only from reading) we both spoke on our fingers. Let "A Sufferer" take courage on reading this.—Frank Smith.

[33328.]—**Sign Language.**—I should advise you to get acquainted and associate with deaf and dumb persons—with one in particular. But if you can keep your hearing do so. To be deaf with a knowledge of the sign language is nothing like being able to talk with and hear others. I can understand it well, but am still able to hear well enough. I have learnt it by working with those who are deaf.—Cabinet Maker.

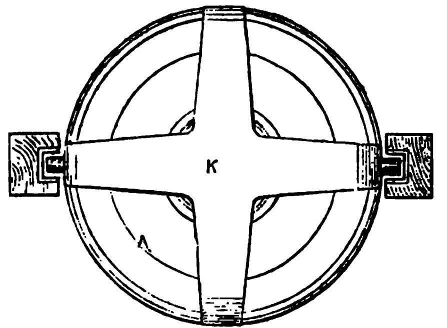
[33320.]—**Hydraulic.**—The hydraulic observed by "L. W." is called an accumulator, and will, I hope, be understood from the rough sketch I have made. It consists of a long cast-iron cylinder, C, in which a ram, R, works up and down. To the top of the ram, R, a crosshead, K, is fixed, to which the wrought-iron annular cylinder, A, is rivetted. In the position shown the accumulator is down, resting on the wood blocks, W. At the bottom of the cylinder, C, are two pipes formed in the cylinder foot-casting, one of these pipes is connected to the pump, and the other to a crane or other hydraulic appliance. The annular cylinder, A, is fitted with scrap iron, furnace slag, or any other weighty material. Two wooden uprights, P, into which a channel iron is fitted, serve as guides to the cylinder, A, in its ascent. The working of the accumulator is as follows:—Water is forced into the cylinder, C, by the pumps, and owing to the incompressibility of water the ram is raised, and as long as the ram is upheld the pressure in the cylinder, C, in the pipes from the accumulator to the cranes, &c., and in the cranes, &c., is the same. The rule for finding this pressure is as follows:—

$$\frac{\text{Weight of ram + weight of crosshead and weighted cylinder.}}{\text{Area of ram, R, in sq. in.}}$$

When the pumps have raised the ram to its highest position, a peg fixed to the lower part of the cylinder, A, lifts a lever connected to the stop valve of the steam pump, and shuts off the steam; and similarly, when the ram has reached its lowest position, the peg moves another lever and turns on the steam, and the ram again ascends. Cranes are usually worked at a pressure of 700lb. per sq. in.; while punching and shearing machines, rivetters, flanging presses, &c., are worked at a pressure of 1,500lb. per sq. in.—T. G. S.



VERTICAL SECTION



PLAN

[33333.]—**Cricket Ball.**—Take it to the nearest cobbler, who will re-cover it for a few pence.—F. W. Woodman.

[33334.]—**Flickering Lamp.**—If all is clean as well as properly trimmed in your lamp, I should say "bad oil." I was much annoyed by the same thing. I scalded the brass-work, used a new wick (which should be full size), tried a fresh dealer for oil, and the nuisance vanished.—W. R. G.

[33334.] — **Flickering Lamp.** — Probably half choked with pieces of charred wick. See that the burner is quite clean right through. If dirt is not the cause, then it will be due to either a badly-constructed burner or too explosive oil. The former can only be remedied by using a new burner; the latter by mixing one part colza oil with five paraffin.—W. J. Lancaster.

[33335.]—**Brown Bread.**—I should say yes, unless you can be quite sure the rye is free from the poisonous fungus, ergot, which so often infests it. Bearing that in mind, wheat and rye are very nearly equal in value as foods—at least so far as chemical analysis can settle the point. Wheat is given at: Gluten and albumen, 14·6; starch, sugar, gum, and fat, 68·1 per cent.; rye, 13·8 and 61·1 per cent.; besides the woody fibre, 1·7 and 10·3 respectively in wheat and rye. Rye is ground whole, I suppose, without separation of bran, and to do the same with wheat is much better than mixing flour and bran.—Daghbert.

[33340.]—**Sulphide of Cadmium.**—Cadmium sulphide can be prepared by mixing solutions of cadmium chloride and potassic sulphide when the cadmium sulphide falls as a yellow precipitate, which can be washed and dried. What does "H. S." mean by "getting cobalt blue"? The best way to "get" it would be to buy it at the nearest colour shop.—F. W. Woodman.

[33340.]—**Cadmium Sulphide.**—This yellow may be prepared by adding a solution of sodium or potassium sulphide to a solution of cadmium chloride. A yellow precipitate is formed, which must be thoroughly washed. It may also be formed by heating cadmium or oxide of cadmium with sulphur by passing a stream of sulphuretted hydrogen through a solution of a cadmium salt, or by the addition of ammonic sulphide. Of course the purer the substances used the purer the paint will be. Cobalt blue is prepared by mixing a solution of nitrate of cobalt with a solution of alum, and precipitating this mixture with a solution of sodic carbonate. The precipitate is collected on a filter, carefully washed, dried, and ignited at a high temperature. The precipitate is pink, but becomes a splendid blue on ignition. Cobalt and its salts also form other blue pigments when united with silica, phosphoric acid, stannic oxide, &c. The shades of colour vary according to substances used. —T. J. H., Bury.

[33342.]—**Magnetic Meridian.**—To enter into any details respecting the variations in declination of the needle would occupy more space than one would care to write for; but roughly, I may tell you that the needle is never constant. There are three variations you should learn all about—viz., daily, annual, and secular. The latter, however, are most important. Thus, in London, in 1657, the needle pointed due north—that is, the geographical and magnetic meridian formed a straight line. In 1818, however, the needle made an angle with geographical meridian of 24° 41′ W.; 1840, 25° W.; 1863, 21° 25′ W.; 1871, 19° 30′. It is now some 2½° less, and the probability is, in the course of the next century, the two meridians will again be equal. Now, the magnetic meridian differs in almost every part of the world from the geographical meridian, and there is not the slightest ratio existent between them. You are altogether wrong about the angle of declination in England; it has not been 24° for a long time. The only method you can adopt to obtain the differences between geographical and magnetic meridian is to have a magnetic chart, with declinations mapped in. Thus, on such a chart a line of equal declination or an isogonic line would form sometimes half an ellipse, in others an ellipse entire, and, again, wavy lines extending from north to south of the globe. In England there is a difference of about 2½° between John o' Groats and London. Dover is 40′ less than London, Hull is 20′ greater; Newcastle, 1° 15′ greater; Edinburgh, 2° 5′ greater; Glasgow, 2° 25′; Liverpool, 1° 30′; Dublin, 2° 30′ greater. All geographical maps have geographical north only. The lines on such maps are, therefore, true meridian lines, and it is impossible to obtain any data from longitude tending to give you the magnetic meridian. Such can only be obtained by observation.—W. J. Lancaster.

[33346.]—**Equatorial and Lightning.**—It would be desirable to connect the top of the pillar to the exterior of the observatory, and to provide there an ordinary conductor point. The pillar, of course, to a certain extent, invites a discharge, if it is a tall one, and will do so still more if properly connected to earth; as a consequence, some injury might occur to the observatory roof. The danger which I referred to in previous reply would be at the foundation. The pillar, providing a shorter path than the air, tends to collect the electricity into that path, and then at the foot of the pillar there would be a violent discharge, and possible destruction of the foundation, and overthrow of the pillar, which a good earth connection would entirely prevent. If a good connection is made, it is of no consequence whether the wire is attached to the stone pillar or not, but it is always best to connect the conductor as much as possible to every part of an edifice it is meant to protect. There need be no difficulty about the revolving top, as a sliding contact piece, such as two tubes one within the other, could be used.—Sigma.

[33347.]—**Iron Battery.**—This is one of Callan's cells, and the best thing its owner can do with it is to employ it for holding sand or any other heavy object. The worst use he can make of it is to charge it, as it is intended to be, with nitric acid, and use it in place of a Grove or Bunsen.—Sigma.

[33347.]—**Battery.**—The sulphuric acid, unless concentrated, would certainly wear away the iron.—F. W. Woodman.

[33347.]—**Battery.**—The battery you mention is *Callan's or Maynooth.* The outer iron cell is to be charged with undiluted nitric acid, while the porous cell is to contain diluted sulphuric acid (commercial oil of vitriol) 1 part to 7 parts of water. If you use dilute sulphuric acid in the iron cell you will dissolve it gradually away, as the oxygen of the water will unite with the iron, forming oxide of iron, which at once combines with the sulphuric acid, forming sulphate of iron, while the liberated hydrogen escapes as a gas.—Owl.

[33347.]—**Battery.**—Your battery is a bad one, unless attended to carefully. It is one devised by Callan. To charge it, use in the porous jar sulphuric acid, 1 part; water, 10 parts; and, in the cast-iron jar, strong nitric acid. If you use weak nitric acid, the iron will be dissolved, and consequently the cell will be destroyed. When using it, and no fumes are given off, then all is right; but the moment you see fumes of a dusky red colour (poisonous) rising from the nitric acid, pour out the acid, well swill, and re-charge with fresh acid.—W. J. Lancaster.

[33349.]—**Running.**—If B. C. Acklam will practise running a quarter or half a mile once or twice a day for a month, he will find, at the end of that time, that he is much longer-winded than he was a month previous. Professional runners keep the head thrown well back and the mouth firmly closed while running, with the elbows close to the sides. Use the bath every morning, and avoid all intoxicants.—Fireman.

[33351.]—**Rifle Shooting.**—I have never heard the remark, but if I had I should have doubted it very much. I should be rather inclined to think the bullet would be longer coming to the water, because of the less sp. gr. of water compared with soil, and hence less gravitation. I have seen all kinds of firing from an ordinary rifle to the 81-ton gun, but could not believe there is any truth in the remark you state.—W. J. Lancaster.

[33356.]—**Qu.**—The reason, I believe, why the letters *qu* are not cast together in type is because the words in which they are used are so few that it would not be worth the trouble and expense of creating a new type, and there are also some few—very few, perhaps—words in which the *q* is used without the *u* (in French names, for instance), so that it would be necessary to retain the single letter as well as having a new one, thus making addition to the number of types already comprised in the fount, and which would only occasionally be needed. The value of combinations in type is very doubtful, or I should suggest that *ch* would be a much more useful one than *qu*; but if one be admitted there would be no saying where it would stop, until the compositor would need, perhaps, not one pair of cases but a good-sized rackful, and might eventually be as badly off as the Chinese compositor, who has to dodge about all day from one part of the room to another to gather together his types. But besides this objection of requiring more space, and entailing more labour and expense, thus neutralising the saving of time, if any, it should be remembered that if one letter of the combination becomes injured the whole piece would be useless, which would involve a greater loss than if a single letter could be thrown aside. In the early founts of type combinations such as *ct* were used, but they have been discarded. *When* we have our words spelt phonetically we shall need new types, but that is not likely to be just yet. —C. Lark.

[33356.]—**Qu.**—The reason these letters are not cast in one type may be found in the following:—1. If any portion became battered the whole is lost; hence a greater weight of type becomes useless. 2. The u tied to the q cannot be used in other places; hence a greater weight of metal would be necessary in a fount. Logotypes have never found much favour with printers, for the reasons above given. The existing types containing more than one letter—ffi, fl, &c.—are so cast to avoid battering or knocking the head off the f.—Typo.

[33362.]—**Telephonic.**—To Mr. W. J. Lancaster.—(1.) No battery of any kind is used with Bell's telephones. (2.) Place the carbon rod in a more inclined position; then the microphone will not be so sensitive to other sounds. When the rod is lightly resting against the upper plate the microphone is so sensitive that, unless the board on which it is screwed is isolated by indiarubber, wool, or other non-conductor, you will have a confusion from hearing too much at once. (3.) No, the same quantity of wire on each, but make the weaker magnet strong again by remagnetising it.—W. J. Lancaster.

[33362.]—**Battery Power.**—For such an object, which is simply the construction of an electro-magnet, small wires are not proper; moderately large wires are requisite—say, from No. 20 as the thinnest. One or two large cells of any common kind—such as the Smee, Bunsen, or bichromate—would give the power required.—Sigma.

[33363.]—**Battery Power.**—You cannot successfully do what you want. Only one or two of the opposite wires and those most out at first will be attracted, and with sufficient battery power be pulled out.—W. J. Lancaster.

[33364.]—**Blueing Steel, &c.**—Get an old iron saucepan, and fill it with sand. After a few trials with it you will succeed. The thing is to have sand enough to get a uniform heat.—Finem Respice.

[33366.]—**Raising Water.**—The querist does not appear to understand my hint that water will not lift itself on any persuasion. No siphon that was ever made would raise a teaspoonful of water one inch (excluding capillary action, which, inde raises, but will not deliver liquids). Siphons only conducting pipes, and deliver at a lower le External force equivalent to the work to be d must be expended. In some places irrigation effected by means of bridges over streams pivoted that every one who crosses pays toll lifting a certain weight of water. A flight of st might be so constructed that every one going up down would have to work a pump or a variety such schemes adapted to any given case might devised, only some one must do the work.—Sig

[33371.]—**Yacht Designs.**—Full "lines" of good 20-tonner were given in the *Rural Alman* for 1877 (I believe), published at the *Field* off price 1s.—I fancy this is exactly what you want Finem Respice.

[33376.]—**Measuring Focus.**—Place a card up a box perpendicular to the sun, then hold the lens the hand with the plane surface towards the s and measure the distance from the edge of the l to the card. When the sun's image is sharply def this distance will be the focus of the lens.—W. Lancaster.

[33378.]—**Works on Chemistry.**—Don't read editions of chemical works. You may read Ros and Williamson, then read Galloway, or Miller, V II., last edition. You will find most of these in a good library, if you have access to one.—W. J. Lan caster.

[33380.]—**Daniell's Cell.**—Copper is alw thrown down on the zinc as a brown powder, then it always sets up some local action, which, course, releases a little hydrogen. Amalgamation a disadvantage in the Daniell cell, except when a are used, and that should not be done. The act may appear less because the mercury takes up copper; but for that very reason it is really mischief.—Sigma.

[33380.]—**Daniell's Cell.**—Use dilute sulph acid in outer cell, and well amalgamate the you will not find any black stain then.—W. J. La caster.

[33384.]—**Microscopic.**—By placing your ins ment in a horizontal position, and using only objective (not higher than ¼in. for good definiti without the eyepiece, and, instead of the mirror, large condenser between the light and the object stage, the whole being inclosed in a box with aperture for the microscope body, you may pro the image of any size on a screen, according to distance it may be placed from the apparatus, by using a prism at the end of the body placed the same position, throw the image down on a s of paper.—C. J. B. F.

[33384.—**Microscopic.**—You can get a fair 4½in. diameter by using the microscope as it is, arranging it horizontally, and having a conde lens in place of mirror, and a good petroleum solar gas light; this must be nicely arranged, then a fair image will be obtained. I am just constructing a simple form of demonstrating mi scope to cover a 12in. disc. When done I will g working details.—W. J. Lancaster.

[33394.]—**Piano.**—It does not at all follow, b cause the treble strings sound clearly when plac that they will do so when struck; but, as it se the treble was all right till lately, it is probable action has sunk, causing the hammers to strike low. To determine this, raise the treble stand by placing a card or two beneath it, so that hammers just clear the top bridge pin. If this s ceeds, the back of the keys can be raised in same proportion, or the hammers might be cast by placing a hot iron behind the stems, and bendi them over it. Examine if the top bridge is rig and that the soundboard has not sunk with too m down bearing.—W. H. Davies.

UNANSWERED QUERIES.

The numbers and titles of queries which remain un swered for five weeks are inserted in this list, and if unanswered are repeated four weeks afterwards. We t our readers will look over the list, and send what informat they can for the benefit of their fellow-contributors.

Since our last Wm. John Grey has replied to 3 J. E. Okill, 32701; "Finem Respice," 32791.

32811. Basso, p. 201.
32814. Emery Stones, 201.
32820. Electrometer, 201.
32831. Toy Balloons, 202.
32832. Exhaustion Valves, 202.
32834. Disconnecting Compound Engines, 202.
32849. Matt Size, 202.
32858. Steam Boilers, 202.

33025. Electrical—Induction, p. 301.
33030. Nitrate of Copper, 301.
33032. Horse-shoe Stall, 301.
33033. Clockwork Mice, 301.
33058. Boilers, 301.
33063. Flint on Crystal Glass, 302.
33071. Cigarette Making, 302.
33072. Tanning, 302.
33076. Length of Curve of Arch, 302.
33079. To Watch Jobbers, 302.
33080. Loco. Slide Valve, 302.
33082. Viewing Transit, 302.

QUERIES.

]—**Jupiter.**—To Mr. Herbert Ingall.—May
rough these columns if that gentleman would
ok up Jupiter about the time of his opposition
large dialyte, and kindly tell us the colours of the
., as seen with that instrument?—Frank C.

]—**Coca Leaves.**—Can any fellow-reader tell
o make a liquid preparation of the above to keep
time?—Rex.

]—**Hysteria.**—Can any one recommend a
t for the above complaint—one that is worth
r I have tried so many without effect?—Suffer-
er.

]—**L.N.W.R. Engines.**—What is the trac-
e of the engines of the "Precedent" class?
the tractive force and size of cylinders of the
h" and "Umpire" class? How many engines
Caithness" class are there? What is the trac-
e of the "Lady of the Lake" class, and when
newest of this class built? Are there any single
uilt since 1870? What classes of engines run the
nail between Rugby and Carlisle, also between
and Edinburgh and Glasgow?—Willesden.

]—**Pith Balls.**—Will some reader tell me what
he best for getting pith for pith balls for electri-
lectrician.

]—**Regulating the Heat of Gas.**—I
glad if any of our correspondents would give
n for regulating the heat of gas in a small cham-
t 3ft. square to keep it within a few degrees of
O.

]—**Crucibles.**—Will some one give me instruc-
nake crucibles, &c., of about one pint capacity,
na clay or pipe clay? I have tried mixing
clay with water, and then drying in the oven
ory to burning, but they always crack in pieces
the oven (an ordinary kitchen one).—Ambitious.

]—**Distillation of Tar.**—I should be greatly
some one would give me a few hints on the dis-
of tar, &c., giving the several products and uses
Is there any cheap work published on the sub-
mbitious.

]—**Steam Yacht.**—I have a small yacht with
sure cylinders. I am all right when running in
er, but if I run forty or fifty miles out to sea I
red with salt water. I am thinking of making
nes surface condensing. I shall save coal by
nd condense water, but shall I be able to keep
ter losing the powerful blast of the exhaust in
? Will any of "ours" give me their opinion,
had no experience in condensing engines?—

]—**Nitric Acid Stains on Cloth.**—How
ove the brown stain caused by nitric acid from
ured cloth?—Aquilarius.

]—**Lantern Spectroscope.**—To Mr. Lan-
Would you kindly oblige by giving a description
trument, suitable for use in a large lecture-hall?
say if he considers the pyro-hydrogen light
enough to use with it, condenser 4½in.?—F. C. D.

]—**Zincography.**—Many thanks to Mr. E. A.
his reply, but may I ask him to oblige me with
ing information? 1. Should the gum-water be
h phosphoric acid as per formula given in letter
. 656? 2. What strength should the gum-water
esume it is ordinary gum arabic; if not please
uld it be thin or thick, or what proportion of
water should be mixed together? 3. Should the
r "gumming up" be allowed to dry before
Will he give particulars of the anastatic process?
?.

]—**Bicycle Tire.**—A friend of mine riding
eep hill on a "Stanley," with front wheel spoon
hich had become worn through that day, found
is that it had cut into the indiarubber tire all
Would any one kindly say whether it would be
reverse the tire, or if there is any cement that
the cuts permanently?—Tangent Amateur.

]—**Water Raising.**—I have two aquariums,
above the other. I shall be obliged for any
ns from your readers as to how I can raise the
m the under tank back into the one overhead by
a jet of water from the upper one.—W.
.

]—**Mortising Machine.**—Would any kind
l me the principle of the mortising machine?
t by boring with a centre-bit or by chisels, as I
nake one very much? A diagram of the above
atly oblige—Mortise and Tenon.

]—**Chemical.**—Can any one inform me if
luble in any liquid?—F. W. Woodman.

]—**"Jenny Lind" Engines.**—Will some
ersant with the subject of locomotives please
cription of this class of engine? I believe there
se on the North-Staffordshire Railway a few
ce.—R. N. H.

]—**L. and N.W. "Bloomer" Engines.**
bliged to "Murano," p. 398, for his reply to this
t I think he has either misunderstood me or else
is answer incorrectly. I had an idea what the
r" engines were like, but I wanted to be sure.
new class of engine (new to Manchester traffic) has
ning the 2 p.m. London train from London.
d the description given to me agrees with the
eviously had—viz., inside cylinders, inside fram-
the wheels, flush boiler, with valve and dome,
" over the foot-plate. I suspect they have now
rs. No. 847, "Odin," was one of them.—R. N. H.

]—**Soda-water Machines.**—Will some one
details for making soda-water and lemonade?
know the detailed construction of soda-water
as sold in shops, shaped something like a double
Upon what principle do they act, and how
&c., as I should like to make one? How is the
acid generated?—Ambitious.

]—**Professor Adams' Discovery.**—Would
mber of the Royal Astronomical Society kindly
it was that Prof. Adams explained on the black-
board at the meeting of the R.A. Society on June 14? The notice of the meeting in the English Mechanic for June 21 states that "Prof. Adams explained a remarkable property he had discovered of the analytical expression for the constant term in the reciprocal of the moon's radius vector, or what is commonly called the constant term of the moon's horizontal parallax."—J. E. A.

[33431.]—**Tables of Weights and Symbols.**—Would "J. M. W., Manchester," Mr. Allen, or any other contributor inform me whether tables are published giving the molecular weights and symbols of the commonly occurring chemical substances—such as potash, alum, aluminic phosphate, baric sulphate, argentic nitrate, &c., &c.? What is the chemical formula or symbol for aluminic phosphate?—Orfila.

[33432.]—**Faulty Silver Solution.**—I have a silver plating solution which gives a good deposit, but whether I work with little or much battery power it will scale off. I made the bath by dissolving silver in a cyanide solution by electricity.—A. T. N.

[33433.]—**Battery Carbon Blocks.**—How can these be rejoined when broken so as to withstand acids? Some gas carbon I have sawn into blocks smears my hands with a kind of black-lead. How can this be remedied? It seems pretty hard—in fact I spoiled two small saws in cutting out two blocks.—Sylvester.

[33434.]—**Sanitary.**—Could any reader inform me what action and cause water has upon lead—both spring and water caught from roofs—as I understand water in some districts eats through the lead cisterns in a very short time? Is it possible by the constant supply system for water conducted through lead pipes to be injurious for drinking purposes, caused by the action of the water on the lead? What is the least fall a river should have to be self-cleansing? Also I want a simple method (other than by algebra) of calculating the discharge of any sewer or drain, size and inclination being given.—J. H.

[33435.]—**Gas Engines.**—It is known that in the best constructed steam engines only about 10 per cent. of the total heat value of the coal is utilised or converted into work. Has it been ascertained what amount of the heat value of gas is utilised in the various gas engines now in use?—B.

[33436.]—**Gelatine.**—I have seen buttons, &c., having the appearance of horn of various colours, that are said to be made of gelatine, hardened and rendered insoluble by admixture of bichromate of potash. Can any correspondent inform me of the best proportions of those substances, in order to make articles of greater bulk, such as handles, &c.? All the accounts I have seen (which are applied to photography) say that the surface of gelatine and bichromate is to be exposed to the action of sunlight to render it insoluble and horny. This, no doubt, is sufficient in cases where the surface is thin and transparent; but where the object is of greater thickness, and opaque, it does appear to me that the surface only will be acted on by the light, and rendered horny, leaving the interior a mass of unchanged gelatine. Is there any means of rendering the gelatine horny, independent of the action of light, or of continuing the change, after having been begun by the action of light?—B.

[33437.]—**Tempering Coned Springs.**—Having made a spring in the form of a cone I am at a loss to temper the same, and should be obliged if any of your numerous readers would enlighten me upon the best method?—W. A. S.

[33438.]—**House Electric Alarm.**—I have lately moved to a house which is very much exposed, both back and front. Several of my neighbours have had their valuables "borrowed," and, in order to prevent a like catastrophe, I am anxious to fix an electric arrangement to the outer doors and windows to ring a bell in my bedroom. A few suggestions as to the most effectual and modern method of doing this will be much esteemed. I may mention that I propose to do the work myself, being accustomed to the handling of tools.—Jonah.

[33439.]—**Painting Bath.**—I have two baths which require painting. One is zinc, and has never been painted; the other has been painted, but wants renewing. I don't know if the latter is zinc or iron. Could any one kindly say how I could do them? Should I have to take the old paint off before painting? If so, how? and should I clean the zinc one before doing the painting? If so, which is the best way to do this? I should like to know the ingredients for the paint, with the different proportions. Also could I put something in the paint, or to use after painting, to put a kind of enamel on to make a nice finish?—Arturo.

[33440.]—**Swelled Fingers.**—I shall be glad if some medical reader can tell me if iodine would be of any use for taking down the swellings on my fingers, caused by rheumatism, which I have had severely several times?—Hesper.

[33441.]—**Reflector.**—Is a complete covering of waterproof cloth thrown over a 6in. altazimuth reflector, placed in a garden, a sufficient protection against the weather if the speculum is removed into the house when not in use? The diagonal reflector at the mouth of the telescope, as well as the telescope itself, has a tight-fitting brass cover.—Alpha.

[33442.]—**Moulton's Rapid Photo Washer.**—Could any brother reader, having a knowledge of the best working machine, named above, kindly give a drawing, with sizes and description?—J. A.

[33443.]—**L. and N. W. Engines.**—Could "Egeria" or "Murano," or any one else, give me the names, with respective numbers, of the engines between Robert Bewson, 2,176, and Buffalo, 2,181? Are there any other engines besides the Amazon, Balmoral, Meteor, and Penrith Beacon, with the arms of the company painted on them? Have the Sir Salar Jung and American Isle got them on? What is the name of 859? Are there any more of that class, or is 858 the first one? Have the engines between 872 (Wizard) and 883 (Phantom) been rebuilt; if so, what are their names? Have any of the 11 hundreds been rebuilt besides Hercules, 1,105?—Tamerlane.

[33444.]—**Galvanised Cast Iron Laundry Boilers.**—I should esteem it a great favour if any of your readers could suggest some means of making the above perfectly useful. I got one, thinking to obviate the liability to "iron-mould" shown by some cast-iron boilers, and find that the remedy is worse than the disease. The grease in the soap appears to have some affinity for the zinc, and adheres to it to such an extent in the neighbourhood of the water-line that it is impossible to prevent the clothes getting daubed with it. I have conjectured that it may be due to some galvanic action or condition, and if so, might be remedied by introducing some counteraction, but I can get no further. Even if simply a chemical action between the zinc and soap, aided by heat and water, you might still be able to suggest a remedy.—Zinc.

[33445.]—**Determination of Blood to the Head.**—Can any of our readers say what to eat, drink, and avoid when suffering from this complaint? Also is it wise to abandon the morning cold bath? I consulted a medical man when first the symptoms appeared and he told me never to take another cold bath. This is a great punishment, as I have been used to it every morning for years. Was he right?—F. U.

[33446.]—**A Molybdenum Compound.**—A stoppered bottle of ammonium molybdate (solved by aid of HNO_3), which has stood unused for about two years, has deposited some bright yellow crystals. Can any one say what they are likely to be (strength of solution, 1 in 20)? The crystals resemble gold chloride. That they contain Mo is shown by heating a crystal with a drop of H_2SO_4 on platinum; by breathing on the moist residue a lovely blue colour was produced. Phosphoric, arsenic, and silicic acids all give bright yellow precipitates with ammonic-molybdate, but neither of the two former was present, nor are the crystals like phospho-molybdic acid. My suspicions light on the silica of the bottle, and the stopper was tight in, as if the glass had been acted upon by the solution.—Daghbert.

[33447.]—**Blacking.**—I want a blacking that will polish over grease or dubbin. Can any of your readers supply me with one?—Quercus.

[33448.]—**American Organ.**—Will "Organon" give the items of necessary expenditure for an amateur to make, say, a one row or one and a half row American organ? I am tired of the miserable drone of the harmonium and want something better. Can it be made as cheaply?—Nemo.

[33449.]—**Russian Tansy.**—Can the powder of the Russian Tansy be bought retail in this country? It is used for insect powder, and is charged for accordingly.—Sabbas.

[33450.]—**Cleopatra's Needle.**—The needle has formed the subject for a number of penny-a-line paragraphs, but can any one explain the meaning of the following, which I take from the *Times*?—"The 68 feet or so of the obelisk are divided by its centre of gravity, and at the centre of its destined base, into two unequal segments, of 28ft. and 40ft." What has the centre of its destined base to do with it? Is it true that the needle is to be beautified, the inscriptions recut, and the whole thing polished? If so I think it a pity that Prof. Wilson and Mr. Dixon are not compelled to take the useless "ornament" and put it in the museum. After all we have heard of the needle, a sight of the thing is enough to quench all faith in "antiquities." Its sole value is as a specimen of Egyptian work, and this is to be destroyed by the chisels of Englishmen.—Nemo.

[33451.]—**Water Power.**—I shall esteem it a favour if some brother reader will give me a little information. Within ten yards of my shop is a river, about 9ft. wide and 3in. deep in the shallowest places in a dry summer. How am I to get this stream to turn a drill and a lathe at the same time? I shall not want it to do more than that; I cannot get much of a fall to it. If there is a sort of water-wheel invented for such a place, I should be greatly obliged by information.—R. E.

[33452.]—**Management of Trains.**—Can any brother reader inform me the shortest distance within which a train travelling at the rate of forty miles an hour can be pulled up on the level, without reference to gauge, weight, or brake power? Of course all these would have a material influence on the distance, but I want to know, without taking them into consideration, the shortest distance in which a train can be stopped travelling at that rate.—P.

[33453.]—**Explosive Force.**—What is the reason that a bottle filled with water, and with the cork driven in tight, will not explode when put on the fire till the water has boiled; and that when brought in contact with cold water it is certain to explode? I am quite sensible to the fact that under ordinary circumstances it would have exploded on account of the cork being in, and the pressure of the steam against it; but why it should have exploded under the circumstances I have stated, I am at a loss to understand, and hope some brother reader will assist me.—W., Aston.

[33454.]—**Hair Work.**—Will some readers give a little information on hair work? I have some hair I wish to put in the form of a nice curl into a brooch on white ivory ground. I do not know how to proceed, or what tools to use.—I.

[33455.]—**Tinning Cast Iron.**—Is it possible to tin cast iron for soldering to rain-water pipes, &c.? Will some practical reader give information?—A. P.

[33456.]—**Heating Kilns.**—What simple and inexpensive method is there of ascertaining the different degrees of heat in a kiln used by potters, as to whether the kiln is at the right temperature for firing ware?—S. W. R.

[33457.]—**Flux.**—Will some reader describe a good flux for melting scrap zinc which will prevent it curdling and render it solid when cast?—Inquirer.

[33458.]—**Frosted Watch Plates.**—Will some brother-reader inform me how gilders frost watch plates?—H. P.

[33459.]—**Alumina.**—Will some correspondent explain an easy and economical process for the production of alumina?—P. S. J.

[33460.]—**Walking Sticks.**—Will some kind reader name the best time for cutting branches for walking-sticks, &c.? What is the kind of apparatus employed for bending and straightening them; and is steam or boiling water used for rendering them pliable?—L.

[33461.]—**Turner's Cement.**—Will some reader give me a receipt for good and cheap turner's cement, and say if it will hold small flat pieces of brass while being turned?—V. R.

ANSWERS TO CORRESPONDENTS.

◆

*** *All communications should be addressed to the* EDITOR *of the* ENGLISH MECHANIC, 31, *Tavistock-street, Covent Garden, W.C.*

HINTS TO CORRESPONDENTS.

1. Write on one side of the paper only, and put drawings for illustrations on separate pieces of paper. 2. Put titles to queries, and when answering queries put the numbers as well as the titles of the queries to which the replies refer. 3. No charge is made for inserting letters, queries, or replies. 4. Commercial letters, or queries, or replies are not inserted. 5. No question asking for education or scientific information is answered through the post. 6. Letters sent to correspondents, under cover to the Editor, are not forwarded; and the names of correspondents are not given to inquirers.

The following are the initials, &c., of letters to hand up to Tuesday evening, July 9, and unacknowledged elsewhere:—

LONDON BICYCLE Co.—Edward Day.—G. H.—New Subscriber.—Willows.—T. Lichtenstein.—E. P. Johnson.—L. Letherbrow.—W. Pouny.—J. R. Wilson.—Douglas Bros.—Dr. Coppinger.—Firth and Co —J. Peppiatt.—J. McLaren.—W. L. Wise.—Leigh Clifford.—J. Gillott.—R. Mill.—W. Rogers.—A. B. Wilbraham.—E. E. Browse.—Cupola.—Candidate.—J. F. H. Edwards.—Pioneer,—Dr. Syntax. — Seconds' Practical Watchmaker. — Mytholmroyd.—Joseph Jewsbury.—T. B.—Americus.—Penderella.—J. L.—Diapason.—J. Probert.—Eldnar.—C. S.—Lyons.—Llewon.—E. W. A.—C. J. Leaper.—Joiner.—Exon.—R. J. Theakston.—F. W. S.—R. H. G.—A Physician.—Aug. F. Perren.—W.—Chas. Robinson. — 8½in. O.G. — D. Strathearn.—Tsenre.—Sartor.—W. P. Iron.—W. H. B.—A. H. S.—A.—Carlos.—E. Harold Grey.—N. Sirch.—B. Snooks.—J. B. H. T.—A Handy Man.—Immit.—Waterlogged.—Pimpernel. R. P. G.—Penance Point.—Emu Park.—Robert Wark.—I. F. Ballard.—Poor Musician.—R. E. F.—M. Sullivan.—John. — Enquirer. — Gelatine.—Horace.—Field-Gunner.—F. J. Jackson.—J. G. P. C.—W. B.—Owen Jones.—F. C. Dennett.—Finem Respice.—B. Boothroyd.—J. A. P.—Daghbert.—Daghbert's Gouvernante.—T. Fletcher.—Carolus.—Financial Agent.—Theo. Izod.—W. S. Travis.—Charles W. Quinn.—Bartlett.

F. G. LL. (The north pole of a magnet, or that end which points to the north when the magnet is freely suspended, is the one usually marked as the positive pole.)—E. SMITH. (The double-headed rail is preferred because it has vertical strength, is easy to make, can be reversed, and can be efficiently joined. The L. C. and D. R. was laid with flat-bottomed rails, but they are either replaced or being replaced with the double-headed. The Vignoles rail, as the flat-bottomed is called, is, however, largely used elsewhere than in this country. See p. 265, Vol. XXIII.)—AMBITIOUS. (A reply to your query about the uses of chemical products would occupy an entire number. Consult Ure's "Dictionary.")—MERCURIO. (The resistance does not increase at all.)—SIDUS. (1. Partly true; but the volcano is hardly to be seen in "full eruption." That is an addition due to the exuberant fancy of the journalist whose communication you inclose. See Mr. Birt's article in our last number on page 407. 2. Get Mr. Proctor's "Small Star Atlas," published by Longmans.)—C. E. S. (We hardly think it worth while to go to the expense of engraving the slotting machine. It has already appeared elsewhere, and seems to be an electro supplied by the makers, who should avail themselves of our advertising columns.)—W. R. S. (See Useful Note on p. 252.)—METEOROLOGIST. (Your requirements are very vaguely expressed; if you will say what branch of the subject you wish to study we will try and advise you.)—DYSPEPTIC. (You should certainly avoid the milk.) — GRIFFIN AND NORRIS, Halifax, N.S. (We have applied to several of the best English tool makers, and they cannot recognise the tool from the description you give, which is certainly very vague. If you would write more plainly we would insert a query. We cannot undertake to select or forward tools to foreign subscribers.)—DYER. (The grains are those of the Cassia Tora or Tagerey Verey. They are used in the East Indies, Arabia, and Japan, as a component of the indigo vat in dyeing, for the same purpose apparently as the bran, madder, or molasses, used in Europe.)—J. D. R. (Brandon is the only place we know of where gun flints are now manufactured in England; there are possibly others, but the produce must be trifling. Those made at Brandon nearly all go to West Africa, South America, and Russia.)—J. MARNER. (A good orange tone may be given to oak as follows:—Melt together 3 ounces of tallow, ½ ounce of wax, and 1 pint of oil of turpentine. This must be rubbed into the wood till it acquires a dull yellow polish. After resting an hour a coating of thin French polish is applied, and the mixture again used, the processes being repeated alternately till the desired tone is produced.)—W. J. MORRIS. (In excavating loose ground a man can throw up about 10 cubic yards per day; but in hard or gravelly soil half the quantity is reckoned a fair day's work.)—M. SULLIVAN. (Directions for making artificial ivory were given on p. 95, No. 524; p. 463, No. 486; and p. 625, No. 492.)—DISSATISFIED. (The concern does not certainly promise well as an investment, and the refusal of permission to transfer your shares is not reassuring. Have you paid all the calls due on the shares? If not, you are not entitled to transfer.)

R. S. H., Edwin, H. S., In the Dark.—See indices to back volumes.

PLYMOUTHIAN, David, T. F. B., Toolman, Ajax.—Your queries are advertisements.

J. H. L. SURGEON, F. W. Woodman, Willows, Lossit, Leith, W. R. S., Black Witch, Novus Homo, G. A. P., Finem Respice, Cantab, R. E. S., Pedestrian, and others have replied to queries already similarly answered.

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English Mechanic
AND
.D OF SCIENCE AND ART.

FRIDAY, JULY 19, 1878.

ARTICLES.

NTARY SCIENCE IN SCHOOLS.

ebate in the House of Commons on
J. Lubbock's motion discloses a
; has been frequently demonstrated
:he past few years—viz., that the
ient needs but to lead to have a
following. The motion was an
.ly simple one, and would have in-
:he addition of three words to
l9, Clause 1, of the Code of Educa-
t Lord George Hamilton, by some
misconception, regarded the matter
f vast importance, and opposing the
found 68 supporters against the 37
. Lubbock. The latter thinks it
e desirable to modify the code by
elementary natural science as one
ubjects paid for, and the question
such a subject should or should not
:d scarcely admits of much argu-
At present the sum of 4s. per
is granted for passing creditably in
ır, history, elementary geography,
n needle-work, and, as a matter of
t year only 600 children passed in
er subjects than those mentioned.
, geography, and grammar, are, no
iecessary subjects to take up in any
of education, but surely no one will
; an elementary acquaintance with
nomena of every-day life is not as
rth 4s. as geography or grammar,
history. It is true that many of
er class of schoolmasters do take up
and give lectures to their pupils on
my, electricity, sound, light, heat,
ietimes, though rarely, geology and
raphy; but these subjects are
p at irregular times, and, as a rule,
hich admit of the performance of a
tractive experiments are chosen.
iasters know the value of these lec-
they promote discipline, and bring
dmaster into more intimate contact
s pupils. A knowledge that exclu-
m the science lecture will follow bad
ur has a more deterrent effect than
e cane; and Sir J. Lubbock was not
g without definite knowledge when
the House that he could prove, by
it abundant testimony from many of
; schoolmasters, and of our most able
ors, and by the actual cases of
in which the experiment had been
iat science, properly taught, was most
:ive and delightful to children. Let
membered that he was not proposing
e science obligatory, but only to give
ool authorities the option of taking
and the opposition he met with
s extraordinary. It is not intended
h electricity, astronomy, or any other
, but merely to bring to the notice
:hildren the received explanations of
enomena of nature—why it rains,
or hails; the cause of night and day,
mer and winter; how a plant grows;
use of lightning and thunder—in
is the Germans call it, Naturkunde
ledge of nature. Nothing very pro-
:an be expected from children, but it
ly as useful for a boy to know that an
of the moon is caused by the earth
g between our satellite and the sun,
for him to be able to give offhand
itude and longitude of Constanti-
r the date of Henry's VIII.'s accession. Dr. Playfair declined to call the subjects elementary "science" because he thought it frightened the ratepayers, but preferred to speak of them as elementary knowledge. There is no doubt that he is right, for otherwise intelligent members of School Boards lose their heads when it is proposed to give only "science" lectures, while others exhibit an unworthy fear of "giving too much education," as they express it. It is abundantly evident that the Education Act will not work well in this country until the members of the School Boards are themselves educated; and technical education cannot be expected to progress as it should, until our children are taught the elements of natural knowledge. It is remarkable that out of sixty-eight members who voted against Sir J. Lubbock's motion no one said a word against it, with the exception of Mr. D. Davies, who thought that elementary science should be taught as an extra provided for by voluntary subscription, and Lord G. Hamilton, the member of the Government who would have the responsibility of carrying it out. The latter showed, in a really ludicrous manner, how utterly he failed to grasp the bearing of the motion; and if the House itself were not lamentably ignorant of elementary science, portions of his speech would have produced a very widely broadening smile. Lord George stated that, to accept the motion, it would be necessary to remodel the whole of the code, and then asking the question, "What was natural science?" he said, "it was very well for the hon. baronet to say that he did not mean anything difficult; but at the rooms of the Royal Society, which was established for the promotion of natural science, he found lectures had been delivered in biology, chemistry, natural history, mechanics, astronomy, mathematics, and botany." It is, perhaps, not a matter for wonder that the official obtuseness which imagines the Royal Society to be a sort of school, should reject Sir J. Lubbock's motion because the "subject was so wide that teachers might give instruction in almost any conceivable subject, and unless the House was prepared to add very largely to the educational expenditure, it would be impossible to add natural science to the subjects taught." We have no doubt that Lord George Hamilton made his extraordinary statement in perfect good faith, and really believed what he said; but before next session it is to be hoped some judicious friend will relieve his mind as to the "responsibility" which he seems so much afraid of, and induce him to adopt the proposal of Sir J. Lubbock. Mr. Forster gave him the lead by saying that it would be desirable to place the teaching of elementary science alongside of grammar, geography, and history, and his refusal to adopt that expression of opinion is only explicable on the assumption that Lord G. Hamilton believes the proposal to be impracticable.

THE AGE OF THE EARTH.

IN a paper entitled "Notes on Physical Geology," which was read during the last session of the Royal Society, the Rev. Prof. S. Haughton, M.D., endeavoured to furnish a geological proof that the changes of climate in past times were not due to changes in the position of the pole, and by way of a sequitur he gives reasons for believing that the whole duration of geological time may be a minimum of two hundred millions of years. The various points of the hypothesis are worked out in a manner that might be expected from the Professor's well-known erudition and skill, and his conclusions will undoubtedly bear a great deal of criticism, and will require some convincing arguments to upset them—at all events, so far as regards his geological proof that changes of climate were not caused by changes in the position of the pole. The minor limit of geological time is deduced from the following considerations:—If the localities of the Arctic fossil remains are examined, and their relations to the position of the present North Pole carefully considered, we can demonstrate, says Prof. Haughton, that the hypothesis of a shifting pole (assuming it possible mechanically) is inadmissible to account for changes in geological climates, and that the pole has not sensibly shifted its place during geological periods. That being so, the conclusion follows of necessity that geological climates are due to the combined cooling of the earth and sun, and, on comparing the rates of cooling of the earth with the maximum measured thicknesses of its several strata, Prof. Haughton finds a remarkable proportion between them, leading to the conclusion that the maximum thicknesses of the strata are proportional to the times of their formation; whence he obtains the data from which he deduces the 200,000,000 years. Fossils of animals and plants now tropical, or which required for their existence a minimum temperature far in excess of that prevailing in high latitudes within the historical period, are found in various parts of the Arctic regions, and in such positions that it is impossible to explain their occurrence by any change in the position of the earth's axis. M'Clintock found in Prince Patrick's Island, latitude 76° 20′, tropical fossils of Ammonites, Monotis, Pleurotomaria, and Nucula, while Sir E. Belcher, at Exmouth Island, and Capt. Sherard Osborne, at Bathurst Island, found respectively fossils of Ichthyosaurus and Teleosaurus. The latter was a reptile closely resembling the gavial of India, which is found nowhere outside the tropics, and requires warmer water than the alligator which flourishes in the neighbourhood of New Orleans, where the mean annual temperature is about 68° Fahr. But reptiles, which we know required such a climate as is represented by those figures, lived in the Jurassic period within 900 miles of the North Pole, where the mean annual temperature is now little above 1° Fahr. Species of Nautilus, Ammonites, Ceratites, and other mollusca have been found fossil in the Triassic beds of Spitzbergen in latitude 79°, while Ammonites, Belemnites, Pleuromya, and Monotis have been found in the Jurassic and Triassic beds near Cook's Inlet, Alaska, latitude 60° N. Prof. Haughton says that it is not possible to explain the occurrence of tropical animals in those three localities by any change in the position of the earth's axis, and he proves his statement by drawing a great circle joining Spitzbergen with Cook's Inlet. This circle passes nearly through the North Pole, and, in order to give a tropical climate to the places named, the pole must be displaced at right angles to the great circle along the meridian of 117° E., nearly that of Peking. The difference of latitude between Spitzbergen and New Orleans is 45°, so that, to make the Arctic regions tropical, the pole would require to be shifted to about 300 miles north of Peking. The South Pole would then have occupied a position about 1,000 miles to the S.S.E. of Valparaiso and the Chilian Andes, where Jurassic strata have been found in latitude 34° S., containing the tropical Ammonites biplex, which is also found in Alaska and in South Austria. That latitude would, however, be within 700 miles of the South Pole, if the earth's axis were shifted as suggested, and the occurrence of Jurassic ammonites in the Chilian Andes is therefore, according to Prof. Haughton, proof that the earth's axis of rotation cannot have changed, even if it were possible that it could change to the extent required.

Regarding now the climate of the Arctic regions during the Miocene tertiary period, there is abundant evidence to show that the northern parts of America and Europe-Asia had a nearly common forest vegetation with a temperate climate. The lignite beds which indicate the existence of this vegetation are found in Greenland. Grinnell Land, Spitzbergen, Alaska, and Mackenzie River, between the parallels of 60° and 82° N. The genus Sequoia (redwood) is represented in all those localities, and one species is very near the Californian representative which flourished during cretaceous times in North America, and still lives in California. In the miocene beds of Spitzbergen two species of Libocedrus are found, one of which is still living in California, while the other is found in the Chilian Andes. Other genera discovered in Alaska and Spitzbergen show, according to Prof. Heer, that the mean annual temperature could not have been much less than 48° Fahr., whereas the existing temperature of those places is little, if anything, above zero. To give them a sub-tropical climate it is found, by drawing a great circle joining the Mackenzie River and Spitzbergen, that the pole must be moved, at right angles to the arc, away from Greenland through 30°, when it will be found to have reached a point close to Yakutsk, within 800 miles of the Peninsula of Kamschatka and the Island of Saghalien. But those places contain miocene coal-beds requiring a climate which must have been impossible if the pole had so shifted. It is safe, therefore, on such evidence alone to conclude that the earth's axis of rotation has not shifted its position, and that the changes of climate have been brought about mainly by the cooling of the earth. The fossils found in Arctic regions afford no evidence of any cooler climate having prevailed there, although many proofs exist of warm and even high temperatures in those regions; accordingly Prof. Haughton gives us a thermometrical scale of the earth's life, which commences with 212°, boiling water, and its next stage is 122°, the temperature at which albumen coagulates. The interval between those corresponds to the azoic rocks, and that between 122° and 68° (the triassic and jurassic periods), to the palæozoic rocks. The neozoic rocks are represented on the scale by the interval between 68° and 48° Fahr., the miocene tertiary period. These temperatures are sufficiently well marked by the stories of the rocks, for until the temperature had been reduced below that of boiling water no stratified rocks could have been formed, and no life could have existed until the heat ceased to be sufficient to coagulate albumen. The plants and animals found in the Arctic regions are self-registering thermometers, and the present temperature we know by experiment, so that the successive epochs are indicated with tolerable accuracy. The rate of cooling of the hot earth suspended in cold space is not known, but the law of such cooling is; and, by calculating with the proportions of the intervals above mentioned, Prof. Haughton finds that the following represents the percentage value or duration of the three periods:—

Azoic (212° to 122°)	...	33
Palæozoic (122° to 68°)	...	41
Neozoic (68° to 48°)	...	26

Taking now the best table that can be procured of the thicknesses of the various strata in Europe, and converting the maxima into percentages, they conincide, when compared with the percentages found from the theory of a cooling globe, in a remarkable manner. Thus, calculated from the thickness of strata, the Azoic period is represented by 34·3 per cent., the Palæozoic by 42·5 per cent., and the Neozoic by 23·2 per cent. The remarkable these figures tends to justify the principle supported by many geologists—that the proper relative measure of geological periods is the maximum thickness of the strata formed during those periods. Carrying the calculation further down—that is to 32° Fahr. (the climate of Labrador), the percentage number between 48° and 32° Fahr. is found to be 32, a result so important that Prof. Haughton deduces from it the following propositions:—1. A greater interval of time now separates us from the miocene tertiary epoch than that which was occupied in producing all the secondary and tertiary strata from the triassic to the miocene epoch. 2. The enormous interval of time that separates us from the miocene epoch affords ample opportunity for the development of the gigantic mammals which are commonly supposed to have suddenly made their appearance on all our continents and disappeared as suddenly. Prof. Haughton concludes that the present condition of the earth's surface is profoundly different from its condition in the geological periods when climates depended chiefly on the internal heat of the earth, and not on that of the sun. That last sentence appears to contain the basis of Prof. Haughton's theory, and if we agree that the temperature so far from rising and falling, fell steadily until it reached 0° Fahr., the phenomena of the fossil fauna and flora of the Arctic regions are satisfactorily accounted for. It will be seen that the fact, that a much colder climate than exists in Britain once prevailed here, does not touch the question, because those changes of climate occurred in geological periods when temperature depended upon the sun and not upon the internal heat of the earth. The age of the earth Prof. Haughton fixes by taking the mean rate of denudation of large river basins, that is, about one foot in 3,000 years, which would, considering the proportion of sea to land, silt up the sea-bottoms at the rate of a foot in 8,616 years. Then admitting that the manufacture of strata proceeded at ten times that rate in geological times, or one foot in 861·6 years, and multiplying by the maximum thickness of the stratified rocks (177,200ft.) we obtain 152,675,000 years, to which must be added one-third at least to bring in the period from the miocene tertiary to the time when the Parry Islands and Greenland had a temperature of 32° Fahr. We have thus a minimum of two hundred millions of years as the whole duration of geological time. It will be seen that the paper is an elaboration of the views expressed by Prof. Haughton at the last meeting of the British Association, and it will be interesting to hear what geologists and physicists will say to the "proofs" since brought forward.

THE ORGAN: A COMPREHENSIVE TREATISE ON ITS MANUFACTURE, PROCURAL, AND LODGMENT.*

By John Watson Warman,

Associate of the College of Organists, London.

PART I.—GENERAL TREATMENT IN MANUFACTURE.

[19, a] THE actual *Location* of the Hydraulic Motor is not a matter of very much moment. It is so very quiet and clean in its nature that it may—supposing there be no leakage, or what little there is properly led off—be placed almost anywhere, in the very drawing-room itself, if desired. One of Forrester's Engines (Duncan's Patent) was in 1874 (and exists to present time, so far as I know) placed thus, under a glass case, and caused no trouble. Certainly a drawing-room ornament in the shape of an Hydraulic Engine can command the merit of novelty.

b. Almost any nook or convenient place, therefore, may be used for the Water Motor;
the chief consideration being to have i
its work (that is, as near the *Feeder* as
it does not follow that that will be
Organ, see 7 b and c.). Where there
under the Organ this will do well for
of Engine, or it may occupy any space
Organ; if the Instrument be raised o
form sufficiently high to allow Bell
placed beneath (as so strongly adv
author (*see Dep.* of Gen. Abr.), the M
well be inside this said Platform along
Bellows.

c. Examples of Hydraulic Bellows-bl
common throughout the country. Inst
furnished by Holy Cross (R.C.) Churc
U.S., 70 Sou. Stops (two Engines
size); Manchester Cathedral (two
Durham Cathedral (three Engines), W
Cathedral (one Engine); Leeds T
(five Engines); Dome, Brighton (one
East Church, Perth, N.B. (one of D
Derby-road Chapel, Nottingham (on
can's); All Saints, Scarborough (Dun
Paul's Cathedral (three of Duncan's
College Chapel (two Engines); Cham
for Mr. Venables, of Taplow; Do.
Huggins, Upper Tulse-hill, S.W.; Do
Arundel, Esq., Downs Park-road,
(Duncan's); Melbourne Town Hall,
(three of Joy's); Rochester Cathed
Engines). Also at Mr. R. J. Smith
Goldings," near Hertford, one Engine,
stated as working at only 24lb. pressu

The Cincinnati (U.S.) Music Hall O
erected by Hook and Hastings, Bos
now the largest in America, is bl
Hydraulics, said to be the most powerf
engines ever made in that country.

d. As the "Duncan" is so highly
I repeat the full address—Forreste
Vauxhall Foundry, Liverpool. The tho
liability of the Firm may be considere

e. In America the use of Hydraulic
common enough, and for obvious reas

* * Steam Engine.

f. Description. The form of this M
well known to require any descript
regulation should be Automatic, as
Water Motor, but owing to the great
the "opposition surface" valve may
sidered *essential*. With reference to
Cylinders *see* next.

g. Attachment. First see Attac
Gas-Engine (17, d. and on). It is not a
necessary that there be a Crank-shaft
Piston motion, being reciprocal and co
in the Hydraulic), may of course be
direct as with that motor; but there is
very important difference, that the
which really means the Engine its
be carefully isolated from the Organ
kept outside in suitable Engine-ho
simple reason is, that an escape
near the Organ is out of question,
finally condensing into water it will
among the metal-work and done much
and even after condensation it is
nuisance, being not so much a wet as a
damp.

h. It therefore follows that when
shaft is dispensed with, the piston mu
Rod, which passes through the side o
as to act upon the Feeders without t
steam getting in at same time; and
obvious that this method is very inco
for any shaking or displacement of th
will tend to jam the rod passing thr
wall, and perhaps create sufficient i
friction to seriously interfere with the
the Engine—possibly stop it entirely.

i. The better way, therefore, is t
a crank-shaft of the usual kind (see W
e.), the said Shaft extending through
(the latter, in fact, receiving the Beari
and, of course, carrying a Band Fly-w
latter thus kept outside the Bellows
All now required is the connection wit
by means of Belt in the usual way.
now seem that one Cylinder would, wit
wheel, be sufficient; but this is not
case, owing to the comparatively slow
at least two Cylinders are always
to get past the "points." Observe,
Fly-wheel is adopted, the Automati
tion can do little more than cause

---

* All rights reserved.

iving, for the mere cutting off the steam can- ot possibly stop or even "slow" instantly, ring to the momentum of the Fly-wheel; but ith three Cylinders the Fly-wheel may quite fely be dispensed with altogether, and the iving made really Automatic. With this rangement the cylinder must generally be lowed in the crank-room; the Bellows them- lves, however, kept isolated by a floor pierced ly with the small slits required to allow the nnecting rods to pass through.

j. *See* also a little more in Description of ind Arrangements of large Instruments , e., and on).

k. For reasons which will presently appear it not worth while to go farther into the con- ruction of Steam Blowing, at all events here.

l. The three largest Organs in England are iven by Steam—viz., at Albert Hall, Alexan- a Palace, and Liverpool Town Hall. The first- med 21 H.P., the second 20 H.P.; these, how- er, can hardly be H.P. real (*see* Table of owers). The large Organ at the Roman tholic Oratory, Brompton, London, is also own by Steam (Bishop, builder). Mr. Holmes' ge Organ, at Regent's Park (Bryceson) is plied by a Steam Engine of 11 H.P. The ton (U.S.) Music Hall Organ, by Valcker, is own by a Steam Engine of 10 H.P. These all, I believe, ordinary Boilers. An example Gas-heated Boiler occurs at St. Margaret's, nham Massey, Organ by Gern.

m. The cheapest Steam Engines made, so far author is aware, are by Tittley, Alton Works, mingham, 1 H.P., £38 (believed complete); d Russell and Co., Talbot Works, Ormside- reet, Old Kent-road, London, S.E., 1 H.P., mplete, £43. For Gas-heated see Gen. Engine d Boiler Company, 8, Union-court, London, C., 1 H.P., £56. *See* also Bought Portions, (own *Dep*).

* * Weight Motor.

n. This is a kind very little used, simply on count of the small amount of power obtain- le, unless a short period of action (or driving) sufficient.

o. There is no exact way of making this otor—a Drum with a train of Wheels termi- ting in a light Fly-wheel, on which, when llows are full a brush drops noiselessly, are obvious features. Wire rope will here be y valuable from the little space it occupies the Drum; Weight will either depend out- the house or inside—down a stair-well, or a trunk led up through floors, or descend a ll dug in ground. The last method is the st and least dangerous if top properly ded over, as no one can then ever get under ht, and so risk being crushed. The Winding h should be close to Organ, and the t may as well be a silent one. An old garden-roller will make a very good t. If Well adopted care must be taken it be a dry one, or the water will, of course, ly diminish the amount of power.

Whenever Weight descends a well the will run straight to Drum; but in all other rope will be led as high as possible (so to se the descent of amount by Weight), often rising far above Drum.

For Crank-shaft *see* Attachment of Gas- ine (17, d.).

An example of a Weight Motor was in use years since in an Organ at one of the dis- ing places of worship (Baptist, I believe) at Margate or Ramsgate—I think the latter. afterwards passed into the possession of Mr. yes, of Margate; and still later was pur- sed by Mr. Holbday, Organ-builder, &c., of terbury. The Instrument had about seven nding Stops, and I believe the wind-supply all that could be desired.

s. The best person to construct a Weight tor will undoubtedly be either a maker Automatic Organs or of Clock-chiming achinery; or, better still, the two working in cert. Imhof and Mukle, 547, Oxford-street, ndon, may be most unreservedly recom- nded for the former—Gillett and Bland, of oydon, for the latter; but the Music smith List in *Dep.* of Bought Portions) will o be valuable.

* * Wind Engine.

t. This has never, so far as I know, been used for driving an Organ Bellows; the obvious reason being the unsightliness of Sails, unless so small as to be practically useless; there is, however, a form of small Horizontal Wind Engine which would be quite powerful enough to *wind up* even a very heavy weight indeed, if only allowed sufficient time, and this is obviously often quite practicable, all required being that it be constantly in gear, *except* when weight fully wound up, *or* on releasing the catch which stops the weight machine; either of which must, of course, throw the wind attachment out of action.

u. The form of the Motor is simply four Blades attached to four arms, as in the ordinary Windmill, only that the arms here are horizontal. The blades are so centred that while one way they remain firm, yet on describing half a circle, and so presenting their other face to the Wind, they are blown over or edgewise—thus, of course, offering little resistance: on completing the circuit, they are blown up again, and so on. It will be evident that the particular direction from which the wind is blowing makes here not the least difference. For description and drawing see English Mechanic, 1876, Dec., p. 318.

v. A somewhat similar Machine, but in which the Blades rise and fall automatically, has been devised by author, but as foregoing is obviously the simpler, and seems quite as effective a design, it will not be worth while giving any detailed description of the former here.

w. No example of a Wind Organ Bellows motor is, as has been already said, known to author.

*** METHODS COMPARED.

x. I now endeavour to give a few plain rules as to where and when a particular Motor may be considered suitable.

y. Foot Blower. *Free Foot Blowers* (*see* def. 16, s). The Cranked Pedal has the advantage of simplicity, of leaving the left foot free for Pedals, and not interfering with latter, of being practicable with almost any size of Bellows, and of favouring the placing of the Handle at the side. Its disadvantages are that only one foot is in use, and that the motion is not in a convenient direction even for that; but latter is much neutralised by providing a proper retaining Shoe (*see* 16, t.) for the foot to rest in. The Straight Pedal has the advantage of its motion better suiting the motion of the foot, and also of still greater simplicity in attaching directly to the Feeder; also either one or two feet may be used, and if the posit be correct the removal of the left Pedal will leave the Playing-pedals free. The disadvantages are that unless Feeder be small it will be out of question for Pedal to attach directly to it, and that by throwing the Feeder hinges to the side nearest the player, it interferes with the Side-blower, so excellent in many cases. The Treadles are the most convenient form of all, and can act on Feeders hinged anywhere, but they have the fatal objection of being too far off if there be Playing pedals properly placed, for Treadles must obviously be beyond latter.

z. *Power Foot-Blowers.* It will be only necessary to notice the Treadle kind. These diminish the possibility of jerky blowing, nor is there necessarily any great elaboration; but the arrangement is open to the fatal objection of being unsuitable—unless Treadles specially and inconveniently elongated—for Operators of diverse weights. Thus, if set for the weight of a full-grown man, it would be useless for a boy; he might not be able to obtain even a puff: if, on the contrary, made right for a lad, a heavy man may cause to descend too fast, and bring about the very evil sought to be rectified.

[20. a.] Gas Engine. The *Lenoir* may be considered out of question, and dismissed at once. The *Hugon* is, as has been already said, quiet and effective, but it is expensive—viz., between 2¼d. and 2½d. per half H.P. per hour, reckoning Gas at 4s. per 1,000, which may be considered a fair rate. (The printed prospectus gave 2d. per hour, and less as Engines increase in size). The Otto and Langen is rather noisy (although the makers believe that this can shortly be got rid of), and a little more expensive at first purchase than the Hugon: but it is vastly cheaper in the running, 1 H.P. per hour being fully guaranteed for 1d., assuming, as before, gas at 4s. per 1,000. Since the above was written, the "Silent" Otto has appeared, removing the only objection to this motor for Organ-blowing.

b. The Gas Engine considered collectively has the following very important advantages:—1. It is always ready to start or stop at a moment's notice, and consumes nothing except while actually working. 2. It is independent of a certain force of fall in the supply—that is, supposing the gas *obtained*, it does not matter with what force it comes—*it brings its power locked up within it.* 3. Facility of obtaining, almost every little town now having its Gasworks. 4. Independence of frost. 5. Perfect safety. 6. No water leakage. 7. Great cheapness, supposing an economical type or form used. 8. The number of explosions, and consequently the actual power, is exactly proportioned to the work done—that is, to the resistance encountered by the driving shaft of the Engine itself. (This only applies to the "Intermittent.") 9. No disturbance of Insurance on Building.

(*To be continued.*)

POISONING WITH ARSENIC.

A RECENT criminal case in Paris, relating to poisoning with arsenic, presents various features of interest from a scientific point of view.

The facts are briefly these: On the 9th of September last year the wife of a druggist named Danval died of an ill-defined malady. The first symptoms—vomiting, accompanied by diarrhœa—were followed by a general wasting away; then the vomitings and diarrhœa recurred with greater violence, accompanied by an incessant cough, night perspiration, and a sensation of burning at the stomach. On the 8th of September she complained more than ever of this burning sensation, also of her tongue being dry and stiff, and her legs nearly paralysed; next day she died. She had been eighteen months married.

The doctors who attended her were of very different opinions as to the nature of her illness—Dr. Dervillez supposed muscular and visceral rheumatism; Dr. Renault a nervous affection; Dr. Covin a commencement of typhoid fever. It should be added that the Drs. Renault and Covin who attended the patient last, prescribed bromide of potassium, bismuth, and, finally, chlorhydrate of morphine.

The character of this woman's death, and the singular conduct of Danval, excited public attention, so that fifteen days after death an exhumation of the body was ordered, and experts were called in to make a chemical and medical examination of the body—M. L'Hôte for the chemical part, and Drs. Bergeron and Delens for the medical. Danval was arrested, tried in May, and sentenced to penal servitude for life.

The nature and results of this scientific examination (as they are described in *La Nature*) we shall now consider. The experts first noted the remarkable state of preservation of the alimentary canal, which retained the normal colour, and showed no alteration. Having ascertained the absence of all organic poison in the organs, they searched for arsenic, a substance which has, in a high degree, the property of conserving the tissues. They used one of Marsh's apparatuses, taking all possible precautions, and making sure that the reagents used were absolutely free from arsenic. The organs were carbonised with sulphuric acid by the method of Flandin and Danger, then the acid liquid was introduced into the apparatus. The experts observed the formation, on saucers, of spots, which they proved to be spots of arsenic, by means of the usual reagents. Repeating this examination on the various organs of the body, they found that there was arsenic not only in the liver, but also in the stomach and the intestines.

On the other hand arsenic was not found either in the sawdust or in the wood, or in the aromatic preparations mixed with the sawdust round the body. The experts further examined the medicines prepared by Danval, which might have incidentally contained traces of arsenic, also the medicinal wines, and the vin ordinaire which the patient drank, but without finding any arsenic. The natural conclusion was that there had certainly been ingestion of arsenic.

The defendant, on the request of the judge, designated M. Bonis, professor of toxicology at the Higher School of Pharmacy, for a counter-examination. The portion of the organs that had been left in the body was examined anew by M. Bonis, but by a different method. The liver, stomach, and intestines, analysed separately, were treated with a mixture of hydrochloric acid and chlorate of potash, to burn the organic matters; then the liquid was introduced into the Marsh apparatus. M. Bonis thus found that the liver and the intestines contained only a very small quantity of arsenic, and that in the stomach the presence of this substance was doubtful. He estimated the proportion of arsenic contained in the whole body at about 1 milligramme, while (he said) 1 litre of Bourboule water contains 6 to 8 mgr. And, further, he stated that the presence of such a small quantity of arsenic might cause inconvenience, but would not cause death.

The two chemists, while agreeing as to the presence of arsenic, had not the same opinion (as M. Bonis) regarding the amount of it in Madame Danval's body.

Now arsenic does not exist normally in the body. In 1839 Couerbe and Orfila supposed that this metalloid existed in the bones, but since the researches of Orfila, in the works of the Academy Commission designated for the purpose, it has been acknowledged that arsenic does not exist in the system, unless it have been introduced in some form; and this, notwithstanding the assertion of Raspail, in the Lafarge case, where this chemist maintained that arsenic existed everywhere, and offered to prove to Orfila that his own body contained it.

M. Bonis, then, did not allude to such normal arsenic, but he represented that the arsenic might have been ingested with the medicaments taken by the deceased, especially the bismuth; he also supposed that the arsenic might have come from the curtains of the bed on which Madame Danval lay, as these contained a good deal of it.

Ores of bismuth, indeed, always contain arsenic, and the first objection was serious. M. L'Hôte met it by analysing sub-nitrates of bismuth of different commercial origin. Of 22 samples only 3 contained arsenic, and they did not come from those who usually supplied Danval. As to M. Bonis's second observation it was the object of a more ardent discussion. The bed curtains contained about 1 gramme of arsenic per square metre, and there were about 27 m. of material; particles might, therefore, have been detached and absorbed by the respiratory or alimentary passages. M. Chatin remarked that such absorptions take place, not by the air passages, but by deglutition, with the saliva swallowed. MM. Bergeron and Delens replied that, while aniline dyes and colours, fixed by means of arsenic compounds, had long been used in industry, this substance, engaged in an insoluble combination, was so fixed that it had been impossible to find it either in the fringes or the folds of the curtains, or in the dust gathered near the bed. The lungs contained no trace of arsenic.

The discussion was then transferred to the medical province, where it became more irritating—the experts, urging the state of preservation of the alimentary canal, and the whole of the symptoms as characterised by the doctors who attended Madame Danval, which were the ordinary symptoms of poisoning by arsenic; also the absence of any other cause to explain the death, demonstrated by the normal state of all the organs; and, lastly, the unexplained presence of arsenic, concluded poisoning. If the arsenic was not found in greater quantity, this was because it had been eliminated by ordinary processes, arsenic being a body which is very rapidly carried off from the system, especially by the urine, and in this respect being unlike some other poisons, which are localised in certain organs (*e.g.*, copper in the liver). To these arguments, M. Gubles added the weight of his high medical authority, in favour of the probability of poisoning; citing exceptional cases, however, where people who had swallowed a coffee spoonful of arsenious acid had escaped all the primary lesions, and got off—an important point, since it concerned the case especially to know whether or not slow poisonings by arsenic necessarily produce organic lesions and fatty degeneration of the liver, as MM. Bonis, Cornil, and Gallard affirmed. M. Cornil, indeed, remarked in the course of the trial that, unfortunately, all histological examination of the brain, the liver, the pancreas, and the kidneys, had been omitted. In absence of the important elements which such an examination might have introduced, the conclusions of the experts not affirming any lesion, MM. Bonis, Cornil, and Gallard were within their rôle in maintaining that arsenic taken in small quantities always produces lesions. This was a grave point of the debate. The jury accepted the affirmations of the experts, and condemned Danval as guilty of poisoning by arsenic.

It is rendered evident by such debates that the physiological action of compounds of arsenic is not yet adequately known. A thorough investigation of the effects of this poison on the system would lead to results most useful in the case of trials like that above described.

BEE MANAGEMENT.

(*Continued from page* 411.)

The Stewarton Hive.

THIS hive differs altogether from the hives already described both in construction and management. Of the latter we shall speak further on when considering the management of "bar frames" generally. It consists of one or more "body-boxes," surmounted by one or more "honey-boxes." Each box is made of ⅝in. wood, of an octagonal form, being dovetailed at the joints. At Fig. 1 two body-boxes, A and B, are shown, surmounted by a honey box, C. Each body-box has a window covered with a sliding shutter and a door, which can be closed when desirable by a narrow slip. It also has several catches for the purpose of fastening it to another box when necessary. The inside measure is 14in. square and 7in. deep. It contains 10 frames, and between each frame and the next a tongued slip is run, so that when all the slides are in, the top of each box is unbroken, and the bees kept in. A section of the bars and slides is given at Fig. 2, which will explain their construction. The top bars, F, are rounded underneath, and have a projecting ridge, to render the waxing of the bars an easier operation. Each honey-box is the same size across as the body-box, but only 4in. deep. The bars are only seven in number, and are furnished with slides, two of which are shown partly withdrawn at S S, Fig. 1. The box has a window and shutter, but no door. The hive body is formed by fastening two or three boxes together, and the honey-boxes are added to the pile one at a time. This hive has several serious faults, the principal of which is the octagonal form, which prevents the interchangeability of bars, which is often most necessary. The propolisation of the frames and slides together is another objection, and the danger to which the whole structure is subject, from its shape, of a complete upset and wreckage by the wind, unless actually fastened down tent fashion, is of perhaps more importance to such as myself, who live in an exposed situation, than either of the preceding.

W. S. Travis.

FIG. 1

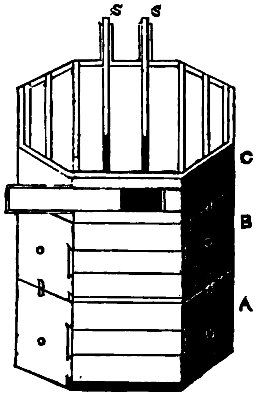
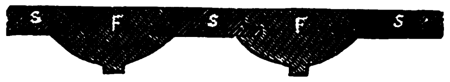


FIG. 2



INFLUENCE OF TEMPERAT THE GAS-EXCHANGE OF AN

A SERIES of experiments has bee
made by M. Theodor, in Bava
respiration of a cat, under the in
different temperatures of the surrou
They appear to be of a valuable cha
animal having been kept for six mont
ber to June) in a small respiration
under uniform conditions of nutri
the production of the higher temper
room in which the apparatus stood wa
heated. For the lower temperature
tions were made on cold winter day
room unheated, or the case containi
mal was placed in the open air,
window, and connected with the
apparatus by means of a caoutchouc
cat had a weight of 2·3kilos., an
daily, up to the 31st of Decembe
meat, carefully cut up, and 10g. of p
as the cat's weight somewhat fell of
regimen, the daily portion was incr
31st Dec. to 120g. meat and 15g.
this increase of food the cat for
gained in weight. Then from 16t
30th March, it remained at about
weight, and from the latter date,
coming in of the warm season, it gr
creased in weight, so that at the end
periment it weighed 3,047g. The au
concludes that in summer less food is
than in winter, since an amount wh
the cold winter months merely main
body at a constant weight, produced
a considerable increase of weight.
of this increase, it is suggested, m
less frequent and intense motion of
in warm weather.

During this time the taking-in
and the giving out of water vapour an
acid was determined on 22 days, du
hours. The food was given at midd
on the days of experiment, when it
after the conclusion of the experime
that the cat at the beginning of
ment had passed 17 hours since the
The results of these determinations,
more frequent measurements of w
given by the author in tabular form.
numbers it appears, with regard t
exchange, that in cold the excretion o
acid and the absorption of oxygen
whereas in heat they decrease. Th
do not, of course, rise uniformly
lowering of temperature (the te
varied between – 5·5° C., and + 30·2° C
be supposed, however, that the cat mo
apparatus, and nothing has a greate
on the production of carbonic acid t
movement.

The greatest variations in the q
carbonic acid were 12·03—22·03g.,
cent., with a temperature difference
Starting with the mean temperature
there was, on lowering the tempe
increase in the quantity of carbonic
on raising it a decrease. Similarly wi

The decrease of gaseous exchan
months of April, May, and June, in w
of the heat experiments took place,
connected with the change in the st
animal's body during the hot season.
the weather was still very cold, and
had not yet gained in weight. From
to the 30th of this month four ex
were made, two in the cold and two i
which did not differ from the run o
The average ratio of the oxygen ta
that contained in the carbonic acid
to 77, and so equal to that obtained i
of a fasting dog. [The original memo
in the *Zeitschrift für Biologie.*]

HOW TO MAKE A PIANOFO

AT first sight the interior of a pian
a mass of complexity, and, tak
whole, there is certainly a great deal
and wonder at; but when it is re
that the whole action may be bough
arranged, and even numbered, for
tion, a great portion of the credit
transferred to the action-maker,
generally entirely overlooked. The
in these days of divided labour the

ker,” as formerly understood, has entirely peared, and in his place has arisen one e sole work is to put the different parts ther. So much has lately been said in ur of “iron backs,” that probably most of English readers would elect to save thems much hard work, and assure stability to construction by employing one. But on other hand I know of numbers in the ies, and elsewhere, who have not the same ities of procuring one, and who consetly would be obliged to content themselves the ordinary wooden back. For their fit, then, I must crave indulgence while st describe how this is put together. The s necessary for its construction are a wrest k, bent side, linings (or end pieces) and ings. The wrest plank is of English beech less than 1¼in. thick, 4ft. 2½in. long, and wide. As this is perhaps the most impor- part of the whole instrument, great care ld be used in its selection. It should be oughly weathered and “shop dried,” and if ible should be cut, as it is termed, “on the er,” that is, the tree is first cut in ers, and the planks, cut off their faces. cut in this manner it is almost impossible lit, and as our readers are aware that a er of holes are bored in it close together, in a line with the grain, this is a lty very necessary to guard against. The side is also of beech, 1¼in. thick, so called se at one time it really used to be bent, hough now cut out of the straight it still rves its old name. The round side should pretty nearly the curve of the bridge as is means the same area of soundboard ywhere between them. A sufficient idea shape may be obtained from the diagram. inings are of spruce, 4ft. long by 4½ × The bottom is the same, but 2½in. longer; acings, also spruce, are 4ft. long by 4½ × There should not be less than six, and would be still better. To prepare these for putting together, the wrest plank first be planed level on both sides, and d. The side selected for the front must be veneered with some clean white veneer, ably sycamore, which should be, for the purpose of strength, ⅛in. thick, and the grain, crossing that of the plank. While this is under the handscrews the spruce may be planed over, making the front sides level, and marking them as such. The linings and bottom are first required—a lap must be cut in the former to receive the plank. The depth of this lap depends on the thickness of the plank, which should stand over not less than ⅜in.; thus, supposing the plank, when levelled, to be 1¼in., the lap should be ⅞in. deep, and calculating the finished instrument at 4ft. 2in., a fair average size, the bottom of this lap should be 3ft. 3in. from its lower end, which will be dovetailed into that of the bottom lining, this being, of course, exactly the same length as the plank. The first part to be put together is the frame—*i.e.*, the four sides, plank, side linings, and bottom, but before doing so the position of the bracings must be determined and marked on the back of the plank and top of the bottom lining (see dotted lines in diagram, Fig. 2). If it is decided to use six bracings it is better to close them together a little at the middle of the back, where the chief strain comes. (These and other measurements may readily be calculated from Fig. 1, which is drawn to a scale of 1 in 12.) Should the operator prefer to make sure by putting in the two extra, it will suffice if the spaces between them are equally divided throughout. When the frame is together, and before finally tightening the hand-screws, test its squareness. The handiest way of doing this is to measure with a pair of sliding rods from corner to corner diagonally, and alter till both are equal; when, if the lengths of each lining are identical, the frame will be quite square. It can then be laid on its face, and the bracings fitted and dovetailed, each being numbered as done. These laps should be 1in. longer than those of the linings, to allow for a wedge. The back will be all the stronger if a 1in. hardwood dowel (F, Fig. 2) be inserted. The bent side is now to be added. The position of this is 9in. from the bottom of the wrest plank at the treble or right-hand end, and 24in. from the bass lining at the bottom. It must be understood that the work will hold much better together if all the joints are made hot before glueing. The back is now finished, with the exception of wedging. The wedges should be of beech, and fit very tightly, with the grain parallel to that of the plank. In hammering them it is advisable that each bracing should be well bedded, as its wedge is forced in, or it is very likely to be torn from its joint. It now becomes necessary for the amateur to supply himself with the requisite metal work, and as it may be of service to him, if he gets a plate, to match which I shall be happy to supply a scale on payment of postage (1 stamp), he is quite welcome to ask for my pattern at Messrs. Hughes, 37, Drury-lane. References to sketches:—Fig. 1, back; A, wrest plank; B, wedges; C, resisting irons; D, bent side; E, dovetail at back of bracings. Fig. 2, top side of bottom; C, resisting irons; E, dovetail for back of bracings; F, dowel. Fig. 3, section of back.

W. H. Davies.

IC 3

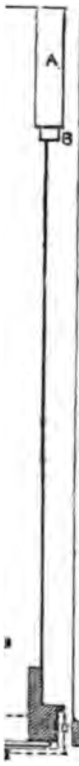


FIG. 1.

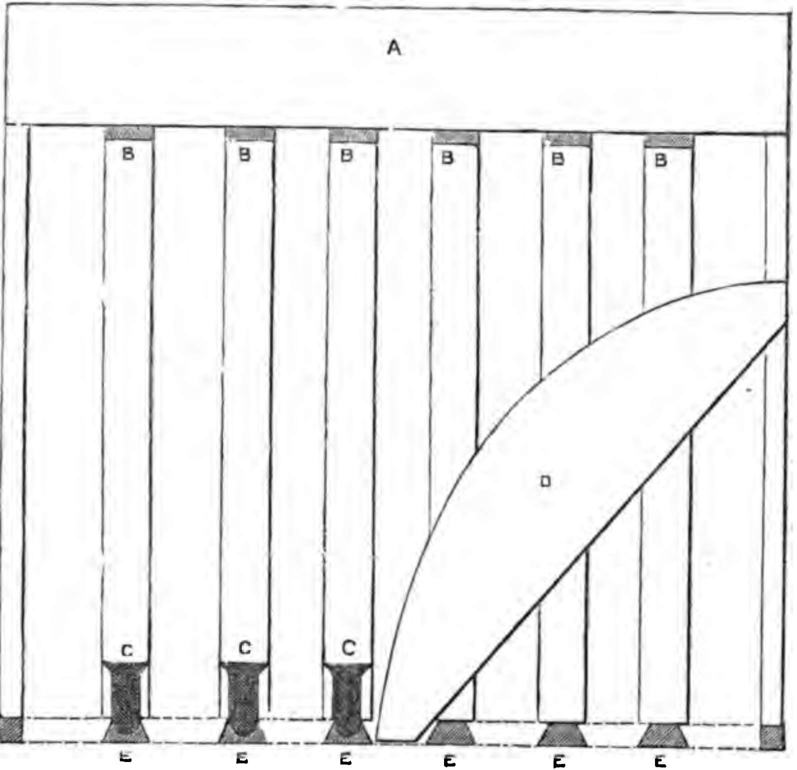
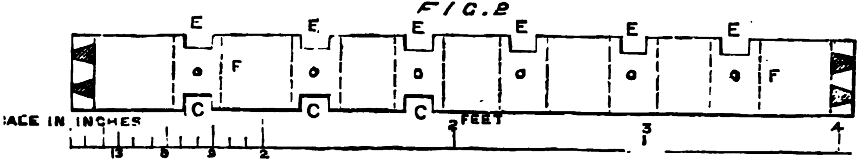


FIG. 2



THE SPEED OF SHIPS.

THE recent trials of the Iris and the Torpedo vessels to which we briefly alluded in our Scientific News, last week, will probably have the effect of drawing renewed attention to the phenomena of the screw propeller. The result of the trials, so far as the Iris is concerned, may be thus shortly stated: The reduction of the size of the propellers, and the increase of their pitch added, as nearly as possible, 2 knots to her speed—a very remarkable result, and satisfactory alike to the public and those who suggested the experimental trials. The Iris, it will be remembered, is one of a fleet of steel despatch vessels, and is, in every sense, an experimental craft, for there is nothing else in the navy having a similar proportion of midship section to length and extreme fineness of entrance, while her ratio of horse-power to displacement is enormous. The results of her first trial were disappointing, as the calculated speed was not reached; and as a sister vessel was then building, in which everything had been sacrificed to attain the highest possible speed, it became important to determine the cause of the failure. Mr. Barnaby had calculated that, with the engines developing 7,000 horse-power, a speed of 17½ knots an hour might be realised; but the practical test proved that, while the engines indicated 500 horse-power over the contract power, the full-power runs only gave a mean speed of 16·6 knots, the revolutions per minute being 91. There were, however, grounds for thinking that the comparative failure was due, not to the form of hull, but to some defect in the machinery. The Iris was propelled by two four-bladed screws, each 18½ feet in diameter, with a pitch of 18 feet, the joint disc-area being considerably greater in proportion to the engine-power than is common in single screw ships, while the surface of the blades was also exceptionally large. On the trial it became evident that the engines were over-weighted by the screws, and that the friction and drag which were set up materially detracted from the effective power of the machinery. It was accordingly arranged, for experimental purposes only, to remove two of the four blades on each fan and to make a series of progressive trials in order to see what improvement would result from a reduction of the blade-area and a consequent relief to the engines. According to an analysis which has been made by Mr. W. H. White, of the Admiralty, the highest power developed under the novel conditions was 4,369 horses, the corresponding speed 15¾ knots, and the revolutions 89. With the four-bladed screws 15½ knots had required 5,250 horse-power, and 4,369 horse-power would have sufficed for 14½ knots only. It was not considered desirable to press the extemporised two-bladed screws by running at any high speeds, nor by their form or pitch were they adapted for use as two bladed propellers; but enough had been done to show that the performance of the ship could be greatly improved by a modification in the size of her fans. At the recent trial the ship was trimmed by ballast and coal to 15ft. 8in. forward, and 20ft. 6in. aft, near about her load-line; and the new four-bladed screws were 16ft. 3in. in diameter, with a pitch of 20ft. The blades were smoothed to prevent friction, conical caps had been tapped into the over the nuts which secure the screws to the shafts, for the purpose of preventing the wave which has been found to follow a bluff ending, whereby the resistance against which the ship has to contend in passing through the water is augmented. Four full-power runs were made on the mile with the following surprising results :—Steam at engines, 62lb.; vacuum, 27in.; revolutions, 96 starboard, and 98 port; horse-power, 7,734 85; speed of vessel, 18 572 knots. The engines thus developed fully 700 horses more than the contract; while the ship realised two knots in excess of the speed obtained from the larger screws, and fully a knot more than the constructive department anticipated to get out of her. Four runs at 16½ knots required 5,132·76 horse-power, with 86 revolutions. This, as will have been seen, was the utmost speed realised at the original trial with 7,500 horse-power and 91 revolutions. The runs at 12 knots gave 1,837·14 horse-power, with 62 and 60 revolutions, and 2 runs at 8 knots gave 607·25 horse-power, with 41 revolutions. The engines were also turned as slowly as possible with the steam at only a little above the atmospheric pressure, when the following data were obtained :—Revolutions, 24 starboard and 19 port; vacuum, 28in.; power indicated—starboard engines, 127, port 59; making a total of 186 horses. Scarcely any vibration was noticed, although at the previous trials the shaking of the ship was excessive.

The result of this series of trials was, therefore, so satisfactory that similar propellers are to be fitted to the Mercury, a vessel upon which no expense has been spared to obtain the highest possible speed. If, however, the speed of the Iris is remarkable, what must be said of that of the new torpedo boats built by Messrs. Yarrow for Russia, but purchased by our own Government? It is true that they have not been tried at sea—only in the tidal waters of a river, and may not unlikely fall off in speed, as the Lightning has done, when in the hands of the authorities. Still, there are the figures of the trial, and there is no doubt that a very extraordinary speed was attained. Both vessels, No. 419 and No. 420, have compound surface condensing engines, with cylinders of 12½in. and 21½in. diameter respectively, the stroke being 12in. The boilers are of the locomotive type, placed in a closed stoke-hole said to be safe for the men in the event of the collapse of a boiler tube. On the first trial, some two months ago, one of the tubes was obliging enough to give way and demonstrate practically the efficiency and utility of the arrangement. Supplementary engines are provided for working the air, circulating, and feed pumps, and these are available for pumping out the vessels, which are said to be unsinkable if 100 holes have been made in them by rifle bullets. Rifle bullets are not the missiles that will be employed against torpedo vessels, so that the statement is of little value. In the trials made at Long Reach No. 420, which has a two-bladed screw, 5ft. 6in. in diameter and 5ft. pitch, made the down run over the two-miles course in 5 minutes 19 seconds, equal to a speed of 22·59 knots per hour. In other terms this vessel attained the remarkable speed of 26 miles an hour. She had six tons of ballast on board, and her draught forward was 2ft. 8½in., and aft 2ft. 7in. The mean revolutions were 460 per minute; maximum, 475; steam pressure, 120lb.; vacuum, 23in. to 25in., and blast 4in. The tide had just turned, and was running out—being, therefore, with the vessel on the run down. On the run up it was, of course, against her. This run was made in 6 minutes 47 seconds, or equal to a speed of 17·69 knots per hour. The mean of the two runs was 20·14 knots, or 23·2 miles per hour. The vessel was under weigh just an hour, during which time she burned 10cwt. of coal, a portion of which was used in getting up steam. No. 419 was then tried. She was run light, without any ballast, her draught forward being 2ft. 5in., and aft 2ft. 4in. The first run was made up the river, and, consequently, against a strong ebb. The two miles were run in 6 minutes 38 seconds, giving a speed of 18·09 knots per hour. The mean revolutions were 459, the steam pressure 110lb., the vacuum 22in., and the blast 4¼in. The second run was made down the river, with the strong ebb, and was accomplished in 5 minutes 1 second, giving a speed of 23·92 knots, or 27·56 miles per hour. The mean of the two runs was a speed of 21 knots, or 24·2 miles per hour. On the last run the mean revolutions were 459, the steam pressure 110lb., the vacuum 22in., and the blast 4¾in. This boat was then put through the circle, which was described rather more than 1,000ft. in diameter, in 2 minutes 31 seconds. There were no heated bearings or any other drawbacks during these trials, which were highly satisfactory in every respect. Such speeds have not been attained by any other vessels, and if they can be repeated at sea, torpedo vessels of this class will become extremely valuable for the defence of coasts. They discount the value of heavy ironclads to a great extent, and therefore render a large and powerful fleet of comparatively little use in attacking fortified places if the vessels forming it are liable to be harassed by these quickly-moving and destructive engines of warfare, which can, moreover, be rendered almost invisible and noiseless. Experiments were recently made to test these points, and the conclusions arrived at were that with Willan's engine, William's Venetian ashpit door, and Justice's quieting exhaust, torpedo launches may be constructed, to detect the approach of which on a dark night would require the greatest vigilance.

THE COOLING OF STEEL DURING HARDENING.*

By Joshua Rose, M.E.

ONE of the most serious losses common to our tool and implement manufactories is that of the cracking and splitting of steel during the hardening process. Not only is the article or piece lost after having incurred the cost of its manufacture, but in many cases the completion of the machine of which it forms a part is arrested until the lost piece is replaced. In many cases this is done at increased expense, because the piece has to be made singly instead of with a number of others, involving as much setting of machine and adjustment of tools as would be required for a large number of pieces. Successful hardening and tempering is indeed, even under ordinary and unvarying conditions, considered and kept as a trade secret. Visitors are excluded from the hardening and tempering room. In some cases the method of heating, in other cases the material used for heating, in yet others the cooling mixtures form the supposed secret. As a matter of fact, however, some of the very best tool manufacturers employ the simple open fire or furnace and water, and it is probable that with these two simple agents good cast-steel can be as successfully and properly hardened for any purpose as it can be under any other process, and the advantage gained by heating in fluxes consists in increased expedition and the necessity for a less expert manipulation.

The splitting or cracking of steel occurs during the cooling part of the hardening process, and is to be easily avoided even with the most unfavourable of steels, if the conditions of cooling are made to conform to the form and size of the article. The cooling is, in a majority of cases, performed by dipping the heated steel in water; and the manner in which the dipping is performed may be made at will to crack, warp, or straighten the article.

The instant the surface of a piece of red-hot steel enters the water a rapid contraction of the submerged portion takes place, and unless this contraction is kept equalised to suit the shape of the article, the side or part most contracted will bend hollow, causing the diametrically opposite metal to bend to accommodate the inner curve. Suppose, for example, we heat a piece of steel, an inch square and 12 inches long, to a red heat, and dip it *slowly* in water, so that one side of the square will strike the surface flat and evenly, then that surface will contract while the diametrically opposite or upper surface will remain expanded; the lower face will curve to a concave, the upper one to a convex. If, then, such a bar were curved during the heating process we may help to straighten it by dipping it slowly in the water with its convex side downward. If it was bent at one end only we may dip at that end first diagonally, and with the convex side downward. If, however, we dip it with the length lying either diagonally or horizontally we are apt to warp it, no matter how quickly it may be dipped, and the reason is, in addition to the above, as follows :—Experiments have demonstrated that the greater part of the hardness of steel depends upon the quickness with which its temperature is reduced from about 500° to a few degrees below 500°, and metal heated to 500° must be surrounded by a temperature which renders the existence of water under atmospheric pressure impossible; hence, so long as this temperature exists the steel cannot be in contact with the water, or, in other words, the heat from the steel vapourises the immediately surrounding water. The vapour thus formed penetrates the surrounding water and is condensed, and from this action there is surrounding the steel a film of vapour separating the water from the steel, which continues so long as the heat from the steel is sufficiently great to maintain that film against the pressure of the water and the power of the water which rushes towards to the steel to fill the spaces left vacant by the condensation of the vapour as it meets a cooler temperature and condenses. The thickness of the vapour film depends mainly upon the temperature of the steel, but here another consideration claims attention. As the heated steel enters the water the underneath side is constantly meeting water at its normal temperature, while the upper side is surrounded by water that the steel has passed by and, to a certain extent, raised the temperature of. Hence the vapour on the underneath side is the thinnest, because it is attacked with colder water and with greater force, because of the motion of the steel in dipping. Suppose, now, we were to plunge a piece of heated steel into water, and then slowly move it laterally, the side meeting the water would become the hardest, and would be apt to become concave in its length.

From these considerations we may perceive how important a matter the dipping is, especially when it is remembered that the expansion which accompanies the heating is a slow process compared to the contraction which accompanies the cooling (although their amounts are of course precisely equal), and that while unequal expansion can only warp the article, unequal contraction will in a great many, or indeed, in most cases cause it to crack or split.

After an article is dipped to the required depth it should, if straightness is of importance, be held quite still until reduced to the temperature of the water, because, if taken out before so reduced in temperature it is especially apt to crack; and it is better to have a deep tank of water if the body of the metal is great, so that the steel may be dipped slowly downwards, and become cooled sufficiently rapidly to harden without any lateral movement, except it be after the steel has lost its redness.

When a piece of steel requires to be hardened at one end only, the dipping must be performed with a view to make the graduation from the soft to the hard metal extend over a broad section of metal, for if the junction of the hardened with the soft metal is abrupt the hardened end is apt to break short off. The method of dipping, therefore, is in this case to plunge the end of the steel vertically into the water to a depth a little more than equal to the depth it requires hardening, and, after holding it still there until it is black hot (that is, as soon as its redness is gone), dip it slowly a little deeper, and then raise it up to the amount of the increased dipping, and slowly immerse again.

When a piece of metal requires hardening and tempering at one part only, we may heat the steel back of the part to be tempered to redness, and dip the article so as to harden the required part, and leave sufficient heat in the contiguous metal to raise the temperature of the hardened part enough to temper it. This plan is always followed in the tempering of lathe and planer tools, flat drills, &c. If, however, the method of dipping is to hold the steel in the water at an even depth after the immersion the temper-colour will be very narrow, while, if the steel is raised and lowered in the water, the colour-band will be broad.

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* From the Polytechnic Review.

THE CHEAPEST RAILWAY IN THE WORLD.

THE cheapest railway in the world is to be foun in the peninsula of East Frisia, in the extrem north-west of Germany. The peninsula has th thinnest population anywhere to be found in centra Europe, and the soil is almost completely moor. A railway was, some years ago, built with Governme assistance, connecting Bremen and Oldenburg wi the town of Emden; but this line had to be la down absolutely straight, to save expenses. Thi left the village of Westerstede five miles from it track, to the distress of the inhabitants, who tri to persuade the Government to deviate from th straight line. When they found that all petitioni was useless, they determined to make a railway o their own. It appeared almost impossible to con struct a line that would pay its expenses, among population of ten inhabitants per square mile, whol agricultural, exporting nothing but cattle, pigs, an the scanty produce of the soil, and importing litt else but a few articles required for domestic consum tion. But the parish of Westerstede may now, say the *Railway News*, boast, probably beyon challenge, of possessing and maintaining the cheape railway in the world. The line, which is a single throughout, is about five miles long, running fro the hamlet of Ocholt, and to the village Westerstede, the terminus here being the yard of t principal inn. It has a gauge of 2ft. 5½in., and t rails, made of Bessemer steel, and weighing 25lb. the yard, are of the Vignoles shape, connected fish-plates only, so that they rest directly on t sleepers. Although the country is perfectly lev sting principally of moorland and heath, the works were not altogether unimportant, as con-ıble drainage works had to be carried out to st the railway from occasional floods, to which hole of East Friesland is liable, since it rises ittle above the level of the North Sea. The ıas its own earthworks, but runs for some ce close alongside the ordinary road, separated it by a ditch and a quickset hedge. There is ıo station on the line, half-way between Ocholt Vesterstede; but, strictly speaking, this is no n at all, merely a halting-place for the trains. ıster's cottage stands here, the owner of which intending passengers to sit down in his room wait the arrival of the trains. The rolling-consists of two small tender-locomotives, three ıger carriages, two closed goods vans, and four trucks. The locomotives, four-wheeled, with el base of 5ft, and a heating surface of 172 e feet, weigh seven and a-half tons when loaded uel and water; they only burn peat, abundant district, and have, instead of a whistle, a bell, is rung at every level crossing. The passenger ges each hold twenty-eight passengers, sitting ıus fashion, with a door at each end, which gement is necessary as the trains cannot turn, being no turntable on the line. The working consists of four persons—an engine-driver, a ın, a guard, and a platelayer, their total wages mounting to more than 13s. a-day. The entire ng expenses are returned as exactly £1 9s. per the items of expenditure being, besides wages, r peat-fuel, and 10s. for maintenance of per-nt way, repairs, grease, and other indispensable ırs. There are no buildings on the line, except gh shed for the cover of engines and carriages ıch end; nor are there any signals. The ıger fares, which are low, being 6d. first-class l. second-class, are collected by the guard. He ıccompanies the goods trains, collecting the es, which are 1s. for a beast, 3d. for sheep and ınd at the rate of 2s. per ton for general goods. ıre the chief article of export of the district. ompany, composed entirely of inhabitants of strict, including agricultural labourers, raised l capital of £11,200, and of this only £10,450 lisbursed in the building of the line, purchase ling-stock, and erection of sheds, leaving a ıs of £750, which sum was placed aside as a e fund. To aid in starting the undertaking, rish of Westerstede, by vote of the communal entatives, subscribed £1,500 as a gift, to be ıed only in case of the repayment of the whole debenture capital. From the returns as yet hed, it appears that, in the first seven months which the line was open for traffic, the gross ts came to an average of £2 8s. per diem, so with working expenses of £1 9s., the net gs were at the rate of 19s. a-day.

REAL BROWN BREAD.*

TWITHSTANDING the labours of chemist and physiologist, the exact composition and ive value of the several products obtained in g wheat have not been thoroughly determined. fine flour contains less nitrogen, and leaves, burnt, less ash than biscuit flour, middlings, y variety of bran, is well known. The per-ges of starch, of the mixture of cellulose and e known as "fibre," and of fat, in several of samples of mill-products, have been ained. Moreover, there have been made many e analyses of the ash of wheat and of the pre-ons derived from it. But we are still some-in the dark concerning both the chemical and logical aspects of what may justly be regarded e central feature of the problem under dis-n. For we are not sure of the nature of the en compounds which exist in the several dis-parts of the grain of wheat; nor do we know r the phosphates and such nitrogen compounds y be ranked with the true albuminoids can be ed when intimately associated with fibre. too, the mechanical condition of these coarser ıts from the milling of wheat is of consider-moment in estimating their actual value as nts.

re endeavouring to reach some conclusion as comparative merits of white bread, brown and whole-meal bread, I will offer in as com-form as possible the more important and in-vertible data which must form the starting-f the discussion.

tly as to variations in composition in the grain These variations, chiefly affecting the per-e of nitrogen, depend upon hereditary qualities rent strains of the wheat-plant; upon climate ason: and, to some extent, but not so largely ten stated, upon cultivation, soil, and manure. rd translucent wheats, *blés durs et glacés*, specific gravity, about 1·41, and, owing to ngthened and wrinkled shape, of low weight shel, these wheats are rich in nitrogen. The aque wheats, of less specific gravity, about 1·38, and, owing to their rounded and plump form, of high weight per bushel, are poor in nitrogen. The hard wheats grown in Poland, in Southern Russia, in Italy, and in Auvergne, are used in the manufacture of macaroni, vermicelli, semolina, and pâtés d'Italie. The softer and more starchy wheats are especially appropriate for the production of fine white flour. According to the most recent analyses, the percentage of nitrogen in different varieties and samples of air-dry wheat may range from 1·3 up to 2·5—numbers corresponding to 8·23 and 15·83, respectively, of gluten or flesh-forming substances. But the same variety of wheat may give a grain having 3 per cent. more gluten in a bad season than when matured in a fine summer. More than this, one may select from the same field, the same plant, or even the same ear, individual grains which shall show quite as wide a variation in gluten as that just cited. For instance, a sample of Hallett's white rough-chaffed wheat of the harvest of 1865 contained many dense and translucent horny grains having 13·2 per cent. of gluten, while the white opaque soft grains from the same sample contained but 9·6 per cent.

It will simplify the consideration of the chemistry of mill-products if we confine our attention mainly to the nitrogen and ash of the grain. It must not be forgotten that all the mill-products included under "bran" contain much more cellulose than is present in flour—namely: from 7 to 15 per cent., or even more, in lieu of 1 per cent., or less. And it would appear that while flour contains more than 90 per cent. of its nitrogen in the form of true albuminoids or flesh-formers, in some of the brans one-third of their nitrogen is in the form of non-albuminous bodies, of no recognised value as nutrients.

How much flour and how much bran will 100 parts of ordinary soft wheat yield on the ordinary system of low-milling adopted in England? As the averages from an immense number of independent estimates we may put down the flour at a total of 80, the bran at 17, and the loss at 3. Thus, from an economical point of view, we appear to lose 1-5, or twenty per cent. of our wheat by submitting it to the numerous treatments involved in the manufacture of flour. But is this really the case? We think not. For much of the nitrogen in the rejected parts is not in the form of flesh-forming matter, and much that does so exist in the bran passes unaltered and unused through the alimentary canal, because of its close incorporation with fibre. But on the other side we must not forget that bone-forming materials are clearly deficient in wheaten flour, and that those phosphatic compounds present in bran are readily soluble to a large extent, not only in the several digestive secretions with which they come in contact in the body, but also in pure water.

But in comparing and contrasting bread made from flour with that made from whole wheat we must consider other points. We shall find it impossible to make, by means of leaven or yeast, a light spongy loaf from whole wheat finely ground, the so-called *cerealin* of the bran inducing chemical changes which result in a moist, clammy, dense product. Even whole wheat merely crushed into meal, and not ground, partakes of the same defect. Fine flour, on the other hand, yields a bread which is light enough before mastication, but which, when masticated, possesses a marked tendency to become compacted into dense lumps which may never be comepenetrated by the gastric and intestinal juices, and which are a frequent cause of constipation. Whole-meal bread cannot be charged with this defect; indeed it acts medicinally as a laxative, and by reason of its mechanical texture is hurried rather too quickly along the digestive tract, so that the full virtue of such of its nutrients as are really soluble becomes in part lost. Yet there is no doubt that for many persons, especially those who have passed middle age and are engaged in sedentary occupations, whole wheaten meal in the form of bread, biscuits, scones &c., forms an invaluable diet.

The following analysis may present some of the foregoing statements in a clearer light, and may add some additional particulars of interest. They represent, so far as a couple of sets of average results can do so, the percentage composition of ordinary white bread and of the whole-meal bread made by Messrs. Hill and Son :—

	White.	Whole Meal.
Water	40·0	43·5
[1]Albuminoids or flesh-formers	7·0	[2]10·5
Starch, dextrin, and sugar ...	50·7	40·6
Oil and fat	0·6	1·6
Cellulose and lignose	0·5	1·8
[3]Ash or mineral matter ...	1·2	2·0

1 Calculated from total nitrogen present.
2 As much as 12·5 in some samples.
3 Includes common salt added.

It is clear from the above figures that if we could reckon the whole of the nitrogenous matter in whole-meal bread as equally effective with that contained in white bread, we should possess in the former a far more perfectly adjusted food; for the ratio of flesh-formers to heat-givers is about 1 to 7½ in white bread, while it approaches 1 to 4 in some samples, at least, of whole-meal bread. Add to this the higher proportion of phosphates in the latter, and its chemical superiority over white bread becomes still more marked: its flavour, too, is far richer.

One word as to ordinary brown bread will suffice. It is a poor preparation at the best. By adding a dash of rather rough bran to flour we do not obtain a satisfactory or rich product: analysis demonstrates this fact clearly.

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*stracted from a paper by Prof. A. H. Church, in

A NEW FLYING MACHINE.

THE first open-air exhibition of Professor C. F. Ritchell's flying machine was conducted at Hartford, Conn., on Wednesday, June 12. It went up to a height of fully two hundred and fifty feet, past the spire of the Colt Memorial Church, and sailed off until over the Connecticut river, the operator meanwhile exhibiting his power to change its altitude and direction at will. When he ascended there was but little wind blowing, and the machine appeared to be under perfect control, but gradually a breeze sprang up, and it was deemed safest to make a speedy return, as there were indications in the sky of a gathering storm. The machine turned and made its way back in the teeth of the wind until directly over the ball ground whence it had ascended, and then alighted within a few feet of the point from which it had started.

From this demonstration of its capacity it was generally conceived that it could do much more than its modest inventor claimed for it. He never expected it to move against a wind of any strength, and has not had the attainment of that end in view in its construction, as may readily be seen by a glance at its proportions, but he does claim that it can be raised or lowered at will to leave adverse currents and enter favourable ones; that it can be made to tack so as to effect a little headway even against a breeze, and that in a still atmosphere it can be moved about as readily and perfectly at the will of the operator as a boat can be moved upon quiet water. All that, and even more, there is abundant evidence of its having done on this occasion.

The inventor, Mr. Ritchell, is a Maine man, but has during several years past lived at Corry, Pa. The project of constructing a flying machine has been a favourite subject of contemplation with him during nearly ten years past, and for the last seven of that time he and his friend, Mr. W. H. Lyman, of Corry, Pa., have incubated his idea together. In November, 1876, they went to Bridgeport, Conn., to put their plans into execution, as they believed they could there obtain most readily just the peculiar materials they required, and have them put together in the most perfect manner. Their confidence in Yankee resources and skill was not misplaced, but their crude ideas were not immediately crystallised into a perfect machine nevertheless.

The flying machine is all clumsiness above, all lightness and grace below. The lifting power is afforded by a horizontally placed cylinder of "gossamer cloth," fine linen coated with indiarubber, twenty-five feet in length and thirteen in diameter, weighing only sixty-six pounds, and charged with hydrogen gas, which is made by the usual process from iron turnings and sulphuric acid. Broad worsted bands extend over that and down to a rod of mandrel drawn brass tubing, nickel-plated, 1¼ inch in diameter and 23 feet long. From that rod the machine is suspended by slender cords. The after portion of the machine is at the base a parallelogram of rods, 2 feet wide and 5¼ feet long, from which rise lengthwise curved rods, 18 inches high in the centre, and drawn near together at the top. All these rods are in reality hollow tubes of mandrel drawn brass, light and very strong. Above the apex of this form rises a cog-edged steel wheel, 11 inches in diameter, with double handles so geared to a four bladed fan moving horizontally directly beneath, that the operator can give the fan 2,000 revolutions per minute. The four blades of the fan are of white holly, each having a superficial area of about 50 square inches, and the extreme diameter of this revolving fan is 24 inches.

The blades are set at a slight angle, like those of a screw of a propeller. Just behind the wheel is a very small seat, upon which the operator perches. His feet rest upon two light treadles above and in front of the fan. From the front of this form spring other rods, carrying at their extremity a vertically working revolving fan, like that beneath the operator's seat, except that it is but 22 inches in diameter. It is so geared to the main or horizontal fan that it may be operated or not, at the pleasure of the driver of the machine, and can be made to turn from one side to the other, so as to deflect the course of the machine in the air. This fan will make 2,800 revolutions per minute when the other is making 2,000. All its movements are controlled by the operator's feet. When he presses the left treadle he throws it into gear, when he presses with the toe of his right foot it turns to the left, and a slight pressure of his heel whirls it over to the right. He can also reverse the action of his main fan, so that when it twirls one way he goes down, and when its course is reversed he mounts in the air.

That this is not merely a claim has been clearly demonstrated. Then the weight of the operator and machine and the lifting power of the gas cylinder have been so nicely adjusted that they were exactly balanced; six pounds have been added to the weight of the machine, and the working of the horizontal fan has caused the apparatus to rise and continue to ascend as long as the lifting power of the machinery was exerted. The weight, normally, of the machine, and the rod from which it is suspended is 48lb. This, then, gives 114lb. as the weight of the entire apparatus.

The second exhibition was given June 13. The weather was far from favourable. The wind came in quite sharp gusts, and there were threatenings of a coming storm. Nevertheless, the ascent was made. Little Quinlan, even if he does only weigh 96lb., has confidence and nerve enough to go up in a gale. Some time was spent in getting the weight and lifting power so neatly balanced as to show that the machine could exert a lifting power of its own. When this had been effected to Professor Ritchell's satisfaction, the apparatus rested quietly on the grass, but could be lifted or set back with the light pressure of one finger. Then the word was given to "Go." Quinlan began turning the wheel, the horizontal fan revolved with a noise like a buzz saw, and the machine darted up almost vertically to a height of about two hundred feet. There a strong, steady current of wind setting toward the south-west was encountered, and the machine was swept away by it, broadside on to the spectators. Then the operator was seen throwing his vertical fan into gear, and by its aid the aërial ship turned round, pointing its head in whatever direction he chose to give it. All this was the work of but a few seconds. Although Quinlan could move the apparatus about he could not make any headway against the strong wind. Reversing the motion of his horizontal fan, he descended apparently about one hundred feet, to get out of the current, but, finding that impracticable, reascended to a much greater height than he had first reached. Still he was swept off towards New Haven, and after a little time went out of sight. He had vanished behind a distant hill, and for a while it was supposed he had alighted. Then he was again sighted, far away, and not less than one thousand feet above the earth. The cylinder of the machine looked no larger than an orange. At length he disappeared altogether. At 6.15 p.m., having been up battling with the wind very nearly an hour, he descended safely at Newington, and at 10 o'clock was back in Hartford. He said that at one time he was eight or ten miles away from his starting point, but by tacking and working between the gusts of wind, won his way back as far as Newington, only five miles from Hartford. He says that the working of the machine is so easy that he could continue it for four consecutive hours, without fatigue, in a quiet atmosphere.—*New York Sun.*

EDISON'S TELEPHONES.

THE invention of the telephone is unquestionably due to Prof. Bell, though other investigators *appear to have laboured with some success in a similar direction. His was the first really useful* instrument, and it still remains, as improved, the best of its kind. Mr. Edison was one of the first to utilise the invention of Prof. Bell, and he has probably made more experiments, and tried more modifications and developments of the speaking diaphragm than any half-dozen investigators in the same branch of discovery. We give from Mr. Prescott's work, "The Speaking Telephone," an abstract of some of the more interesting and useful applications of the principle devised by Mr. Edison, most of which were made while he was endeavouring to perfect a system of multiplex telegraphy, which should have for its base the transmission of acoustic vibrations. What is known as the tuning-fork system was the first of these devices, and the chief feature of interest in connection with it was the receiving telephone, one of which is shown in Fig. 1. These receivers were formed of telescopic tubes of metal, by lengthening or shortening of which the column of air in either could be adjusted to vibrate in unison with the proper tone of the fork, whose signals were to be received by each particular instrument. An iron diaphragm was soldered to one end of these tubes, and the latter placed in such a manner as to bring the diaphragm of each respectively just in front of an electro-magnet, which in action would cause them to vibrate. When the column of air in either receiver was properly adjusted to a given tone, the signals due to stopping and starting the vibrations by the distant key were very loud, as compared to other tones not in harmony with the column of air. Flexible rubber tubes, with ear pieces were connected to the receivers, so that, in using the instruments, the head of the operator was not required to be held in an unnatural or strained position. This system worked very well, but one defect in it was apparent from the first, and that was its continual tendency to give the operator what is termed the back-stroke, which renders signals unintelligible.

FIG. 1

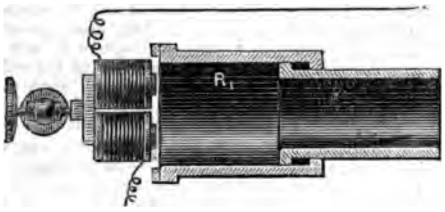


FIG. 2

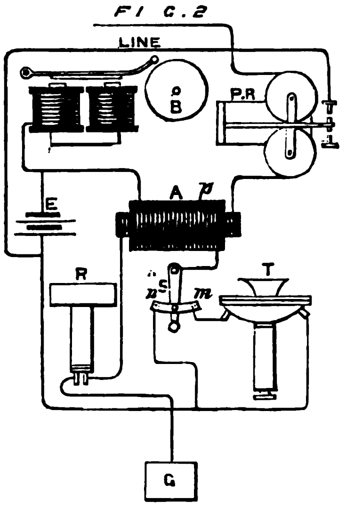


FIG. 3

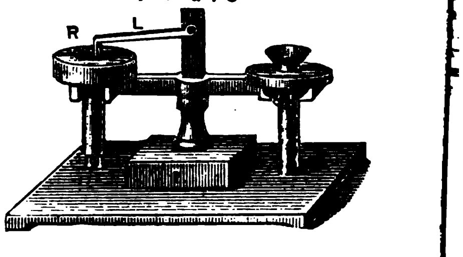


FIG. 6

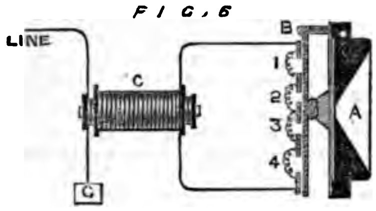


FIG. 7

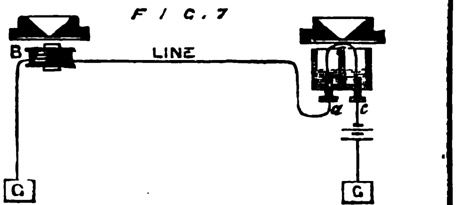


FIG. 4

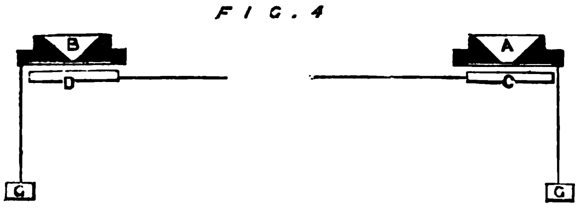
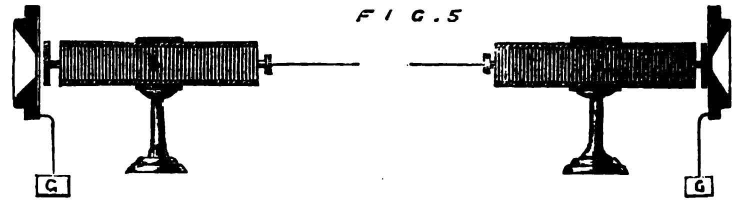


FIG. 5



While engaged in experimenting with this telephone Mr. Edison discovered that the sound waves could be transformed into electrical pulsations without the movement of any intervening mechanism—a discovery that led to the invention of the carbon telephone.

The manner in which this result was reached is thus described by Mr. Edison:—I first substituted a spiral spring of about a quarter inch in length, containing four turns of wire, for the rubber tube which connected the diaphragm with the discs. I found, however, that this spring gave out a musical tone, which interfered somewhat with the effects produced by the voice; but, in the hope of overcoming the defect, I kept on substituting spiral springs of thicker wire, and as I did so I found that the articulation became both clearer and louder. At last I substituted a solid substance for the springs that had gradually been made more and more inelastic, and then I obtained very marked improvements in the results. It then occurred to me that the whole question was one of pressure only, and that it was not necessary that the diaphragm should vibrate at all. I consequently put in a heavy diaphragm, one and three-quarter inches in diameter and one-sixteenth inch thick, and fastened the carbon disc and plate tightly together, so that the latter showed no vibration with the loudest tones. Upon testing it I found my surmises verified; the articulation was perfect, and the volume of sound so great that conversation carried on in a whisper three feet from the telephone was clearly heard and understood at the other end of the line. This, therefore, is the arrangement I have adopted in my present form of apparatus, which I call the carbon telephone, to distinguish it from others.

The accessories and connections of this apparatus for long circuits are shown in Fig. 2. A is an induction coil, whose primary wire, *p*, having a resistance of several ohms, is placed around the secondary, instead of within it as in the usual manner of construction. The secondary coil, *s*, of finer wire, has a resistance of from 150 to 200 ohms, according to the degree of tension required; and the receiving telephone, R, consists simply of a magnet, coil, and diaphragm. One pole of the magnet is connected to the outer edge of the diaphragm, and the other, which carries the wire bobbin of about 75 ohms resistance, and is included in the main line, is placed just opposite its centre. P R is the signalling relay, the lever of which, when actuated by the current from a distant station on the line in which the instrument is included, closes a local circuit containing the vibrating call bell, B, and thus gives warning when speaking communication is desired. Besides serving to operate the call-bell the local battery, E, is also used for sending the call signal. S is a switch, the lever of which, when placed at *o*, between *m* and *n*, disconnects the transmitter, T, and local battery, E, from the coil, A, and in this position leaves the polarised relay, P R, free to respond to currents from the distant station. When this station is wanted, however, the lever, S, is turned to the left on *n*, and depressed several times in rapid succession. The current from the local battery, by this means is made to pass through the primary coil of A, and thus for each make and break of the circuit induces powerful currents in the secondary, which pass into the line and actuate the distant call-bell. When the call signals have been exchanged, both terminal stations place their switches to the right on *m*, and thus introduce the carbon transmitter into their respective circuits. The changes of pressure produced by speaking against the diaphragm of either transmitter then serve, as already shown, to vary the resistance of the carbon, and thus produce corresponding variations in the induced currents, which, acting through the receiving instrument, reproduce at the distant station whatever has been spoken into the transmitting instrument.

For lines of moderate lengths, say from one to thirty miles, another arrangement may be used advantageously. The induction coil, key, battery, and receiving and transmitting telephones are similar in every respect to the apparatus shown in Fig. 2; the switch, S, however, differs somewhat in construction from the one already described, but is made to serve a similar purpose.

I have also found on lines of from one to twenty miles in length, that the ordinary call can be dispensed with, and a simplified arrangement substituted. This latter consists simply of the ordinary receiving telephone, upon the diaphragm of which a free lever, L, is made to rest, as shown in Fig. 3. When the induced currents from the distant station act upon the receiver, R, the diaphragm of the latter is thrown into vibration, but by itself is capable of mly a comparatively weak sound; with the sting upon its centre, however, a sharp ing noise is produced by the constant and bounds of the lever, which thus answers very calling purposes at stations where there is tively but little noise.

Edison has also used direct and induced to release clockwork, and thus operate a d by the action of these currents on tuning lls were rung and signals given.

other call apparatus two small magnetic s, whose rates of vibration are the same, ed in front of separate electro-magnets, the f which join in the main line circuit. When he pendulums is put in motion the currents d by its forward and backward swings in the electro-magnet pass into the line, and at site terminal, acting through the helix there, e second pendulum to vibrate in unison with er.

shows a form of electrophorus telephone ts by the approach of the diaphragm con- n A or B towards, or its recession from a harged electrophorus, C or D. The vibrations ansmitting diaphragm cause a disturbance of ge at both ends of the line, and thus give rise sounds. Perfect insulation, however, is ne- and either apparatus can be used both for tting and receiving, but the results are ne- very weak. Another form of electro-static e is shown in Fig. 5. In this arrangement iles of some 20,000 discs each are contained tubes, A and B, and conveniently mounted , wood, or metal stands. The diaphragms, re in electrical connection with the earth, are ed opposite to one pole of each of the piles, e opposite poles are joined together by the luctor. Any vibration of either diaphragm is able of disturbing the electrical condition of hbouring discs, the same as in the electro- telephone; and consequently the vibrations, oduced by the voice in one instrument, will to corresponding electrical changes in the nd thereby reproduce in it what has been to in the mouthpiece of the former.

this arrangement fair results may be ob- and it is not necessary that the insulation be so perfect as for the electrophorus appara- ig. 6 shows a form of electro-mechanical e. Small resistance coils (1, 2, 3, &c.) were ged with connecting springs near a platinum ver, B, in connection with the diaphragm in any movement of the latter caused one or the coils to be cut in or out of the primary f an induction coil, C, the number, of course, with the amplitude of the vibrating gm. Induced currents corresponding in with the variations of resistance, were thus the line, and could then be made to act upon ary receiving telephone. By arranging the n a sunflower pattern about a circular lever, te sentences have been transmitted by this but the results were very harsh and dis- le.

7 shows a form of the water telephone, in double cell was used, so as to afford con- e variation of resistance for the very slight nts of the diaphragm. The action of the us will be readily understood from the en- , where a wire in the form of the letter Ω is with the bend attached to the diaphragm, and s dipping into the separate cells, and thus form part of the circuit when the line is o the instrument at *a* and *c*.

Edison is now conducting experiments with a electric telephone, which gives some promise ming serviceable. In this arrangement a gm of vulcanite is placed in front of a sensi- rmopile at each end of a line wire, in the of which are included low resistance-receiving ents. The principle upon which the appara- ks depends upon the change of temperature d in the vibrating diaphragm, which Mr. says is much lower, as the latter moves for- than in the return movement. Sound waves s converted into heat waves of similar ristic variations, and the inventor hopes to be able, by the use of more sensitive thermo-piles, to transform these heat waves into electrical currents of sufficient strength to produce a practical telephone.

AN IMPROVED FORM OF MARQUOI'S SCALE.*

THE attempt by one of the students in the Dynamical Engineering Department of the University, to invent some form of parallel ruler which would line shade cylindrical surfaces, led the writer, following out an idea suggested by Marquoi's Scales, to the invention shown in the accompanying sketch, and described below. The instrument consists of the following parts (Fig. 1):—1. A white wood straight edge two feet long, E F. On one edge it is divided into ¼in. spaces. On the other edge a scale of versed-sines to a radius of 4in. is laid off. Diameter, 8in. 2. A pair of white wood rulers, A D and C D, each 8in. long, hinged with an ordinary rule joint at D, and arranged so that they can be opened to any angle under 30°, and held there by means of a brass strip, A B, able to turn about the pin at A, and sliding under the clamp at C with sufficient friction to be held at any point.

If we take any triangle, as G H K (Fig. 2), and laying its hypothenuse, G K, along a straight line, G K_1, slide it along this line a distance as G G_1 = K K_1, we see that the new position, G_1 H_1, of the line, G H, is distant from its former position a perpendicular distance, G_1 L = G G_1, sin H G K and parallel to it.

Let a = the required distance apart of the parallel lines.

Let m = the length of one division on the rule, E F = G G_1.

Let ϕ = the angle, H G K.

We have

$$a = m \sin \phi.$$

$$\sin \phi = \frac{a}{m}.$$

FIG. 1

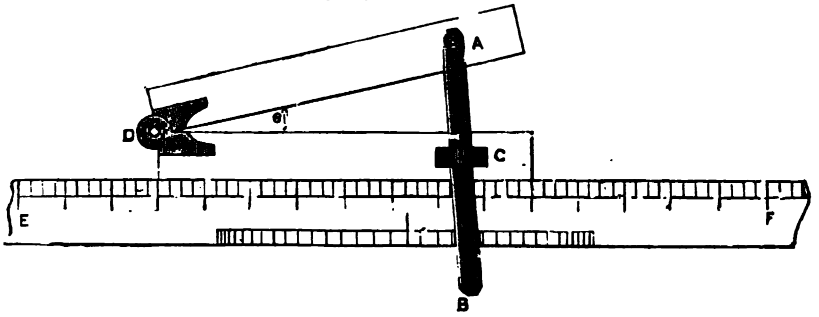
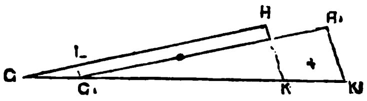


FIG. 2



In the scale shown in Fig. 1, the upper edge of the straight edge has been divided into spaces of ¼in. length.

To rule parallel lines ⅛ of an inch apart, we must place the hinged rulers at an angle $\phi = 30°$.

Thus,

$$\sin \phi = \frac{\frac{1}{8}}{\frac{1}{4}} = \tfrac{1}{2}. \quad \text{Therefore, } \phi = 30°.$$

For space = $^1/_{12}$ inch. $\sin \phi = {}^4/_{12} = {}^1/_3$.
,, $^1/_{16}$,, ,, $\phi = {}^1/_4$.
,, $^1/_{20}$,, ,, $\phi = {}^1/_5$.
,, $^1/_{24}$,, ,, $\phi = {}^1/_6$.
,, $^1/_{32}$,, ,, $\phi = {}^1/_8$.

Therefore $\phi = 19° \ 28'$
,, $\phi = 14° \ 29'$
,, $\phi = 11° \ 33'$
,, $\phi = 9° \ 36'$
,, $\phi = 7° \ 11'$
&c., &c.

Considering now the scale of versed sines, which is laid off along a diameter of 8in., for intervals of 5° of arc, and observing that the ratio of the distance between any two ruled lines to the length of a division on the rule = sin ϕ; we see that we have a means of altering the diameter of the cylinder to be shaded, and also the distance apart of the shade lines in any ratio we may desire. Thus, for a cylinder 1in. in diameter we have the ratio

$^1/_8 = \sin \phi$ and $\phi = 7° \ 11'$
For a ¾in. cylinder $^3/_{32} = \sin \phi$ and $\phi = 5° \ 23'$
,, ½in. ,, $^1/_{16} = \sin \phi$ and $\phi = 3° \ 35'$
,, ¼in. ,, $^1/_{32} = \sin \phi$ and $\phi = 1° \ 47'$

For intermediate values ϕ can be accurately calculated or set by approximation, as desired.

The advantages derived from the use of this scale are:—

1. The reduction of error. Thus, an error of one one-hundredth of an inch on the scale in adjusting the rulers becomes, if the angle $\phi = 7° \ 11'$, or $\sin \phi = \frac{1}{8}$, one-eight-hundredth of an inch.

2. An exquisite accuracy in spacing of cross-hatching, division of lines, or shading of cylindrical surfaces, otherwise only attainable by long and constant practice.

3. The sight is greatly asissted, the divisions on the scale being so much larger than the distances between the lines.

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* By WM. D. MARKS, Whitney Professor of Dynamical Engineering, University of Pennsylvania, in the *Journal* of the Franklin Institute.

USEFUL AND SCIENTIFIC NOTES.

Synthesis of Isatin and Indigo-Blue.—Baeyer has endeavoured to prepare isatin by oxidising the CH_2 group in oxindol to CO, but has failed to accomplish this either directly or by the introduction of chlorine or bromine. He now points out (*Ber. Deut. Chem. Gesell.*, 1878, xi., 1228) that the nitrosooxindol, described by Knop and himself, contains the nitroso-group in the desired position, and that by oxidising the amidooxindol derived from it, with iron chloride, copper chloride, or nitrous acid, isatin is quite readily prepared. By the synthesis of isatin the problem of the preparation of indigo-blue from coal-tar is solved, since it was shown some time since by Baeyer and Emmerling that isatin could be converted into indigo blue. Baeyer has found, moreover, that indigo blue can be obtained from hydrindinic acid and amidooxindol by the employment of phosphorus oxychloride and pentachloride.

Gilding Metallic Articles.—In the *Chemiker Zeitung* Dr. E. Ebermeyer gives a formula for gilding metallic articles so as to look like polished gold, by simply dipping them into a warm solution. Dissolve ten grammes of gold in forty grammes of hydrochloric acid and fifteen grammes of nitric acid; stew down, letting as much of the acid escape as possible; then throw down the gold as fulminating gold by means of spirit of ammonia; filter, and wash. In the meantime dissolve one hundred grammes of cyanide of potassium in as little water as possible, and then dissolve the gold upon the filter with the cyanide solution. Pour this solution again and again over the filter until all the brown particles are dissolved, when the gilding solution is prepared by the addition of one litre of distilled water. Into this solution, while warm, dip the metallic object to be gilded, and when drawn out it will have all the appearance of polished gold. The formula for silvering is as follows:—Dissolve twenty grammes of silver in sixty grammes of nitric acid, and precipitate with a solution of twenty grammes of caustic potash in water upon a filter, and wash with water; now redissolve upon the filter with a solution of one hundred grammes of cyanide of potassium in water; then dilute the whole to two litres with distilled water, and use like the gilding solution.

Blasting Gelatine.—Nobel, the inventor of dynamite, is reported to have devised a still more powerful explosive, to which he gives the above name. Its composition is 93 to 94 per cent. of nitroglycerine, and 6 to 7 per cent. of collodion cotton. It is tough, but may be made into cartridges, cakes, or balls, and may easily be cut with a knife or scissors.

Large Lenses.—Messrs. Chadburn, of Nursery-street, Sheffield, optical instrument manufacturers, are now making a couple of spherical lenses which, when completed, will probably be the largest ever made. Each is 22in. in diameter, each has in it 400 square inches of glass, and each weighs over 1 cwt. They have been made for the Autotype Works, Brownlow-road, Ealing, and with them the company will be able to take photographs 7ft. long—the largest ever produced. There is great difficulty in working such a massive piece of glass to keep it perfectly free from flaws or scratches, and to get an equal polish on it all over. If polished more in one part than another it would not be sufficiently accurate for the purposes for which it is intended. Each lens takes about three months to grind; and, after the polishing, care has to be taken to let it cool gradually. One of the lenses is finished, and the other is in progress, and when finished they will be perfect and unique pieces of work.

SCIENTIFIC NEWS.

THE trial of the Pyx was duly made last week, and was, as usual, satisfactory—in fact, the most accurate pyx made since the new trial plates were introduced by the Coinage Act of 1870. The old complaint of the machinery, which is antiquated and almost worn out, is renewed; but there is no intention of replacing it until something is definitely settled as to the site of a new mint. If the mint is still to remain in its old quarters new machinery must soon be supplied; but if it is to be removed, and it should be if the new bridge is thrown over the Thames, the Government will probably wait before ordering the machinery. The deputy-master of the Mint is forming a classified museum of coins, with a view to improvement in the designs of the dies employed for our coins, some of which are the reverse of artistic.

The telephone has been fitted up at Wimbledon in the council tent, at the firing points, at the meteorological tent, and at the press tent, and has worked very well indeed considering the number of sounds continually heard on the common. Many of the wires are, we believe, carried through tubing, which has the effect of preventing the telephone wires from transmitting signals passing on the ordinary telegraph wires.

A bill has been printed which proposes to enable the trustees of the British Museum to remove the zoological, geological, palæontological, mineralogical, and botanical collections to the Natural History Museum at South Kensington. The bill is endorsed by Mr. Walpole, Mr. R. Lowe, and Sir J. Lubbock.

The Pandora has been renamed the Jeanette. She was to leave Havre last Monday for San Francisco. to refit and prepare for her Arctic voyage in June next. It is not yet settled whether Mr. J. G. Bennett or Mr. Stanley will have the command of the expedition.

Sheffield is leading the way in the matter of sending artisan reporters to the Paris Exhibition, and not a few firms are giving some of their trusty workmen an appropriate holiday by combining business with pleasure. There is, of course, plenty of time, but it is to be hoped that the arrangement set on foot by the Society of Arts will not be hurried at the last moment, and so fail in its main purpose.

A fatal case of poisoning by peach kernels is reported from Paris. The child is stated to have been less than six years old, and yet he had sufficient strength and perseverance to obtain enough kernels to kill him. We doubt the story as we receive it, but it cannot be too widely known that the flowers and kernels of the majority of peaches are poisonous, and even the leaves. Of late years some sweet-kerneled varieties have been obtained from Syria, and been put into cultivation in this country, and it is doubtful whether one ounce of these kernels contain so much as a grain of hydrocyanic acid. All members of the genus Amygdalus contain more or less prussic acid in their flowers and fruits (the latter, of course, being the stone); the sweet almond possesses a very infinitesimal quantity, but the bitter almond and the peach and nectarine contain notable quantities in their kernels. The apricot is a Prunus, and has, like the plum, a bland and harmless kernel.

A report on the use of steam on the Vale of Clyde tramways has been presented by Major General Hutchinson. In the main it is favourable, as the locomotive employed does not emit steam, smoke, or hot air in quantity sufficient to annoy passengers. He proposes, however, that the run (1¼ mile) should occupy 12 minutes instead of 9½, including an average of five or six stops, and he would limit the speed to 8 miles an hour.

Two prizes have been offered by the faculty of Göttingen for the best treatises on the causes affecting the chemical composition of plants of the same species, such as soil, climate, &c. They must contain the results of independent research, a critical review of the facts *known, and suggestions as to the method of carrying on the work. The treatises,* which may be written in German, French, English, or Latin, must be sent in before the end of August, 1880. The prizes offered are 1,700 and 680 marks respectively—*i.e.*, about £85 and £34.

Prof. W. Hoffmann directs attention to the spontaneous ignition of hydrogen. The phenomenon has been noticed in works where large quantities of chloride of zinc are prepared. Fragments of the zinc, when very porous, are lifted above the liquid during the violent evolution of the gas, and act in the same way as spongy platinum in the presence of hydrogen and air. He, therefore, recommends the preparation of zinc chloride out of doors. The ignition of the hydrogen can be shown by treating a few kilogrammes of finely-divided zinc with acid. The zinc dust may even ignite upon contact with water.

M. Coquillion has brought a point of considerable importance to coal miners before the Academy of Sciences. He finds that when the atmosphere is still, the gas escaping from the coal mixes very slowly with the air, and appears to form distinct zones.

Major Ford, giving an opinion as to the explosion of dynamite by which two miners were killed near Barrow, showed that by emptying a dynamite cartridge into a tumbler of water the sand fell to the bottom, while the nitro-glycerine floated. He pointed out that the latter would find its way through the fissures in the rock, and explode whenever it reached the requisite temperature, whether from a blow or from fire. He suggested that dynamite cartridges should be charged in waterproof bags.

The distribution of prizes and certificates to the working men and women who passed the examination on Mr. Twining's lectures will take place at the City of London College, 52, Leadenhall-street, on Friday, the 19th inst., at 8 p.m., when the Rev. Prebendary Mackenzie will take the chair. The admission is free, and all friends are cordially invited.

The process of so-called sulphuric saponification was first made known by M. Fremy in 1836. In it sulphuric acid is caused to act on fatty substances, producing sulpho-glyceric acid and sulpho-fatty acids. These double acids, submitted to boiling water, are decomposed into glycerine and fatty acids. M. Fremy's hope that the discovery would be utilised by candle-makers has been largely realised — the old method of saponification by lime being abandoned by many for the new method. Hitherto distillation has generally been resorted to to purify the fatty acids obtained by means of sulphuric acid. This is rather inconvenient, and M. Fremy therefore counselled the manufacturers to do on a large scale what he has done on a small one in his laboratory—viz., either previously purify the neutral fatty matters employed, or cause the sulphuric acid to act in a slow and moderate way, thus dispensing with distillation. The suggestion has in some quarters been adopted, and at the Paris Exhibition may be seen solid fatty acids, entirely white, obtained without distillation by means of sulphuric saponification.

We may here note that a valuable paper by M Kopp, on Chemical Industry at the Paris Exhibition this year, is commenced in the *Moniteur Scientifique* for July. In the same number will be found a paper (abstracted from the Italian) giving physico-chemical researches on the different allotropic states of hydrogen, by M. Tommasi.

A curious parasitic affection of the hair is said to occur in the province of La Canca, Columbia. The hairs affected by it present a series of small, very hard nodosities or knots, invisible to the naked eye, at regular intervals of their length. When a comb is passed through the hair it produces a peculiar crepitating noise, whence the disease is called "la piedra" (the stone). The disease is not contagious. It can be cured by greasing the head well. M. Desenne has made a microscopical examination of those knots, which are resolved into a number of polygonal elements, &c., and appear to be the product of some cryptogam. The details will be found in *Comptes Rendus.*

The chemical composition and the functions of leaves of plants has been engaging the attention of M. Corenwinder for some years past, who describes his researches in a recent number of the *Annales de Chimie et de Physique.* His results are against the common theory that plants have two respirations, one by day, the other by night, and that these are in opposite directions. Briefly his views are these: Leaves, in regard to air, have two distinct functions. By their protoplasm they constantly respire—*i.e.*, absorb oxygen and produce carbonic acid. By their chlorophyll, on the other hand, they "inspire" by day only carbonic acid, and "expire" oxygen. In early age protoplasm predominates in the cells, and there is little chlorophyll; thus during this period the respiratory function prevails over the chlorophyllian function, so that the leaves exhale carbonic acid without interruption. As the leaves grow larger the protoplasm diminishes, and the chlorophyll increases, so that they rapidly lose the power of emitting carbonic acid by day, and ere long they emit only oxygen. It is, then, only by placing them in the dark, or at least softening the brightness of the light—*i.e.*, suspending more or less the action of chlorophyll—that the effect of respiration can be shown. There is thus only one true respiration—the rôle of the chlorophyll is of a different order; it is an act of assimilation.

The common gold leaf electroscope does not manifest its indications very readily to a large audience, and the method of projection is not always easy. On this account a new lecture spectroscope based partly on the principle of the torsion balance, has been devised by M. Boltzmann. It is described in Carl's *Repertorium.*

The city of Paris has just expended more than 400,000 francs in bringing water into a large basin constructed in the Place d'Italie. This basin measures 40 metres in diameter. Its fountain, tried lately, attained a height of 13 metres. According to *La Nature,* "an elegant square of circular form surrounds this jet of water."

There has been discovered in Algeria, about 8 kilometres from the port of Oran, a quarry of excellent lithographic stone, likely to rival in every respect the best stone of the old quarries of Munich, which are now exhausted. The quarry is at the side of a national road, and is said to be of large size.

The postal wrappers and envelopes in common use can, of course, be opened easily by loosening the gum with moisture. Postage stamps can, in the same way, be dishonestly detached. The object of a recent American patent (No. 191420, of 1877), by Mr. Fox, of Baltimore, is to meet this evil. Two adhesive compounds are used—one is applied to the flap, the other to the part against which this is pressed. The latter, which is not touched with the lips or the tongue, is prepared thus:—About 2·5g. crystallised chromic acid is dissolved in 15g. water and 15g. ammonia. To this mixture are added about 10 drops of sulphuric acid, and 30g. of sulphate of cupric oxide-ammonia, as also 4g. fine white paper. The other solution, for the flap (which is moistened with the mouth), is obtained by dissolving isinglass in dilute acetic acid (1 part acid to 7 parts water) over the water bath. When the parts of the wrapper, &c., are fastened together, the union is so firm as to resist all loosening influences, acids, alkalies, hot or cold water, or steam; the wrapper can only be opened by tearing or cutting.

The steam elevated railways in the streets of New York seem to be amply fulfilling the gloomy prophecies that were made regarding them. Accidents occur on both lines with alarming frequency. Two persons have been killed falling from the metropolitan structure. A workman had his head nearly cut off by a locomotive while painting the ironwork. Sparks from a furnace have set fire in one case to bales of cotton; in others, to awnings in the street below; and several persons have been struck and injured by objects falling from the track. On the thoroughfares below there have been numerous runaways, and one person was seriously injured on leaning out of a street car by his head striking one of the supporting pillars of the road above. On the New York elevated line some mischievous boys climbed up by the lattice-work pillars and placed heavy paving stones on the rails. The train was greatly shaken, but fortunately the guard rails kept it on the track. This is a sample of what is going on, and it is suggestive to remember that the line on which nearly all these accidents have occurred is less than five miles long, and has been in operation only three weeks. The amount of nuisance also connected with such railways is now being fully realised.

The Italian physicist, M. Maggi, stated some time since, that in studying the thermal conductivity in a circular plate of soft iron, placed on the poles of a powerful horseshoe electro-magnet, he found the curve produced by the fused wax to be an ellipse, whose greater axis was at right angles to the line passing through the poles of the magnet. It was, on the other hand, circular when the plate was in its natural state. This result has been doubted. MM. Naccari and Bellati, having tried to realise it by a great many different means, conclude that f the effect described be real, it is much less marked than M. Maggi stated, and is within the limits of possible experimental error. It s thought that Maggi, in his single experiment, did not avoid the abstraction of heat caused by the contact of the electro-magnet, and that a perturbation resulted, which, uniformised through the plate, was manifested, n the upper part, by a larger elliptic form in the curve of the fused wax.

If two electric sparks be produced simultaneously at the ends of a short tube smoked nteriorly, the two explosions give interference igures in form of a black ring in the middle of the tube. If the sparks are not simultaneous, he ring is somewhat displaced. This method M. de Waha has recently pointed out) may erve for determining the velocity of sound. It may also be used for measuring the velocity of propagation of electricity in a conductor by causing one of the sparks to be formed at he middle, the other at the end of a long wire. The method presents some practical difficulties. It is necessary to have complete ymmetry in the extremities of the tube, and o suppose that the two waves produced are dentical. In the case of the discharge of a battery, the ring examined in the microscope s seen to be formed of several rings, due to he oscillating discharge. From the position of these rings the partial discharges are inferred to be separated by an interval of about a millionth of a second.

In a recent communication to the French Academy M. Tholozan gives some information regarding diphtheria in the East, and specially in Persia. It seems to have been quite unknown in Persia previously to 1869.

Copying by Photography.—Mr. H. Pellet, a French chemist, has invented a new process for the purpose of making photographic copies of machinery, drawings, plans, maps, &c., in blue lines on a white ground. This process (according to *La Nature*) is based upon the peculiar property of perchloride of iron, by means of which it is changed into protochloride on exposure to light. The inventor prepares a sheet of paper by first dipping it in a solution composed of 100 parts water, 10 parts of perchloride of iron, and 5 parts of oxalic acid. This process renders the paper very sensitive. The paper can be sized as desired by the addition of isinglass, gelatine, or other substances. M. Pellet calls paper so treated cyanafor paper, and when dried in the dark may be kept for almost any length of time. When it is desired to make a drawing on transparent paper, the drawing is stretched over a dry sheet of the cyanafor and a plate of glass placed over this, after which it is exposed to the light. When the full rays of the sun in summer are allowed to fall on the glass it requires from one-fourth to one-half minute to decompose the perchloride of iron. The parts, however, directly under the lines of the drawing, being protected, do not become affected by the light. In winter double this time is required, and in cloudy weather from two to six minutes. The paper is now dipped in a bath of prussiate of potash, the solution being in the proportion of 16 or 18 of the prussiate to 100 of water, and the perchloride where unchanged becomes blue, the changed surface remaining white. The surface of the sheet is then freely washed in water, and dipped in a solution composed of chlohydric, 8 to 10 parts, and water, 100 parts, and again washed off in water when the drawing appears in distinct blue lines.

LETTERS TO THE EDITOR

◆

[We do not hold ourselves responsible for the opinions of our correspondents. The Editor respectfully requests that all communications should be drawn up as briefly as possible.]

All communications should be addressed to the Editor of the English Mechanic, 31, *Tavistock-street, Covent-garden,* W.C.

All Cheques and Post-office Orders to be made Payabl to J. Passmore Edwards.

*** *In order to facilitate reference, Correspondents, when speaking of any Letter previously inserted, will oblige by mentioning the number of the Letter, as well as the page on which it appears.*

"I would have everyone write what he knows, and as much as he knows, but no more; and that not in this only, but in all other subjects: For such a person may have some particular knowledge and experience of the nature of such a person or such a fountain, that as to other things, knows no more than what everybody does, and yet, to keep a clutter with this little pittance of his, will undertake to write the whole body of physicks: a vice from whence great inconveniences derive their original."—*Montaigne's Essays.*

◆

CASSEGRAIN REFLECTOR—"ASTRONOMICAL" (?)—MEASURING FOCUS—THE ZODIACAL LIGHT—JUPITER AND SATURN—THE HARVEST MOON—PROFESSOR ADAMS'S DISCOVERY.

[14588.]—I am sorry to say that I am unable to give any definite reply to Mr. Godfrey (letter 14527, p. 417). Probably the most likely place for him to find the paper by the Astronomer Royal of which he speaks would be in one of the early volumes of the *Cambridge Philosophical Transactions.* To these, however, I have no access in the place whence I write, and nothing of the kind spoken of by your correspondent occurs in any of Sir George Airy's books or papers in my own possession.

"Triangle" (query 33367, p. 430) has addressed his question to the wrong periodical altogether. He should write to the editor of *Zadkiel's Almanac,* and not to the English Mechanic.

In reply to "J. A. W." (query 33376, p. 430) the focus of a convex lens is measured from the side nearest the focus—*i.e.*, from that opposite to the one on which parallel rays are incident.

With reference to the query (33379) put by "X." on p. 430, I am unaware of any recorded observations of the Zodiacal Light of this year (certainly there are none either in the R.A.S. *Monthly Notices* or the *Astronomical Register*); but I have myself seen it, and pointed it out to others upon more than one occasion during this last spring. I made no record of the dates of this, as the phenomenon is so very familiar a one to me. I may add that my observations were made in England.

"G. T. G." (query 33392, p. 431) is mistaken in supposing that Jupiter and Saturn will be "very near" to each other either in 1880 or 1881. In 1880, for example, Jupiter will come into opposition with the Sun at 10 a.m. on October 7th. When he crosses the Greenwich Meridian that night his R A. will be 0h. 55m. 39·69s., and his Declination North 4° 11′ 1·4″. At this time we may take Saturn's R.A. to be 1h. 41m. 42·81s., and his Declination 7h. 31m. 25·3s. North, so that the planets will be separated by a considerable interval. Again, Saturn comes into opposition with the Sun at noon on October 18th, 1880, his R A. at Transit that night being 1h. 38m. 28·06s., and his North Declination 7° 15′ 28·1″; while Jupiter's R.A. will be 0h. 50m. 16·91s., and his Declination North 3° 37′ 59·5″. This, as may be seen at a glance, shows that Jupiter and Saturn will have separated during the interval between their respective oppositions. Turning now to 1881 we do find that at 1 p.m., on April 22nd, Jupiter will be in conjunction with Saturn. At this instant, however, Jupiter will be 1° 18′ North of Saturn, so that the idea of getting them both into a telescopic field, whose diameter subtends an angle of 40′, is a wholly visionary one; even were it not the fact that Jupiter is on the Meridian almost precisely at noon on that day.

"X." (query 33395, p. 431), may find the date of the Harvest Moon for any year, by remembering that it is the Full Moon which falls nearest to the Autumnal Equinox, either before or after it. In 1878, the Sun enters Libra at 4 a.m. on September 23. Now the Moon will be full at 3h. 49·4m. p.m. on the 11th of September, and again on the 11th of October at 8h. 51·4m. a.m. The former date is actually the nearer to the Equinox; and, therefore, the Full Moon of September 11 is the Harvest Moon.

Pending the appearance of the supplementary number of the R A.S. *Monthly Notices,* I should recommend "J. E. A." (query 33430, p. 457), to buy the *Astronomical Register* for July, published by Potter, 31, Poultry, London. In it he will find a lucid précis of Professor Adams's paper, together with a report of the discussion which followed it.

A Fellow of the Royal Astronomical Society.

ZETA ORIONIS.

[14589.]—Has not Mr. Percy Smith (letter 14578, p. 448) made some little mistake in the position angle of the faint companion to ζ Orionis? I had considered the measure of this star, on p. 69 of Vol. XLII. of the "Memoirs," a misprint for 6·7°. (there are, by the way, several misprints in the "Temple" measures), and had marked it as such in my own copy of the "Memoirs of the R.A.S.," but Mr. Smith's letter in last week's English Mechanic seems to militate against this assumption. I have not time now to look up many previous measures, so I will only give one or two on which I can lay my hand at this moment:—

Herschel 1780·77 : 6·58°, **position not extremely exact.**
H. & S. 1823·14 : 7·2°.
Sm. 1839·19 : 7·8°.
Se. 1855·99 : 8·84°.

The variation, if any, seems in the opposite direction to that which Mr. Smith's measures seem to indicate. Secchi's distance of 114″ is of course absurd, but one can easily see how the mistake has arisen. Mr. Smith's 0·7° is, I think, impossible; the registered measure is, however, stated to be the mean of six observations, but the number of nights on which they were obtained is not mentioned. I should be glad if Mr. Smith would refer to the original record to see if there is any mistake in transcription. Mr. Lockyer says of this star, in the fourth edition of the translation of Guillemin's "Le Ciel," edited by himself and revised by Mr. Proctor:—"The small star below [the close pair], which the late Admiral Smyth in his charming book, 'The Celestial Cycle,' mentions as a test for his object-glass of 5·9in. diameter is now plainly to be seen in a 3¾in. The colours of this pair have been variously stated, Struve dubbing the sixth magnitude, which, by the way, was missed altogether by Sir John Herschel, olivaceæ subrubicunda." I have never met with Admiral Smyth's statement in the "Cycle," and it would be odd if the star was not to be plainly seen in a 3¾in., inasmuch as Smyth rates it at 10m. Sir William Herschel was the one who missed the close pair. We are also informed that Betelgeuse has recently descended to the sixth magnitude, and that at its minimum epoch of light Mira becomes "completely invisible, not to the naked eye only, but even to our telescopes." This last mistake has also found his way into many textbooks, including even those of Arago and Webb. **Herbert Sadler.**

SOLAR OBSERVATION—JUPITER.

[14590.]—Mr. B. Templar's method of solar observation is very good, when, as he says, several are going to observe at once; but for a single observer I must say a camera, in some form or other (preferably that of a lightly made cone), is best, for then the absence of extraneous light brings out the spots so much better, and exhibits the mottling on the disc. The camera may be advantageously supported on an arrangement like that proposed by Mr. Templar.

I glanced at Jupiter a little before 13h. on July 3, and was struck with the increased darkening of the equatorial zone since I last observed the planet with my 2½in. last September. On July 6, under very fine definition, I found the tint of the equatorial dark belts very easy, to my no small surprise. The colours were especially easy when a light cloud passed over the planet. As during last year, the N. belt exhibits most colour. The approach of I. and II. satellites on this evening was very interesting: to me they appeared as one star. Can any one tell me the distance separating their centres when nearest to each other? **F. C. Dennett.**

NOTES IN TRAVELLING.

[14591.]—Before leaving England at the end of May I noticed that a discussion had been going on in the columns of the English Mechanic respecting the possibility of seeing the reflection of a rainbow. I am glad that the foreign tour, from which I have not yet returned, has enabled me to give direct testimony to the fact. On June 18th, as I was coming back to Lucerne from an expedition to the site of the fearful avalanche which destroyed the village of Goldau, I noticed a beautiful rainbow on the opposite side of the bay of Kussnacht, which, as many of my readers may be aware, is an arm of the singularly-shaped lake of Lucerne. The shadow of the hill, along the lower part of which our road passed, and behind which the sun was declining, was thrown across the lake so as to cut off the bottom of the rainbow, and to cause an interval between the end of the bow and its reflection, which was remarkably fresh and vivid, and even the reflection of the pink and green of the outer bow was at one time distinctly perceptible. It was interesting to remark that when after a time the lake became so ruffled as to intercept entirely any distinct image of the opposite shore, the reflected rainbow was equally as conspicuous as before. A less intelligible peculiarity was the fact that, unless my eye greatly deceived me, the object and the image, had they been "produced" to meet, would not exactly have coincided so as to form a continuous arc, the reflection falling nearer to the centre of the circle by perhaps 1-8 to 1-10 of the breadth of the bow. I do not know whether this may have arisen from the change of angle which exhibits a bow to every eye—even in the same head, but no other explanation has occurred to me. The whole phenomena lasted for a considerable time.

As on many previous occasions I was impressed by what must strike even the most careless observer—the deep darkness of the nocturnal summer sky. This, of course, arises from the diminished northern latitude, which leaves but a feeble trace of twilight beneath the pole, but its effect, in conjunction with the greater purity of the air, is much more decided than might have been expected, the Galaxy and a multitude of minute stars being brought out in beautiful and, to us, unwonted brilliancy—a marvellous advantage to the Swiss or Italian astronomer.

On the night of July 22 there was a magnificent thunderstorm over the S. end of Lago Maggiore, which I watched for a considerable time from the hotel at Stresa. The distance being probably from 5 to 10 miles, the thunder was never loud, but the flashes which followed each other in rapid succession were very interesting in character. In three several directions the clouds were glowing like fiery furnaces, and frequently with an obvious mutual communication. As usual, the majority of the flashes were mere illuminations of the surrounding clouds by discharges out of sight, but frequently the narrow undulating ribbon of dazzling flame exhibited unmistakably its true nature. Very few indeed of these descended to the earth. I noticed only one. They seemed to be those discharges from cloud to cloud, the production of which in such rapid and prolonged succession it is so difficult to understand. On several occasions the form of the flash was most remarkable. Once I saw several long sinuous streaks—I believe three—all of the same pattern, slightly diverging from a focus out of sight, and reminding one strongly of the "thunderbolt" of the image of Jupiter Tonans. On the other hand some discharges were more like very short sparks. But on the whole, nothing that I saw gave me the impression of anything like "brush" or "glow" discharge, all the wide extended sheets of paler flame appearing to be nothing more than reflections of actual disruptive discharges hidden behind dense volumes of vapour, and such, from the observations of many years, I am inclined to think, is at least the general explanation of what is termed "sheet lightning." Another thing I noticed, with which I was previously familiar—that, notwithstanding theoretical considerations, the direction of the flash was occasionally very perceptible. How this is to be explained I do not know, but the impression upon the eye was frequently very distinct, and one curved flash appeared to dart upwards as evidently as others in an opposite direction. Having an excellent pocket spectroscope with me, by Browning, I made considerable use of it, though after a grudging fashion, as it interfered with my uninterrupted enjoyment of the exceeding grandeur and awful beauty of the display. The spectrum was, I think, invariably continuous, but once, probably when the slit happened to receive the direct flash, a bright band stood out conspicuously in the green, and on some other occasions the spectrum seemed to be crossed by a number of brighter lines.

Bonn, 11th July. T. W. Webb.

MECHANICAL POWER ON STREET TRAMWAYS.

[14592.]—We were once indebted to a Mr. Robert Crickmer for some very interesting communications, and in one of them he referred to steam carriages for common roads; would it be too much to ask this contributor to assist us with his experiences and views, now, on above similar subject? I may here suggest that there are many who are much surprised to hear of the light pressures and thin metal used in the boilers of Hancock and Ogle—say half a century ago. And a reference in "our" journal to these points by a qualified contributor like Robert Crickmer, would, I feel sure, convey interesting information to many hardly aware of what our predecessors worked up to in those days.

F. W. S.

THE WAY TO JOINT A BELT.

[14593.]—If "Chelt," letter 14531, after thinning the ends of the belt will cement the surfaces and hold them pressed together until the cement is set, and then stitch them in the way he describes, he will have the best possible joint; but this cannot be done in making the closing joint of a belt in position, because of the time required, and often the operator has a joint to make when he is mounted on a ladder. The following plan I saw in use in a bobbin mill some years ago. I was told it was the best for their use, where the spindles made about 6,000 revolutions per minute. I have since used it with success, and in *cases* where a thin belt passing over a small pulley *at a high speed, and doing light work,* has to be used, I believe it to be unequalled; it passes over the smallest pulley with perfect ease, and can be made in less than half the time required to make an ordinary spliced joint:—Place the ends of the belt to be joined as in Fig. 1, and with an awl make a row of holes at *a*, through both ends; then take about half a yard of strong twine (in some cases a lace or gut is best) and draw half the length through the first hole, then pass each end of the twine through the second hole, one end to the right and the other to the left, and draw both tight at the same time, and so on until the last hole is reached, when one end only of the twine is passed through; the two ends of the twine are then knotted tight together and the excess cut off. Fig. 2 shows the joint when the belt is stretched. Fig. 3 shows it passing over a small pulley, where it will be seen that in the act of bending over the curve there is no friction between the lace and the belt, and this is the reason of its superiority over other methods, where there is always more or less friction between the lace and the belt when bending over a curve. Another advantage is, that in this system the lace does not come into contact with the pulley, so that whatever friction or slipping may take place between the belt and the pulley, the lacing is perfectly unaffected by it.

FIG. 1

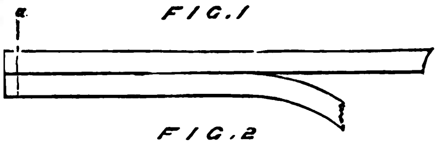


FIG. 2

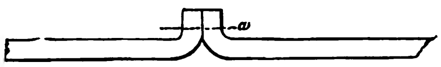
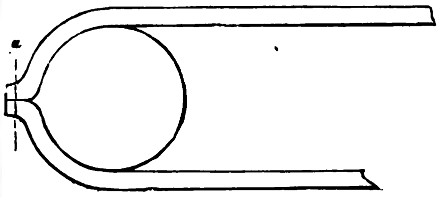


FIG. 3

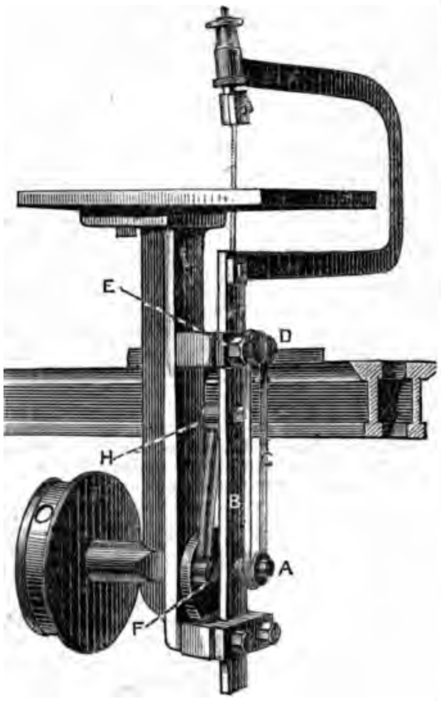


W. H. B.

A HANDY FRET-SAW MACHINE.

[14594.]—I inclose a photograph of a fret-saw machine I have made, and which I find a very useful addition to my workshop. It can be fixed either upon the lathe bed and driven from a pulley upon the crank shaft, or it may be fixed upon a bench and driven from any source of power. I drive it about three hundred strokes per minute, and can cut baywood 1¼in. thick without difficulty. In sawing fretwork I cut through several thicknesses at once, which is not only a saving of time, but in delicate work lessens the liability of breakage. I can also cut brass ⅛in. thick. I use any kind of saw suitable for the work I am engaged upon, from the finest German to a strong coarse one. The machine is so simple that an explanation is hardly requisite. The only part that may requir
explanation is the following:—From a stud,
slide, B, is an indiarubber band, C, passing
a knob, D, cast on cap, E; this band act
spring, and is of sufficient strength to draw
slide, B, &c.; by so doing all "backlash" or
of crank pin, F, and stud, H, are got rid of,
when the saw is at work there is little or no
The saw being well strained, and the frame
in a straight line, makes the cut clean and
through the wood, which is not the case in
of the small machines I have seen, which ar
better than toys, as they will not cut wood
than ¼in. or ⅜in. thick, and even then the p
the saw is rather uncertain. I may add in
sion that all the sliding parts were planed
planing machine, illustrated on p. 418 of this jo

W. T



ON THE APPLICATION OF THE ENGINE AS A MOTOR FOR ST TRAM CARS.

[14595.]—If the gas-engine can be succ
applied, in an engineering sense, to the propu
tram cars, the following advantages may rea
be expected to result, in comparison with
ployment of steam:—1st. A saving in the de
non-paying weight to be carried, by dispensi
the boiler and water tank and contents,
tank for condensing exhaust steam, and the c
and its contents. 2nd. Saving of the space o
by the boiler, &c. 3rd. As there is no fire
urged, so no noisy blast-pipe or troublesome
fan will be required. 4th. The total abse
smoke or vapour discharged into the air.

Against these a gas-holder will be required
to those used for lighting railway-carriages, o
I think will be preferable, the employment of
movable spherical vessels to contain the g
highly-compressed state. I assume that the
of the gas-engine will be about equal to that
steam-engine proper of the same power—a
the spaces occupied will be about equal. Ta
case of a car that requires on starting the
tion of three horses' power, if propelled by a
steam engine, a somewhat greater power
needed, because of the increased dead weig
be on the safe side, suppose that a power
horses has to be applied at times of em
although probably an average of not more t
and a half horses will be expended. I ob
your advertising columns that a respectab
state that their silent gas-engines work at
of 1d. per horse per hour, with gas at 4s. p
feet, but gas of good illuminating power is
some towns at 2s. 6d. per 1,000ft., and proba
of inferior illuminating power, but service
motive power purposes [is carburetted h
more or less valuable as a motor than th
volume of pure hydrogen gas?] can be m
much cheaper rate, probably not more than
1,000ft., including cost of compression and
At this rate, the car averaging two and
horses' power, will only cost in gas 1¼d. per
a rate more economical than any small
engine I have yet had to do with. As to w
cost of maintenance, that can only be det
by actual working, but stationary gas-engi
been found to cost little more in maintena
steam-engines. On the whole I think that
of the gas-engine for propelling street cars is
the attention of engineers and capitalists, ou
cipal authorities, and the general public.

W.

THE MONOPOLY IN LAND SCARCITY OF HOUSES FOR WORKING CLASSES IN SCOT

[14596.]—Before the present general de
in trade, when the British workman w
referred to as the most favoured in Eu
respect of the amount of wages paid to
class grudged that prosperity more than
proprietors of the country. To catch a sha
general prosperity, and much more than a
of the same, proprietors of feuing stances (
ing lots) in the neighbourhood of towns den
price for such equal to double that which w
for the same article at any other period.

In several instances which have come
own observation the price asked for buildin
the suburbs of thriving little towns in the
Scotland is now more than three times
paid for the same area during the past eigh
Building lots which used to be had for £3
are now offered at £13 for the same, givi
privileges than those enjoyed by those holdi
old charters in perpetuity.

The philosophy contained in the saying
with your own as you please" is well unde
the landed proprietors of Scotland. Highl
have been depopulated in the midland and
counties to make room for the red deer;
considerably benefiting the individual pro
respect to increase of rents; while, at the sa
the lord of the manor, or the superior of

olding tenaciously to their feudal rights and
), put their own value upon suburban lots
for feuing purposes; practically saying,
hem or want them; such is my price, and the
ly which I enjoy as a land proprietor I dare
sible Government to interfere with."

such an incubus as this pressing upon the
of a country, where is the possibility of
If the wages of the working classes are 40
. better than they were some 40 years ago,
ouse rent, local taxation, and the more neces-
icles of consumption have been advanced in
e proportion, where are the advantages
y the wages-receiving portion of the com-
?

ig the season of prosperity the working class,
stry and frugality, manage to get on com-
; but, when a commercial crisis comes, they
first to feel the change, and in no way so
in the fact that, while the market prices of
cessary articles are less, the house rent is
same. The prices now asked for building
owns are such that it is altogether impossible
ruct houses for working men and make the
king profitable from the return of rent.

such conditions building operations have
fewer, and the working classes are crowded
uses with small accommodation and high
The "superior," the term in Scotch legal
ogy for landlord or feudal proprietor, having
ed upon a price for the ground on his estate,
for building purposes, never afterwards takes
sideration the effect that such a course must
ily have upon the class directly affected by
t of the most unjustifiable monopoly existing
ountry.

long such an injustice as this is to be tole-
y the working class of the country it is
le to say; only, to the more intelligent of
ss, the social and political power of trade-
eem very insignificant when compared with
and well-established union of British land-

resent depression of trade is said to affect the
vilised world, and in every centre of indus-
he country manufacturing and commercia,
e is more or less paralysed. To revive trade
late industry, to advance science, and to
ur commerce, let the monopoly in land in
ritain be for ever abolished.

ve I am justified in calling your attention to
ect, knowing that the ENGLISH MECHANIC
nown to many of the worthy sons of labour,
, by your permission, many of its readers
e an opportunity of considering a question
have only here suggested as one well worthy
attention, and one in which they are deeply
d, in respect to the power which it exercises
y effort which they may make to better
dition or advance the social and industrial
of the country. **Pioneer.**

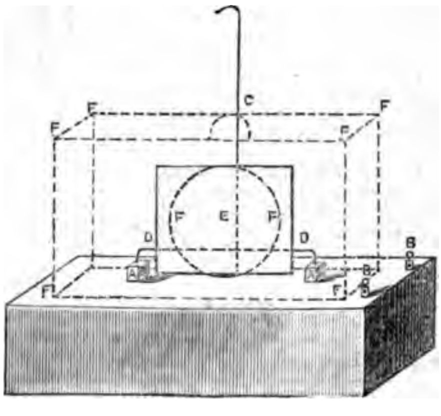
MICROPHONES.

.]—SUFFERING from a severe attack of
onimania, I have been trying my hand at
of making a microphone or two, trying
methods in the endeavour to arrive at the
and best. I venture to offer your readers
t of some days' work. I think that no one
the directions I now give will fail of success.
a toy-shop and buy a child's toy tambourine.
thin piece of white pinewood, say 2in. by
Vith a pair of scissors cut a piece of thin
per about ½in. broad, 2in. long. Keep one
d, cut the other by taking off the corners
t point, drill a hole towards the broad end
ough to take a small brass screw, at the
d another hole, but only large enough to
he end of small copper wire. Place this
opper thus shaped in a hand vice, and turn
ight angle the pointed end to the height of
inch. Now take another piece of copper
same breadth, a little short of an inch in
urn up one end in the same way. Bore a
this to take brass screw, get a piece of
ile it to 1in. long, ½in. broad, 2-8ths deep;
through it for screw. Now place this piece
across the larger piece of copper plate, and
firmly on to the board, passing, of course,
the plate.

he other piece of copper and screw it to the
the other end. Two very small blocks of
y now be cut, into which fix binding screws.
ajuline fix these one at each edge of the
ne, and then by the same process fix the
the centre with its two ends towards the
screws. When thoroughly firm bring a
er wire twisted into a helix, through the
e upright and twisted firm to that hole.
e other end round the screw of the binding
d screw it well down upon it. You have
ection with the carbon plate. Take a small
ut a nick in the centre of the upright at
end of the board, just deep enough to carry
f stout brass wire. Connect the copper in
way as the other to the binding screw in
th it, the distance between the two copper plates on the board being about half an inch. You have only now to cut a piece of stout brass wire, which, falling into the nick shall, by another nick in itself, so balance, that one end filed to a knife edge shall just touch the edge of the carbon.

This is a long story to tell of what, when seen, is very simple. As to the effect, although I have purchased some microphones from well-known makers and found them very good, for a large field, for fly walking, &c., the tambourine I find far the best. If the tambourine was supported on four pieces of oak I think it would improve it. **S. G. O.**

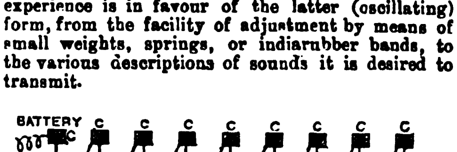
[14598.]—THE following is the description of a microphone which I have found to transmit the human voice as well or better than any I have made or seen. Talking 12ft. or 15ft. away from it can be heard with great distinctness, and a watch placed on the box can be heard equally as well, though I cannot hear a fly walk, nor have I been able to, with any I have made or seen, and I have made all those described in your paper. On a thin wooden box 10in. in length, and 6in. in breadth and depth, I place two hard pieces of gas carbon,



1in. square, A A, 3in. apart, and connect them with the binding screws, B B, at the end of the box. I next take a piece of iron wire (not too strong) and make an upright rod, C; from this is suspended a piece of copper wire, D D, with the ends well sharpened and turned slightly downwards, just long enough to rest on the middle of the blocks of carbon. It is best suspended on a very fine filament of silk. It is almost better to make small holes in the blocks and allow the ends of the wire just to rest in them. It requires some little care to raise this wire, but it quite repays any one to spend a little time over it. In front of this wire I glue a piece of card 2in. square, E; I then inclose all the working parts in a box, F, with a hole opposite the middle of the card, and when you are talking to it you must direct your voice to the hole. A piece of carbon will do instead of the wire, D D, but I think the wire is best.

Birmingham. **J. F. H. Edwards.**

[14599.]—I PROPOSE to give, as briefly as possible, an account of the results of some experiments I have made with various forms of microphones, premising that I do not pretend to be anything more than the merest amateur. All my microphones and telephones I have constructed myself chiefly from information gathered from your journal. I have the ordinary horizontal and vertical ones chiefly in use, and my experience is in favour of the latter (oscillating) form, from the facility of adjustment by means of small weights, springs, or indiarubber bands, to the various descriptions of sounds it is desired to transmit.



The weaker the battery power, within a reasonable limit, the clearer seems to be the tone and the better the effects generally. I use with the best results a battery composed of a piece of zinc and a piece of carbon, each scarcely the size of the little finger, separated by a piece of cork, and placed in a small tumbler with a very weak bichromate solution (about a large tea-spoonful). The pile microphone, with a similarly weak solution on blotting-paper appears to me to give excellent results (especially for articulate sounds), but at any rate, as I have constructed it, it is troublesome to handle, from the necessity of removing the zinc when not in use.

A succession of microphones connected together on one board in this way I found to have neither better nor worse results than a single one.

The pencils, A, are fixed in the usual way, the others, B, simply lean from block to block. The letters C indicate the carbon blocks, which are glued to the board, with the exception of the first and last of the series, which are fastened with the binding screws leading to the battery and line wire. Theoretically I think this arrangement should be efficacious.

I have produced sounds, but not of great distinctness, from a microphone constructed in the following manner:—I took off the sound-box containing the diaphragm from an ordinary telephone, and supported it on two little uprights in such a manner that a carbon pencil hanging downwards from the centre of the diaphragm came almost in contact with a globule of mercury contained in a depression in a small block of carbon placed beneath it. The diaphragm and carbon-block being connected so as to form part of a circuit with a battery and telephone, on speaking loudly to the diaphragm sounds were transmitted, but not very distinctly.

For the information of your correspondent, "L. B. B.," who writes to you on "Singing Microphones," I may tell him that I was startled by exactly the noise he described. This was on last Sunday fortnight, the day of the great thunderstorm. There was no apparent cause for the sound, which could be heard plainly throughout a large room, and I can only attribute it to the state of the atmosphere acting inductively in some way. A slight touch on the pencil of the microphone would stop it at once.

A cheap and effective apparatus to call attention is, I think, a desideratum amongst telephonists. Allow me to describe one I have constructed, which for power and cheapness will be difficult to equal. A small tambourine (bought at a toyshop for 3d.) is screwed at right angles to a board. In the centre of the skin is glued a strip of ferrotype plate or tin (so called) in such a way as to form an armature for the poles of a small electro-magnet placed close in front of it on a suitable support glued to the baseboard. A battery and contact-breaker complete the apparatus. The battery I have described above, with plates 2½in. × 1¼in., is quite sufficient to produce noise enough to rouse the seven sleepers, and single taps or combinations may be given with greater ease than with an ordinary electric gong. Simple forms of contact-breakers will readily suggest themselves, and the whole may be made for—

	s.	d.
Tambourine	0	3
Electro-magnet (Second hand) ...	2	0
Battery	0	8
Contact-breaker, nominal, say, ...	0	4
Total	3	3

length of wire, 50 yards. To produce similar results with an ordinary electric bell and two Léclanché's would surely cost £1.

I may add that on inserting a microphone into the circuit instead of the contact-breaker, my tambourine gives out the ticking of a clock (at the other end of the line) loud enough to be heard several yards distant. Speech and singing it also reproduces tolerably well, and I have no doubt that with more care in construction, and a smaller and more tightly stretched membrane, a sensitive telephone fit for using with microphones could thus be made for, say, half a crown.

In conclusion I may say that, with regard to the microphone generally, I have been struck with the fact that similar effects do not always follow similar means employed. I mean as regards battery power, distance of the speaker from the instrument, pressure on the carbons, &c. I could easily enlarge on this, but perhaps others of your readers have noted the same inconsistencies, and may be inclined to corroborate this statement by facts within their own knowledge. **Innuit.**

[14600.]—IN experimenting on one of Mr. W. J. Lancaster's pile microphones, which that gentleman was good enough to send me, I find that by holding a piece of wood, wire, or indeed any solid substance on the top carbon resonator with the tip of the finger the noise of the blood coursing through the veins can be heard most distinctly. At first I thought the sound was caused by the hum of the traffic in the street, but on repeating the experiment in the dead of night, and pressing the object held with two or three fingers, the sound was proportionately increased. I do not think this has been noticed before.

Charles W. Quin.

[14601.]—"L. B. B.'s" letter (No. 14548) attracted my attention as describing a most wonderful discovery due to his "wonderful works," until on reading it through I saw the mistake and difficulty "L. B. B." was labouring under, and about which I should like to make a few remarks, trusting that they will put him right, as well as any other of your correspondents who have heard the same phénomenon, and who are not looking in the right direction for its elucidation. I will presume your correspondents are well acquainted with "Trevelyan's Rocker," which is an instrument capable of converting heat into sound (see Prof. Tyndall's "Heat, a Mode of Motion"), and also with the magnetic tick of an electro-magnet, which is due to the rapid molecular motion in the magnet or soft iron core, whenever the current is suddenly increased or circuit made, the effect of which is to increase their lengths and diminish their section. The singing heard by "L. B. B." and "the admiring friends" was a compound noise due to two causes having a common source—viz., the rapid vibration of the carbon pencil (which had a very delicate and sensitive adjustment depending on the pitch of the note) which caused an intermittent flow of electricity through the microphone and telephone, as well as the magnetic tick of the latter's magnet, produced by the making and breaking of the said current.

My explanation is as follows:—Supposing the carbon pencil to be in this certain state of fine adjustment or balance (I am not prepared to specify it), and that by some slight extraneous cause it is slightly displaced. On resuming its normal position the circuit is made, and the current established. At the same instant a spark is formed at the point, of contact, and heat is evolved. Carbon being a bad conductor, such heat is confined to the neighbourhood of the point, which causes it to expand, and a little nipple to jut out, so throwing the pencil up and causing a fresh point to come in contact with the block, which in its turn is thrown upwards so that the pencil keeps up a rapid tilting from point to point. At the same time an intermittent electric current is sent through the circuit, which gives rise to the magnetic tick of the telephone's magnet. The combined effects of these act on the diaphragm.

My microphone has the sounding board horizontal and parallel to the stand. Upon this soundboard is placed the carbon pencil and block, the former being suspended by a small brass axle in brass bearings. When it sings, which I can make it do by proper adjustment, on slightly pressing the pencil with a slip of paper, and drawing it gradually along from the centre outwards, the vibrations of the pencil get quicker and quicker, the note at the same time rising in pitch, a tap on the floor, a breath of air or other slight disturbing actions are sufficient to either throw it in or out of adjustment. During one of my experiments, and while this singing was going on, I took off the mouthpiece and diaphragm of the telephone, and heard the same pitched note, but very much fainter, this being solely due to rapid alteration in the molecular structure of the magnet. I repeated this experiment with three other telephones and got the same result. If the microphone be in a dark room, little sparks can be distinctly seen, varying in position. I think that these facts conclusively prove the accuracy of my explanation.

G. Goodwing.

[14602.]—I HAVE found my microphones act as "L. B. B.'s" (let. 14548), only the note was not always constant. It only occurs with the delicate ones, and is caused by a make and break of contact with the carbon point. The most delicate one I made was a round pencil of gas carbon, pivoted like that of Prof. Hughes (p. 256), with a small, fine needle fixed on the top of one end with shellac, for weighting, which was done by sticking small pieces of bread crumb on the point. The singing in this was very annoying when nicely adjusted, so I tried it in the night. When set oscillating it would sound at the telephone, tap tap, quicker and quicker, till it reached a note, then gradually died away. It took up the vibrations of an approaching train or a market cart long before I could hear them, and began to "sing." I think this shows it is a very rapid break in the current—the wire, perhaps, in some cases communicating the vibrations to the microphone. **Pimpernel.**

[14603.]—THE somewhat curious phenomenon mentioned in letter 14548 was experienced by me a few weeks ago. I first heard the peculiar humming sound while investigating a certain idea. I had a piece of fine copper wire (No. 35) tipped with powdered graphite, and damped with oil, resting horizontally between two carbon blocks, and the whole arrangement inclosed in a small oblong box, varnished black inside, and having a glass cover. This was placed in electrical circuit with a Bell's telephone and six Léclanché cells. On completing the circuit I got a white flickering spark, which, to my astonishment, changed into a pleasing tone, and swelled out so much that I could hear the note some feet away from the telephone. I tried to ascertain the cause, and found that the white flickering spark had dwindled down to a very minute and steady red spark. I have heard the same tone when a carbon pencil has been between two carbon blocks. The tone probably arises from a uniform succession of sparks, because when the spark flickered—an indication, no doubt, of some irregular movement—then jarring sounds were heard, but when the spark was small and steady the tone was audible, and a simple tone depends upon continuous rapid and isochronous vibrations. **J. Probert.**

MAGIC SQUARES.

[14604.]—I HAVE been interested to see this subject again discussed in your columns, and hope that more information will be elicited about those curious combinations of numbers which form a sort of mathematical recreation.

There is one curious property of the squares which I do not see mentioned by any of your correspondents. In any square of n figures in a side, either natural or magic, the sum of any pair of numbers equidistant from the centre and on a straight line passing through the centre is constant and equal to (n^2+1). Take, for instance, the magic square below, the centre of which I have marked with a *: $3 + 142 = 145$, $58 + 87 = 145$, $74 + 71 = 145$, &c., and $145 = 12^2 + 1$.

In the absence of any really mathematical treatment of the question, this property will assist us in the formation of magic squares. By the following method it is easy from a natural to construct a magic square of n figures in a side, where n is divisible by 4. Draw horizontal lines so as to cut off $\frac{n}{4}$ rows at the top, and the same at the bottom; also draw vertical lines to cut off $\frac{n}{4}$ vertical rows at each side. This divides the large square into 5 smaller squares and 4 rectangular pieces. Leave the 5 squares untouched, but make every figure in the rectangles change place with the one directly opposite to it—that number which together with it makes up $(n^2 + 1)$. I give a square of 144 numbers formed in this way:—

1	2	3	141	140	139	138	137	136	10	11	12
13	14	15	129	128	127	126	125	124	22	23	24
25	26	27	117	116	115	114	113	112	34	35	36
108	107	106	40	41	42	43	44	45	99	98	97
96	95	94	52	53	54	55	56	57	87	86	85
84	83	82	64	65	66	67	68	69	75	74	73
72	71	70	76	77	78	79	80	81	63	62	61
60	59	58	88	89	90	91	92	93	51	50	49
48	47	46	100	101	102	103	104	105	39	38	37
109	110	111	33	32	31	30	29	28	118	119	120
121	122	123	21	20	19	18	17	16	130	131	132
133	134	135	9	8	7	6	5	4	133	134	135

It is needless to point out the properties of these and similar squares: any one can discover many curious relations in them. For instance, each of the diagonals is formed of numbers in arithmetical progression, with common differences of 13 and 11 respectively—*i.e.* $(n + 1)$ and $(n - 1)$; a property also possessed by the natural square. Again, if smaller squares be cut out of the centre of the large one, as by the dotted lines in the diagram, each of these squares will possess many of the magic properties of the large square.

In making magic squares, we may use, instead of the natural numbers, any series in arithmetical progression. For instance, we may multiply or divide all the numbers by any factor, or we may add or subtract any number to or from all of them. Thus, from the simple square—

8	1	6
3	5	7
4	9	2

we may obtain such squares as—

24	3	18		25	4	19
9	15	21	and	10	16	22
12	27	6		13	28	7

which are possessed of similar properties. Or, as Mr. S. Jewsbury points out on page 416, we may substitute a series in geometrical progression as—

256	2	64
8	32	128
16	512	4

when we shall find that the continued product of every row—horizontal, vertical, or diagonal—is constant—viz., 32768. The reason of this becomes apparent when we write the square—

$$\begin{matrix} 2^8 & 2^1 & 2^6 \\ 2^3 & 2^5 & 2^7 \\ 2^4 & 2^9 & 2^2 \end{matrix}$$

and remember that in multiplying together powers of the same number, we add the indices: the G. P. square then reduces to the simple magic square of 1 to 9, as given above.

I think it would interest others beside myself if Mr. Jewsbury would give the formulæ to which he refers in his letter. Also I have seen somewhere a magic square of 1 to 64, which gives also a solution of the very interesting, though less difficult, problem of the "knight's tour" on the chess-board. Can any one give this square, and any information about it?

July 12th. **Amare.**

MIDLAND ENGINES.—To "L

[14605.]—I AM very glad to see that " 419, has sent a diagram of one of the Mid engines. There have been so many othe requiring my attention in the ENGLISH that I have been unable to finish a drawin have commenced of one of the large engines, built by Dubs and Co.

There is so little difference in outside and design between Nos. 1320 and 1330 drawing will now be unnecessary. In "L. L.'s" question, No. 1288 is stationed ter, and runs to London, Manchester, and ham. It is fitted with Smith's vacuum br 1297 and 1298 are stationed at Liverpool. with other engines they run to Marple, D the 10 45 a.m. express between Liverpool a ter. They also are fitted with Smith's vacu

July 11th.

SINGLE v. COUPLED ENGI

[14606.]—IN answer to "W. J. S." (let p. 419), the L. and N. W. Company did n or two trains from Manchester to Liverpo *versâ* in 50m., but seven each way in "W. J. S." says 31 miles in 50m. wa remarkable by the side of the Cheshire li hourly—not 31½, but 36 miles in 45m. L. and N. W. service in 50m. was starte shire line was not opened—was only i stage of construction. When it was well traffic the L. and N. W. put on an hourly Newton Bridge, accomplishing the distanc the same time as the Cheshire line. The L. trains are generally worked by single eng of the Lake class, and the following will gi of the speed they run at, which slightly miles per hour:—

		h.		Distanc
Manchester (dep.)	...	9.0		m.
Newton Bridge (pass)	...	9 20	...	15¾
Edge-hill (arr.)	...	9.38	...	30¼

After the statements made about the L. it is only fair to mention the steps they to bring about a better state of things for dating Manchester and Liverpool traffic. new termini are to be erected—one in Sa nearer the Exchange by some hundred Victoria, and a second at London-road, to date an express service to Liverpool *viâ* ton. This is practically an enlargement o road station. The line between Vic Ordsall-lane, Cross-lane, and Astley, and road and Old Trafford will be doubled.

The object of "Itzaex's" tables (letter 419) seems to be to prove that the L. a expresses get up to speeds quite as high as expresses. I never doubted it for a mome do not think "Itzaex" can prove I said a the kind. When I said the L. and N. W the direct route, had no occasion to run fast between stations as the G. N., I n they were allowed more time between sta G. N. for the same distance. Taking " trains, the L. and N. W. is allowed 98m. f and the G. N. only 92 for 76½. "Itzaex' will no doubt prove very interesting to rea ENGLISH MECHANIC, but for the particul he has in view I cannot call them quite observe that the L. and N. W. train s late, and reaches Rugby in time, having 2¼m., and to accomplish this runs faster t On the other hand, the G. N. train leav cross in time, and reaches Peterborough 2 speed, therefore, being below the averag compare the running of the expresses leavi cross and Euston at 10 a.m., and reaching ter at 3.10 p.m., you see that both tra distance in 300m.; the G. N. have 15 than the L. and N. W. to run, and must stoppages and run faster than the L. and get to Manchester at the same time. make seven stoppages, amounting to 23 and N. W. nine, amounting to 27m. Av by the L. and N. W. 41 miles per ho G. N. 44 miles per hour.

In answer to "Arlesden" (query 3341 Tractive force of Precedent class = 17^2 × 88 92lb.; ditto, Lady of the Lake class + 90 = 68·26lb.

July 13th.

[14607.]—WM. J. S. (letter 14535, p. 4 unfortunate. He now says the Great No trains from the Central Station, Liverp Cheshire lines, which is incorrect, as tha although joint owners to the extent of o not run their own trains. The Midlan run certain goods, passenger, and occasio sion trains to and from their own lines to with which exceptions the traffic is M.S L. engines and Cheshire lines wagons, &c. At present I believe the and Liverpool traffic is worked by M engines exclusively, the remaining stoc that of the joint lines. **Finem**

CONTINUOUS BRAKES.

To "C. E. S."

]—"C. E. S." contradicts my remark that of May 29th, p. 315, is a *réchauffée* of the ouse circular, dated April 6th, and would readers to suppose that at the time of is letter he was ignorant of any such Will your readers kindly compare the —

om Mr. Westing- cular, April 6th.	*Extract from "C. E. S's" letter, May 29th.*
icle has two brake or drums of dif- ameters. Each one end closed by the opposite end bber diaphragm ted, with from 32 between a flange am and an iron h diaphragm is ed in the centre ro circular plates nd these plates that connect to in such a manner aphragm or drum st the other, at time turning a aft that applies the brake blocks.	Each vehicle has two brake cylinders or drums of different diameters. Each drum has one end closed by metal, and the opposite end by a rubber diaphragm, firmly bolted between a flange on the drum and an iron ring. Each diaphragm is also clamped in the centre between two circular plates of iron, and these plates have rods that connect to two levers in such a manner that one diaphragm or drum acts against the other, at the same time turning a rocking-shaft that applies or releases the brake blocks.
ms have commu- with the brake n air is exhausted ain brake pipe by tus on the engine vacuum is also both drums.	Both drums have communication with the brake pipe. When air is exhausted from the main brake pipe by the apparatus on the engine a vacuum is created in both drums.
e drums pull ch other, and as larger area than it follows that agm or piston of ne will be drawn drum when the created, and that agm of the small be forced to its utward position. sition the brake away from the	As these drums pull against each other, and as one has a larger area than the other, it follows that the diaphragm or piston of the large one will be drawn into its drum when the vacuum is created, and that the diaphragm of the small drum will be forced to its extreme outward position. In this position the brake is "off."
enience the larger led the "pull off" the smaller one on" drum.	For convenience the larger drum is called the "pull off" drum, and the smaller one the "pull on" drum.
the brake pipe pull on" drum is lve that permits from the drum pe, but not from to the drum. The drum has a large ddition to that r the movement hragm, and when n is once created t serves as a store or the application e blocks.	Between the brake pipe and the "pull on" drum is a check valve that permits air to flow from the drum into the pipe, but not from the pipe into the drum. The "pull on" drum has a large space in addition to that required for the movement of the diaphragm, and when the vacuum is once created within it, it serves as a store of power for the application of the brake blocks.
e "pull on" drum ade large enough ally the case) a cuum chamber is and is connected or iron) pipe to case containing ned release and that governs the from the "pull o the brake pipe.	When the "pull on" drum cannot be made large enough a separate vacuum chamber is employed, and is connected by a pipe to the valve case containing the combined release and stop valve that governs the flow of air from the "pull on" drum to the brake pipe.
e in the "pull nd pipes amounts ubic inches for iage, and 2,400 s of air have to ipes and drum of age to fully set s by destroying vacuum of 12lb. or, on a train of s, 36,000 cubic ir have to flow, essure, into the gh the brake valve e, and distribute ghout the pipes off" drums, some aving to pass the th of the train or of over 400 feet.	The space in the "pull off" drum and pipes amounts to 3,000 cubic inches for each carriage, and 2,400 cubic inches of air have to enter the pipes and drum of each carriage to fully set the brakes, by destroying the partial vacuum of 12lb. pressure; or, on a train of 15 vehicles, 36,000 cubic inches of air have to flow, at low pressure, into the pipe through the brake valve in the engine, and distribute itself throughout the pipes and "pull off" drums, some of the air having to pass the entire length of the train, or a distance of over 400ft.
xperiments show troy a vacuum of es and vessels of dimensions thus equires about 10	Careful experiments show that to destroy a vacuum of 12lb. in pipes and vessels of the above dimensions thus arranged requires about 10 seconds.

e above your readers will no doubt *draw conclusions*, and I must decline to notice r correspondence from "C. E. S." upon t of continuous brakes.

R. D. Sanders.

CONTINUOUS BRAKES—BARKER'S HYDRAULIC.

[14609.]—Barker, Harris, and Co. (letter 14588, p. 420) state that "they thought somehow that the question between us was whether Barker's brake is the same now as at the Newark trials." How they got this impression I cannot understand. What I stated upon p. 269 was, that the engine, tender, 13 carriages, and two vans, which formed the "experimental Barker train" at the Newark brake trials, are stationed at Bedford, and run to London and to Northampton. This is a fact beyond contradiction. In the same letter, Barker and Co. state that "C. E. S." "still persists in saying the brake is the same." I am at the present time away from home, and cannot therefore refer to the back numbers of the English Mechanic, but, from memory, I can positively say that I have never made such an assertion. What I have said, and still say, is the fact, that the train is the same. The brake is not the same, because it has been considerably improved. I am well acquainted with these improvements, because I have worked the brake upon this train since they were made, and also Mr. Barker himself explained them to me.

As to the discussion upon Captain Tyler's paper all I can say is, that the worthy chairman's ruling was characterised by the utmost fairness, and that Mr. Harris made a long speech, and could have mentioned the stop referred to if he had wished. Had he done so he would have been asked to let the society see a similar stop made again. I have to thank Barker and Co. for their offer to allow me to examine their train. It is unnecessary that I should again do so. I have carefully examined it both as it was at the Newark trial and as it now is on the Midland and Great Eastern Railways, and I also have had the advantage of having it explained to me by the inventor. Mr. Barker also, not long ago, at St. Pancras station showed me the diagrams of his automatic arrangement. As soon as the automatic train spoken of is running upon the Great Eastern Railway I shall gladly accept the offer of Barker and Co. "to inform me of its working," and, for the benefit of other readers, I hope the information will be given through the columns of the English Mechanic.

July 11th. **C. E. S.**

DISTANT SIGNALS.

[14610.]—In letter 14559, page 424, J. Brown advocates the use of visual signalling for sending messages at distances beyond the reach of the voice. He would employ the Morse code, making a "dot" by a wave to the right, and a "dash" by a wave to the left, when signalling with a flag in daylight. I suggest to him, and others who may take an interest in this matter, that they had much better adhere to the mode adopted and in use in the army (see "Manual of Instruction in Army Signalling," published by authority, price sixpence). The way therein laid down to make a "dot" is by a short wave of the flag, a "dash" by a long wave. It is extremely easy to learn, and has stood the test of experience. I have constantly used it myself, and seen it used by others for the last six years.

Field Gunner.

[14611.]—If J. Brown (let. 14559, p. 424) can buy or borrow the "Boys' Own Magazine," vol. III., edited by S. O. Beeton (Ward, Lock, and Tyler, 1864), he will find on page 185 a capital system of communication between persons at a distance, simply by holding the arms in certain positions. It can be easily learnt, and I have not yet seen a better system. I think that whatever system is used, a small telescope will be necessary, and with it the signs may be seen at a much greater distance than without. **Mytholmroyd.**

THE COMPOUND PULLEY BLOCK.

[14612.]—Referring to my letters (14281, May 3rd, and 14398, May 31st) "Aliquando" says (letter 14550, July 5th) :—"I understood Mr. Jewsbury to be describing a live block. Surely, however, he is but ventilating a fancy." To this I say that it is a real live block, unequalled for power and speed, has been tested by the side of its inferiors, and proved victorious by more than 25 per cent. Further on "Aliquando" says :—"Will Mr. Jewsbury please to say if he knows how many rotations of B will be sufficient to move A at all, let alone a complete rotation?" I should have thought that a word to the wise would suffice, and no one, however little versed in mechanics, would have asked such a question after seeing my statement (letter 14398), which I still maintain, that the small pulley, *b*, would take up 6ft. of chain, while the small pulley, *a*, would take up 1ft. Ergo, 6 rotations of B to 1 of A. I should not be surprised next of the question being asked how to arrange two semicircles so that they should form a complete circle! However, it is not an easy matter to remove prejudice.

I hope "Aliquando" does not wish to strangle the new block, although I have no interest, either commercially or in its manufacture, other than for the welfare of the public. I have sent a small model of the block to our Editor, which will, I am sure, satisfactorily prove that I am quite correct in my statements, and if "Aliquando" will pay me a visit I will show him a "real live block," and then he will be able to exclaim that "seeing is believing."

Joseph Jewsbury.

Brookfields, Birmingham, July 8th.

[In the model sent to us the power pulley rotates about four times to one revolution of the lifting pulley : it is a "real live block," and if "Aliquando" cannot avail himself of Mr. Jewsbury's offer he can see the model.—Ed.]

CASSEGRAIN REFLECTORS.

[14613.]—With reference to the letters of Mr. Fennessy (14502) and T. Godfrey (14527), as to glass specula silvered at the back, those gentlemen will find, in Dick's "Practical Astronomer," an account of some reflectors made on that principle. For destroying the secondary image formed by the reflection from the surface of the glass nearest the eye, that surface was ground to a curve, so as to have its focal distance within the focal distance of the silvered side. The only advantage that possibly could be obtained by silvering mirrors on the back would be a greater immunity from tarnishing; but would it be worth the extra expense, to say nothing of other obvious objections? With tolerable care mirrors silvered in the usual way last for a long time. Mine was done by Martin's process two years ago, and practically is as good as new.

A. H. S.

[14614.]—With reference to letter 14527, line 13, I may state Dr. Dick once made, or caused to be made, a reflecting telescope, with a glass speculum silvered on the back or convex side, and found it gave, as he had foreseen, a double image, but he got over this difficulty "by forming the concavity of the mirror next the eye of a portion of a sphere different from that of the convex side which was silverised." See "The Practical Astronomer," by Thomas Dick, LL.D., August, 1845, pages 329, 330, and 331. **8½in. O.G.**

MINOR 9th, OR DIMINISHED 7th?

[14615.]—Kindly allow me a few words on Mr. Ballard's letter (No. 14581). I am not going to quarrel with him as to whether the chord is a diminished 7th or a minor 9th, for the question is merely one of nomenclature, and I had thought that by this time all persons possessing any knowledge of harmony were aware that "the diminished 7th" is but an old-fashioned name for the first inversion of the minor 9th, with the root omitted. That the chord GEC♯B♭ is not a minor 9th on G does not require much demonstration, but that it is a 1st inversion of the minor 9th on C, without the root, is so universally admitted that it did not occur to me to occupy your space by entering into this point. I should also wish to remark that the chord of the so-called "diminished 7th" is as often taken in the *major* as in the *minor* mode; and the fact that in one or other of its three forms and their inversions it may be taken on every note of the scale—major, minor, and chromatic—makes it specially adapted for inducing modulation into any key, no matter how distant from the original tonic; in this case it would lead from C into any one of the 24 keys just as well as into B minor.

May I refer Mr. Ballard to such standard works as Stainer's, Macfarren's, Banister's (which is the text-book of the Royal Academy), or that of Sir J. Goss (see page 33), that he may make himself acquainted with the true derivation of the diminished 7th. The whole, however, of Mr. Ballard's letter is *nihil ad rem*; for the disputed note is not the D♭ (or C♯), which is the minor 9th, but the B♭ which is the minor 7th, and the question is upon the relative pitch of this note, and that of the A♯ following. Will "H. C. K." be so good as to say whether my explanation satisfies him.

A. Coates.

ENHARMONIC DIFFERENCES.

[14616.]—Your correspondent, "H. C. K.," repeats his inquiry. Is A sharp higher or lower or equal to the pitch of B flat in the bar of music which he has submitted? A sharp in the instance quoted I have affirmed to be the 7th of the key of B minor to which it introduces us. B flat considered as the 7th note of a scale, is the 7th of the key of C flat, minor or major, and the ratio is : As A sharp, the 7th of the key of B minor or major, is to B natural, the tonic respectively of these keys, so is B flat, the 7th of the keys of C flat, major or minor, to C flat, the tonic respectively of these keys. If, therefore, C flat is higher in pitch than B natural, B flat, the 7th of the key of C flat is higher in pitch than A sharp, the 7th of the key of B natural; if lower, lower; and if equal, equal. The question thus turns entirely upon the ratio which the notes of the enharmonic scales of C flat and B natural bear to each other. Possibly, "H. C. K." will give his own solution.

Chelmsford, July 6. **I. F. Ballard.**

A NEW MUSICAL NOTATION.

(*Concluded from page* 318, *letter* 14440.)

[14617.]—The existence of clefs along with sharps and flats is a standing proof of the want of ingenuity in notation-makers, and how easily all these evils could have been avoided if they had only got hold of the idea of doubling the staff of lines and spaces! The word clef signifies that the same line in different clefs has a different name, each clef having a peculiar mark which gives the name. These clefs are a continual source of inconvenience to musicians. In the making of clefs the notation-maker had his choice of two evils—either make a number of ledger lines on the upper part of the bass stave, and have the lines and spaces of the same name, or have the bass stave of the same appearance as the other staves, but of different names. The notation-maker has chosen the latter evil.

In the new notation all these evils are avoided. You may have as many parts of music as you like, and all the lines and spaces will have the same name. The broad line is to the musician what the pole star is to the navigator: when he sees a broad line he knows at once the names of his lines and spaces. However useful the broad line may be it could not be used in the old notation, owing to the fact that three and a-half spaces hold an octave, so that if the broad line had been on a line in the one octave it would have been on a space in the next octave, which would have been useless.

Whatever opinion there may be as to the merits of the above method in singing or playing there is not the smallest doubt as to its great superiority in teaching the theory of music. More knowledge of the theory may be had in one night from the new notation and its appliances than can be had in six months from a blackboard and a bit of chalk on the old notation—a most miserable way of teaching the beautiful and simple science of music in the latter end of the nineteenth century, amid the many hundreds and thousands of inventions and improvements in science and art.

Should the musical world adopt the above notation two sets of characters will have to be employed, the same as in literature. In literature we have printed books and written manuscripts; the printer uses his own characters for the sake of beauty and legibility, while the scribe uses the written characters for the sake of expedition, and yet no person complains of the labour of learning two sets of characters. The notes and rests of the old notation can be written on the staff of six lines and six spaces. Sacred music in four parts can be printed in one colour, but catches and other pieces with equal voices will require one more colour, that every singer may know his own part. This will make such pieces a little more expensive, but it will be found to be true in the long run that the best is always the best pennyworth.

Young people who are not acquainted with any notation prefer the above to every other, but old singers and old players look upon it with indifference. They are familiar with the old or the sol-fa, or both, and these will serve them as long as they live, and they are not going to trouble themselves to learn another notation, however perfect it may be.

The above method has occupied the mind of the writer for upwards of 29 years, and he is quite satisfied in his own mind that it is the very notation musicians have been looking after from time immemorial, but it may not suit their preconceived notions of a perfect notation; consequently it will not be accepted by them. However, if such dissatisfied critics can invent a superior notation they are welcome to all the honours of such an invention, and, if not, they will have to content themselves with the makeshifts of the old and the monotony of the letter and figure notations till the end of time.

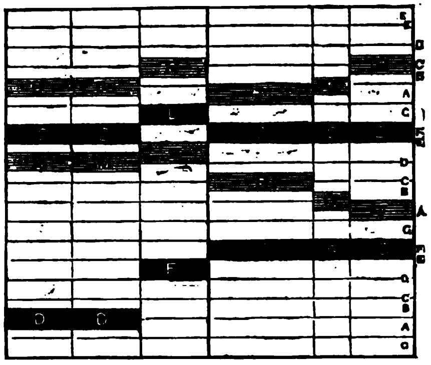
Full score in the old notation has 16 spaces and 20 lines, making in all 36. In the new notation full score has 19 lines and 18 spaces, in all 37—all in one clef, and all the lines and spaces of the same name, and no sharps or flats are required.

The printed music on the measurement principle is far superior to the written music on the character principle—it is neat, firm, and compact, like a piece of solid masonry; the runs of the harmony, whether parallel, converging, or diverging, are seen at once—the octaves and unisons are easily known; the intervals from one half-tone to eleven half-tones can be pointed out on any full score of printed music.

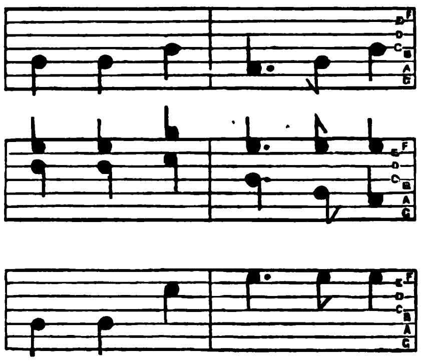
Music printed in colours is well adapted for public schools. How the children would like it, and if ever they are to sing at sight it must be by a notation of this kind. Pieces of music in large size, like geographical maps, hung on the wall, could be sung by the whole class, and changed every now and then, and, although it should be a little more expensive than other notations, the advantages would far more *than counterbalance* the disadvantages.

Specimen of the New Notation—The National Anthem.

MAJOR MUSIC AS PRINTED



MUSIC AS WRITTEN



In the new notation music for the voice is done in printed characters, while music for the organ or piano is done in written characters. The notes and rests of the old notation are written on the new staff of lines and spaces, so that there will always be a marked difference between the music for the instrument and the music for the voice, and those who have been accustomed to play from the old notation will find little difficulty in playing from the new.

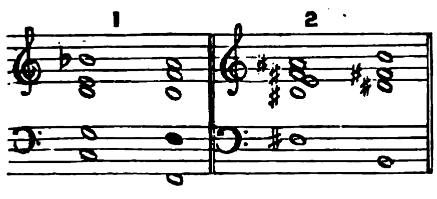
Robert Wark.

98, Reid-street, Bridgeton, Glasgow.

MUSICAL TONES.

[14618.]—I am glad to see Mr. Jackson's reply to my question (letter 14583), and that he acknowledges that the sharp of the note below (in the scale) is higher in pitch than the flat of the note above; for if it is so in the instance I have given on p. 344, it must obviously be so in all cases. Of course this is a question for the ear to decide; there is no other authority whatever; no preconceived notions from analogy, however symmetrical, however elaborately supported by figures, can have any claim to settle a musical question—to the cultivated ear, and the ear alone, the final appeal must be made.

To enable any one who has a good and practised ear, that has not been biassed by the equal temperament of the keyboard, to decide this point for himself I would suggest the following out of many examples—



Take each example by itself, and having adjusted the ear by playing a few consecutive chords on the pianoforte in the same key, then strike the first of the two chords given, take up the B♮ with the voice, and then sing A with voice alone. Upon sounding the A on the pianoforte immediately afterwards, it will be found to be too flat, or, what is the same thing, there is too wide an interval between A and the B♮, which by equal temperament is made to do duty for both A♯ and B♮. Now modulate into the key of B major, in order to adjust the ear, and follow the same course with the second example, and the B of the pianoforte will be found to be even more strikingly too sharp. The conclusion is obvious—viz., that B♮ is lower in pitch than A♯.

I should add that the pianoforte must be of strictly equal temperament, and thoroughly well in tune, to insure success. And any one who tries the experiment should (unless he is accustomed to such delicate shades of pitch) not be content with merely one attempt, but try it over and over again after an interval when the ear is not excited.

I may as well say here, in answer to A.
whose letter (14513) I take to be good
sense—that I am very far from looking
perament with anything like contempt.
contrary, I consider it to be a marvellously
and practical compromise, satisfying the
well, and simplicity itself, when contraste
complicated keyboards that have been
posed by Mr. Bosanquet and Mr. Colin B
former of whom has, if I mistake not, th
blot of the old tempered scale—viz., one
duty for both sharps and flats. The la
Blagrove has more than once remarked to
discussing these matters with him, "all
say about these refinements and the diff
intervals in the different keys is no doubt
true; but only play as well in tune as
forte and you will do well enough." What
says about the Temple organ, and its
sharps and flats, Prof. Macfarren told
correspondence I had with him some years
subject I was discussing with him at the
same subject which I treated of in the
Mechanic (Vol. XVIII., p. 337), a
"J. S." inquires about.

And now with regard to that further
said I had to ask if I got a correct reply to
It is this: If A♯ is higher in pitch than
how is it possible in the nature of things
the intervals in the major keys of G, A,
same in relative vibrations as those in the
major, there being no room for inserting
either a major or a minor tone without
into the tone above?

[14619.]—"H. C. K." (letter 14557)
impatience with the definition I gave i
"G. P." of the rule that determines the
the notes of music in their relations to a
note, and implies that he himself does
stand it, and that, most probably, ne
"G. P." I think it is likely that this
first thing "H. C. K." has met with i
cussion that he has not understood; but
think it desirable, and it is certainly not p
that for his instruction I should go thro
explanatory details already supplied, the
which is concisely stated in the definitio
to. I may, however, be allowed to re
"H. C. K." ought to know, if he does
two kinds of series of notes are signifi
terms the harmonic and the hypharmonic
and to thoroughly perceive that they a
the two most simple kinds of series of re
that can exist, and that the diatonic sca
posed of two of each of these connected t
the manner which is also the simplest
and that it so happens that the diatonic
take it, forms a very accessible illustrat
principle of evolution, or the growth or
or procession of natural facts and circu
which principle, as it seems to me, is si
directness in the connection, sequence, o
all phenomena in their respective classe
the structure of the scale this kind of re
most visibly perfect.

But if "H. C. K." comprehends the
of the terms the harmonic and the hy
concords, and if choosing a key-note, say
first write down the notes of the harmon
which has C for its origin, and then
the notes of the hypharmonic concord
most closely related with it—namely,
and in the next place write down, as
harmonic concord, the one which he f
most closely related to that of C—namel
monic concord of G; and, lastly, writ
the second hypharmonic concord, the
closely related to that of E obtained abov
the hypharmonic concord of A—he will
the diatonic scale according to the princ
definition at which he appears to take
The several concords he will have put
when he has so done will be the two
concords—

C_1 C G C^1 E^1 G^1, and G_1 G D^1 acute, G^1
and the two hypharmonic concord
E^1 E A E_1 C_1 A_2, and A^1 A D grave, A_1

All these notes may, it is obvious, be r
any octave; and, placing them within
of one octave, the diatonic scale in the
shown as consisting of the notes C, D gra
E F G A B C^1. Now the resultant ra
notes, within the octave, are—

$$1, \frac{10}{9}, \frac{9}{8}, \frac{5}{4}, \frac{4}{3}, \frac{3}{2}, \frac{5}{3}, \frac{15}{8}, \frac{2}{1}$$

and they are the ratios which have agai
been verified in the most satisfactory
physicists of the greatest ability, in
mony the most perfect reliance is pla
sally by thinking men who have not fo
performed the experiments. "Allo
"H. C. K.," as I understand him, "
so, if you are referring only to the ke
deny that these ratios are equally appli
keys." Whatever acquaintance "H. C

siren or tonometer, of the use of which he .t is evident he has not yet got all the in- it is qualified to assist him in obtaining, pears he has yet to learn the simple, well- ied, indisputable, fact that the ratios of the the same in every key—*e.g.*, the ratio of ve is always 2 : 1; of the fifth is always the third, 5 : 4; of the fourth, 4 : 3; and

H. C. K." give us a single instance of a which he has discovered, by means of the er, that the ratios of the notes in relation to -note are not the same as they are in the ; and will he inform us what these un- ansuspected ratios are?

Fred. J. Jackson.

IL'S MATHEMATICS OF MUSIC.

.]—Mr. Fred. J. Jackson's valuable tions to the science of the mathematics of otwithstanding, I must candidly confess whatever cause owing—my own obtuseness ther—his elucidation of the generation of does not convey to my mind so clear an e matter as does Catel in his treatise on ny," which received the sanction of the toire de Musique of Paris, on the 11th in the 9th year of the Republic, May 1, Vith him a string of a certain length in its sion gives the sound of a certain tonic; is string its octave; one-third, its twelfth; h, its double octave; one-fifth, its seven- ne-sixth, its nineteenth; one-seventh, its rst; one-eighth, its twenty-second; and , its twenty-third. Setting out from the ve. of the first sound, there is found in ression of thirds the chord 1, 3, 5, 7, with r 9th, and, setting out from the triple 8ve., 1, 3, 5, 7, with the minor 9th. These e says, contain all those employed in har- Thus from these we have the major common isisting of one major and one minor 3rd; r of one minor and one major 3rd, or the e imperfect common chord of two minor the second note of the minor mode; the 7th of one major and two minor thirds ly on the dominant; the minor 7th of two irds and one major on the tonic; the d 7th of three minor thirds in the leading the minor mode; the major 9th of one wo minor thirds and one major, and the of one major, and three minor thirds on . From this inspection we gather the im- of the minor and major thirds in music, corroborate a prior assertion to the effect tain in the mind accurate and clear appre- f the nature of the intervals of the minor r thirds is the first step towards becoming and proficient in the theory and practice of e of music. **Isaac Fowler Ballard.**

OGRAPHIC OR COLLOTYPIC PRINTING.

.]—Some time ago I saw a notice in these of an autographic printing process, by which it was asserted that a number of ald be obtained from the one writing. I took ble to procure the specification, and give wing as an abstract:—

iginal writing or drawing is to be made by an ink having special or peculiar properties sibility, to non-liability to run or spread in nce of moisture, and to the permeation of r or surface written or drawn on. This ink is compounded by dissolving aniline (of the colour the ink is required) in acetic in other suitable solvents that will effect purpose, and adding thereto a small per- ay, about ten per cent.) of glycerine. The r drawing having been produced by this description of ink, when dry is placed nk surface downwards on a zinc plate or ermeable substance; a sheet of paper damped is then placed upon it, and is with a waterproof sheet to prevent the of wet or moisture therefrom. They are ther subjected to pressure in any ordinary ress that will give an even and continuous until the ink from the original writing or enetrates to the sheet of paper above it, duces thereon a counterpart or copy of al. This copy is then removed, and a fresh paper substituted, and the same operations nuously repeated until the ink from the riting or drawing is exhausted or ceases to ct copies. The application of this invention nfined to the use of ordinary paper or pens.

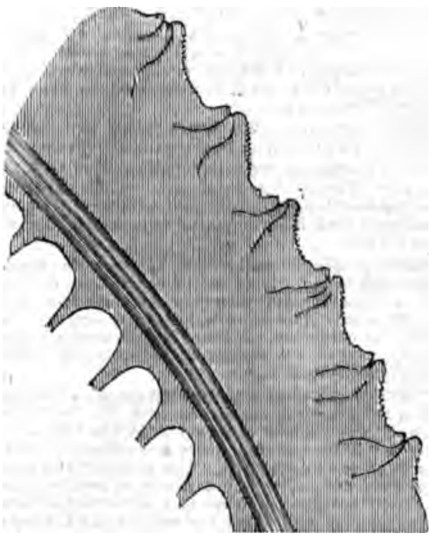
dification of the process a paper is dressed rnish which is brittle under pressure, and ith the above described ink thereupon, the sing any suitable instrument for conveying d pressing therewith sufficiently to rupture e of the paper in the direction of the lines riting, drawing, or other device. The duplication or copying thereof is then proceeded with as above described, and when the ink is about exhausted, or in aid of its replenishment, fresh colour is supplied by means of a pad.

The advantages that can be derived from the adoption of these improvements as compared with other processes of autographic printing consist, it is said, in the great simplicity of the operations, in economy of printing colour, in an increased production or number of copies, and in great economy of time, as there are no intermediate operations necessary between writing the original and printing the copies. It will be observed, however, the patentee says that the application of the invention is not confined to the use of ordinary paper. It would be interesting to know if ordinary paper is suitable for the purpose, or whether the paper must not be specially prepared. If so, it appears to me that the claim to a patent fails by inadequacy of specification.

Selim.

MICROSCOPICAL.

[14622.]—I have examined the ovipositor of the saw fly prepared in Canada balsam; undoubtedly there is the appearance of openings mentioned by "Humble Bee," yet I do not believe they exist, but only appear so in the prepared slides. The idea is quite justified because gall flies (cynipidæ) in ovipositing do insert an irritating fluid that causes the galls for the protection and nutriment of their larvæ. The specimen I have is larger than a small wasp, being a little over ½in. in length. The saws are different to the illustration in Hogg's manual. I quite agree with the wish to have histological matters discussed in the English Mechanic. There are one or two questions I should like to ask microscopical contributors. Has any one seen a vertical section of human retina as generally given in textbooks—say Quain's or Huxley's? I am perfectly aware that they are meant to be diagrammatic, but I want to know whether any one has seen slides that would justify this interpretation, or a preparation that would convey the idea from which the semi-diagrammatic representation of two small lobuli of the lungs in Quain—this is also given in Huxley's "Elementary Lessons," and others—*i.e.*, the termination of the smallest bronchial ramifications. Also a section of kidney that will show an afferent and efferent vessel complete in a malpighian capsule.



Theo. Izod.

[14623.]—I think if "E. C. H." (letter 14576 looks a little longer at the foot of the fly he wil modify his opinions. He is certainly deceived in thinking each pad has a slit in it. Let him clean a slip and confine a fly upon it for a few seconds, hanging head downwards. He will then, with a sufficiently intense oblique light, be able to see the footprints. There is no vestige of split, but a series of dots like the pattern on a diatom. Each dot I consider the mark of a separate hair on the membraneous pad. Evidently the pad bears all over it, touching with each individual hair. He must not let his fly remain long, or else he will, with his claws, scratch his footprints all to a mess. He must also hold the slip horizontally, or the fly cannot hold in one place. When the slide is on edge his feet slip like those of a man on a clay hill-side in wet weather, only more so. It is no use to put the fly to walk on top of glass, as having no necessity to use his pads he will make no marks with them. I think "E. C. H." will also find, if he can make a piece of good glass chemically clean, the fly will not be able to walk upon it without great difficulty. "A. T. J." (33034) can stain wood sections with any of Judson's dyes.

The replies of Mr. Lancaster and "Jepepy" to query 33320 will scarcely be satisfactory to Edgar Stone. Mr. Lancaster cannot have seen a Seibert No. 7, or he would know there is no word "uncovered" to set it to; therefore the rest of his instructions are not of much use. Besides, there are few stands steady enough to turn the adjustment of a 1-16th, and allow the object to remain in distinct focus while the fingers are upon it. Being an immersion it is not easy to bring surface of cover into view. My instrument is Collins's best, and it is not firm enough to perform such an operation on successfully. I found it best to put the collar to No. 3, and never alter it. Being an immersion it does not matter whether the collar is at 1, 2, 3, or 4. Find the best point, and then do not mess with it. I have had little time lately at my disposal, but I think it will be well for correspondents not to waste their time over the "polariscope spot lens," or the starch observations of Mr. Sims, spite of Mr. Allen's approval of the latter. I think Mr. Robson (14568) will find that heat is not the cause of tadpoles becoming frogs earlier than they otherwise do. I find heat actually retards them. It is animal food that is a necessity. **Essex.**

DI-METHYL AND ETHYL HYDRIDE.

[14624.]—I am much obliged for the reference Mr. Darling gives in letter 14528, p. 417, and which seems to settle the matter in favour of the identity of free methyl and ethylic hydride.

Wm. John Grey.

Newcastle-upon-Tyne, July 11.

Ivory may be restored to its original whiteness by cleaning it with a piece of burnt pumice-stone and water, and then placing it under glasses in the sun's rays. Can any of our readers corroborate this statement?

Taps.—A tap for a nut an inch deep required to be just movable upon the bolt by hand must be made a trifle larger than if it were intended to make a nut 2in. deep a similar fit. The reason is that the variation in the pitch of the thread, which always occurs in hardening, is greater in a length of 2in. than it is in 1in. of the length of the tap.—*Scientific News.*

Black Finish for Brass.—Make a strong solution of nitrate of silver in one dish, and of nitrate of copper in another. Mix the two together, and plunge the brass into it. Now heat the brass evenly until the required degree of dead blackness is obtained. This is the method used by French instrument-makers to produce the beautiful dead black colour so much admired in optical instruments.

Strength of Iron at Different Temperatures.—G. Pisati and G. Saporito-Ricca find that the strength of iron at different temperatures shows peculiar irregularities. The strength in a wire which is exposed to a dull red heat diminishes, with increase of temperature from 14° to 50° C. then increases to 90°, diminishes rapidly to 120°, remains constant to 200°, sinks slowly to 235°, then comes a sudden increase, which is followed by a gradual diminution. The strength is greater at 300° than at 140°.

The Telephone as a Galvanoscope.—M. d'Arsondal has compared the telephone with the animal nerve, as an indicator of electricity, and states that the poorest telephone is at least a hundred times more sensitive than the nerve. In the silence of the night he has heard the telephone vibrate when the induction coil was removed to a distance fifteen times greater than that of the minimum nervous excitation, indicating, according to the law of inverse squares, a sensibility more than 200 times greater. He regards the telephone as the best of all galvanoscopes, both for feeble electric variations, and for feeble continuous currents.—*Comptes Rendus.*

Manganese Bronze.—Prof. Genti publishes an analysis of a specimen of manganese bronze from a Transylvania factory. It is nearly of the colour of brass, is tenacious and ductile under the hammer, and contains sulphur, manganese, copper, zinc, iron, with traces of silica, tin, and carbon. The essential ingredients are 15 parts of copper, 4 of manganese, and 1 of zinc.

Eddies.—In Faye's communication to the French Academy on the movement of tempests, he referred to a memoir of M. Belgrand's upon the eddies of running water. In some subsequent remarks Belgrand stated that every modification of the bed of a river produces eddies which diminishes the velocity of water. The phenomenon is so common as to attract little attention. The well-determined causes, which may give some idea of the movements of the atmosphere or of the erosion of valleys, he considered under three heads: 1. Eddies which bring the water from the middle towards the banks of a watercourse; 2. Eddies at bends; 3. Eddies at the junction of confluents. He illustrated his remarks by reference to numerous geological results, especially along the banks of the Seine, the Marne, and the Yonne.

REPLIES TO QUERIES.

◆

⁂ In their answers, Correspondents are respectfully requested to mention, in each instance, the title and number of the query asked.

[32269.] — **Systematic Memory.**— If language means anything, surely Wm. John Grey (32269, p. 424) must be joking when he would try to persuade us "Dates are about the most useless form of knowledge." He could scarcely hold the persons who could fix the exact date of all events in the world's little history were behind others in their peculiar line of research into the secrets of facts or fiction.—FINANCIAL AGENT.

[32269.]—**Systematic Memory.**—Being only a tyro in the art of mnemonics I doubt whether I can be of much assistance in the way pointed out by Mr. Grey. I inquired in the ENGLISH MECHANIC, March 1, for a more useful work on the subject than Maclaren's or Stokes's. Failing to obtain one I set to work on Maclaren's system, and compiled the table published June 21, which, though imperfect, I find very useful. My first attempt was to remember six subjects in a sermon; my next to remember 22 heads and other particulars of a sermon I was listening to. I succeeded in remembering 20 of them in their proper order. And any method of enabling one to rembember a sermon or lecture is not to be disparaged. The same means could, of course, also be employed to enable a speaker to remember the heads of his lecture, &c. I have lately, by the same means, fixed in my memory the text and the first verse of each hymn in Keble's "Christian Year" for the 26 Sundays after Trinity. Neither do I see much difficulty in applying the same process to the acquirement of any science or language where such help may be necessary. Mr. Grey says dates are about the most useless form of knowledge, but such an assertion would be disputed by many scholars; and dates are acknowledged to be one of the most difficult things to remember without some kind of artificial assistance to the memory. The "Fall of Lodore" might certainly be learnt by heart in the ordinary way, but, without some system of mnemonics, most persons would find great difficulty in remembering 26 texts and first verses—as mentioned above—in their proper order. When the memory has no great difficulty I don't see the need, or even use, of mnemonics, but when anything unusually difficult has to be mastered my limited experience teaches me that mnemonics will work wonders. I hope some one more able will reply to this query, if not I will endeavour to look into the subject and reply again, although I don't think Mr. Grey would find much difficulty in tracing out a path for himself.—W. P. IRON.

[32461.]—**Turners' Cement.**—Several recipes for turners' cement are given in Spon's "Workshop Companion." The essential ingredients of these are resin and wax. The common elastic glue sold at the grindery shops would possibly serve "V. R.'s" purpose, unless he wishes to polish his brass discs in the lathe, in which case he had better use soft solder and a metal-faced chuck.—GIMCRACK.

[32712.]—**Secondary Batteries.**—If a piece of copper and a piece of zinc are partly immersed in dilute sulphuric acid—$H_2SO_4 + H_2O$—and the two metals are joined by a piece of copper wire, the zinc begins to dissolve immediately, and bubbles of hydrogen collect on the copper plate, whence part of them rise in the liquid. At the same time a current of electricity flows in the connecting wire, and its existence can easily be proved by means of a galvanometer. In a very short time, however, the current begins to gradually decrease in strength. The cause of this occurrence is to be found in the accumulation of hydrogen on the copper plate. These bubbles of hydrogen set up a current flowing in an opposite direction to that of the current produced by the battery itself, and, though secondary currents, partly neutralise the primary. This phenomenon is inadequately called polarisation of a battery. Various expedients have been resorted to to overcome its evil effects. One of the most successful has proved the use of the porous partition and two liquids for one pair of metal plates. Grove soon made use of polarisation, and invented his well-known gas battery. But the most useful application of the laws of polarisation is the secondary battery. Grove's gas battery consists of a glass bottle filled with dilute sulphuric acid. In the liquid are fixed two plates of platinum, each of which is connected with a platinum terminal fused into the glass. When the poles of a circuit containing a galvanometer and a battery are attached to the two terminals of this gas battery, hydrogen is collected on and over one of its platinum plates, and oxygen on and over the other. If, after a while, the battery is taken off, the needle of the galvanometer shows a deflection opposite to that shown before with the primary battery. We have here, then, a striking proof of the effect of "polarisation" of plates of metal. The two platinum plates show polarity. They are the "poles" of the gas battery, whose currents flow in a direction opposed to that of the primary current. If we take a circuit containing a galvanometer, and whose terminals are two plates of platinum, and we insert one of the plates in a jar filled with hydrogen, and the other in a jar filled with oxygen, and then quickly plunge the plates in water, the galvanometer shows a deflection: a current is flowing from the plate which was plunged in hydrogen to that which had been kept in oxygen. In this case a current has been obtained with one metal, and without the use of the primary battery. De la Rive, of Geneva, first discovered that the chemical affinity between peroxide of lead and hydrogen was exceedingly powerful. From this fact it was concluded that plates of lead would make a better secondary battery than plates of platinum, and Ritter experimentally determined that a battery with lead plates would give six times the electro-motive force of one with platinum plates of the same size. Lead is a very cheap metal, and it can easily be hammered into very thin sheets. Plates of very large size can therefore be put in a small space when rolled up. All these qualities recommend lead highly for use in secondary batteries. To construct a powerful secondary battery we should make twelve cells, each couple consisting of two thin plates of lead of 12 square feet, 9in. wide, and 16ft. long, sewn in coarse cloth, and rolled into a spiral, in the same way as the plates of a Hare's deflagrator, and arranged in the ordinary way, each couple being in a cell containing dilute sulphuric acid. If we now send the current of 15 Grove's cells (which may be very small indeed) through the secondary battery, its plates will acquire polarity after some time, and if we then quickly take the primary battery out of the circuit we get from the secondary effects of extraordinary power. The secondary battery acts very much like a condenser. It seems to store up the current of the primary, and produces sparks in its discharge which could only be obtained from a hundred or more cells of a primary battery. The querist, "Investigator," made his solution by far too weak. It is impossible to make out from his description how he coupled the cells. He says: "I coupled one of each pair of plates to either pole of a single-cell battery." I suppose he had three cells of a primary battery. He should have coupled them in the ordinary way for electro-motive force—say, carbon—Z + C—Z + C—zinc; and the secondary battery in the same way. In that case he would have obtained a result.—WIESENDANGER.

[32773.]—**Sir I. Newton's Magnet (U.Q.).**—Try it. I don't think it would move a delicately-suspended needle. A magnet would have practically no influence at a much shorter distance than 10 yards.—PIMPERNEL.

[32796.]—**Kaolin.**—The pit referred to is in the parish of Old Deer, Aberdeenshire, N.B.—PIONEER.

[32814.]—**Emery Stones (U.Q.).**—Send to Soho Foundry, Leeds, for catalogue. I think their smallest machine costs about £80, with screen, which requires about 3-horse power to work it.—TELESCOPE TELE.

[32820.]—**Electrometer.**—A Lippmann's capillary electrometer was exhibited in the Loan Collection of Scientific Apparatus at the South Kensington Museum. It is described at some length on p. 289 of the catalogue. Perhaps the instrument now forms a part of the permanent collection at South Kensington.—R. P. G.

[32835.] — **Three-Cylinder Engines.**— Having had some practical experience with the Willan's class of three-cylinder engine, I think the following reply to "A Mechanic's" query appearing on p. 399, may be of some use to him. The virtue of this particular class of engine is not nearly so great as was originally anticipated. One of the greatest defects is the rapidity with which the crank-shaft bearings wear out, even when roller bearings are used, this being occasioned by the great velocity they run at, and the fact of the cylinders exhausting into the chamber in which the crank-shaft rotates. These engines require a very large amount of steam, the piston-valves only cutting off at about ⅞th of the stroke. For all ordinary purposes I should most certainly recommend an ordinary double-acting engine, but if the space at command should be limited, a three-cylinder engine might be found very useful. The great advantage they possess over ordinary engines is the ease with which they may be reversed, and in many cases—such as steam cranes, launches, &c.—this is an important item. In the management of them skilled labour may often be dispensed with on account of this advantage. An idea has lately been experimented on to try the effect of exhausting above the cylinders, thus keeping the crank shaft much cooler, and using slipper guides to prevent the cylinders from wearing oval, and it has given a much better result.—DRAUGHTSMAN.

[32863.] — **Electro-Magnet.** — Three Daniell's cells, if properly constructed, will ring a bell satisfactorily through a circuit of ordinary resistance. If telephones are in the line when you ring the bell the effect will be weakened, because the coils of No. 36 wire add an enormous resistance. You should now find out whether the fault is either in the battery or in the bell, or in the circuit. Join the bell to the battery by means of two thick copper wires only about 2ft. long. If it rings loud enough then you may conclude that there are faults in the line, or that the line offers too much resistance. If the latter is the case you would best make another three cells, and use the six together. If the three-cell battery, arranged as described last, does not ring it loud enough you may be sure that you have not made the battery carefully according to the instructions given. I should advise you to make another three cells, and to soak top and bottom of the porous cells in melted paraffin. I advised you to do so because it is very important. As you did not think it of primary influence I will state the reasons why it should be done. Take the zincs out of your battery, whose porous cells have not had their tops and bottoms soaked in paraffin. You will find that the zincs are covered with black or brown mud. This mud is nothing else than a deposit of copper. "Leakage" takes place in your battery, and the deposit of copper on the zinc produces "local action"—that is to say, a current is started in an opposite direction to that of the battery. This local action neutralises part of your battery current. Several querists have complained that the same occurred in their Daniell's cells. If they had been very careful in making the cells they would not have had any reason to complain. The top of the outer cell should be coated as well with paraffin or varnish, but not for the same reason. If it is not coated crystals of sulphate of copper will soon be formed outside on it; this weakens the cells, and is waste. Are you quite sure that the plates do not touch the porous cell? and is your solution of copper sulphate saturated? Never fill the cells quite to the top, leave at least ½in. free. Try again; the cost is trifling, and you will feel satisfied when you have constructed a good battery for yourself.—WIESENDANGER.

[32928.]—**Pastry Oven (U.Q.).**—You cannot build so small an oven of brick to be of any use, because you could not heat it properly. The size you mention is not much bigger than an ordinary brick oven furnace. The probable cause of your tea-cakes blistering is either the dough is too soft or the oven too hot—perhaps both.—PIMPERNEL.

[32967.]—**Hematine Turning Brown (U.Q.).**—I believe it is due to the presence of logwood.—TELESCOPE TELE.

[32972.]—**Grafting Stockings.**—"Is the art of grafting stockings extinct?" Ask the mistress of the nearest Board school. You would probably receive an instructive answer, if not precisely the kind of instruction you expected. You should understand Swiss darning before attempting grafting; but with silk hose the latter will not be so very easy, on account of the fineness of the loops. "Grafting is joining two pieces together, as a new foot to an old leg, &c. Ravel both edges until the thread runs even; let all the loops appear clear and distinct, as if the stitches were going to be picked up with a knitting-needle for knitting. Hold both pieces together in the ordinary position for hemming, letting the loops be exactly opposite to each other, and take up two loops—*i.e.*, enter the needle into an upper loop, and bring it out in the next loop: draw out the thread, then enter the under loop opposite the last upper loop, and come out in the next loop, and draw out the thread; continue thus, two loops at top and two at bottom, using one fresh loop each time, and the two pieces will be effectually joined with an almost invisible seam." The above extract is taken from "Plain Knitting and Mending" (Griffith and Farran), which has diagrams, making the process still clearer.—DAGHBERT'S GOUVERNANTE.

[32980.]—**Leather Strapping for Chairs (U.Q.).**—Please to make query a little clearer. Where does the strapping go? Is it morocco leather, or what? If you make this query a little clearer, I will try to help you.—TELESCOPE TELE.

[33022.]—**Hominy.**—Copied from a book that is supplied with hominy. Hominy and Milk: Hominy should be soaked overnight in boiling water, in addition to the boiling prescribed in the following: Stir 6oz. of hominy in 2 quarts of boiling water, stirring it occasionally to prevent burning; just before dishing add a teaspoonful of salt or more, and serve with milk and sugar or syrup. Another for the same: ½ cup of small hominy, 1 quart of cold water, pinch of salt. Boil 1 hour; stir often. While hot, mix some soft hominy cakes, 2 cups of fine hominy, boiled and cold, 1 cup of flour, 1 quart of milk, 3 eggs well beaten, 1 teaspoon salt. Beat smooth the hominy, work in the milk and salt, then flour—lastly, the eggs. Bake at once, and keep the mixture well stirred. Hominy fritters: Make a batter with one egg, flour, milk, and salt, mix with 1 quart of boiled hominy, and fry. These are only two or three recipes. I can give the following, if required:—Hominy pudding, fried hominy, hominy croquettes, baked hominy, buckwheat cakes, tomato soup, tomato summer soup, Johnny cake, corn-meal crumpets, corn-meal muffins, nonpareil corn bread, batter or egg bread, boiled Indian meal pudding, Indian meal gruel, &c.—TELESCOPE TELE.

[33034.]—**Staining Wood Sections.**—To NEMO.—My object in wishing to stain the wood sections is to throw the diversity in the structure of the wood into strong contrast, in the same manner as the stained sections purchasable of any dealer in microscopic objects.—A. T. I.

[33054.]—**Sulphuretted Hydrogen.**—I am well aware that many text-books dilate upon the very poisonous nature of this gas, and doubtless it would be dangerous to take a good inhalation from a kipp in vigorous action. At the same time no unpleasant consequences are to be feared from any ordinary use of the gas. I fancy "Daghbert" will not make much progress in analytical chemistry if he is unable to bear sulphuretted hydrogen even in the open air.—WM. JOHN GREY.

[33072.]—**Tanning (U.Q.).**—1½lb. to 3lb. of bark.—TELESCOPE TELE.

[33090.]—**Dipping Needle.**—"X." should visit the shop of a maker of surveying instruments.—VIDEO.

7.]—**Organ.**—"Gothic" has made a mistake the size of the Pyramidon; it should be ı. *square* at the top and 8in. *square* at the He has evidently mistaken 2ft. 3in. *square* . 3in. *round* the top. With regard to Mr. ı query about bourdon, the length of a 5½in. CCC bourdon is 7ft. 4in., according to my but I cannot say whether this is the total or the length from the lip to the top; so I advise him either to measure the speaking of his CC stopped diapason (if he has one—if ny other large stopped pipe) and cut his n in proportion, or else to make one bourdon ı the 8ft. scale. Cut that down, and make t in proportion. I have a very good rather cale bourdon, which I will give:—

	Depth.	Width.
C C C	$6\frac{1}{8}$ ...	$4\frac{5}{8}$
G G	$4\frac{3}{4}$ ...	$3\frac{1}{4}$
C C	$3\frac{5}{8}$ ...	$2\frac{13}{16}$
F F	$3\frac{1}{16}$ ...	$2\frac{5}{16}$
Ten. C	$2\frac{3}{16}$ ...	$2\frac{1}{16}$

in. wind the mouth should be cut up half the the tone is firm, plump, and pure. But for organ I should prefer a lieblich gedacht of owing scale:—

	Depth.	Width.
C C C	5 ...	$3\frac{3}{8}$
G G	$3\frac{3}{4}$ ...	$2\frac{11}{16}$
C C	3 ...	$2\frac{3}{16}$
F F	$2\frac{1}{2}$ ...	$1\frac{11}{16}$
Ten. C	$1\frac{7}{8}$ ...	$1\frac{3}{8}$

e above decrease to half-size on the eleventh e usual German scale), and are of decidedly ne.—DIAPASON.

.]—**Universal Telegraph.**—I believe this 'ul telegraph never became even a commercial It is certainly not universal, and no descrip- it is to be found in the manuals of telegraphy.).

).]—**Rendering Woodwork Fireproof.**— t with two or three coats of whiting, mixed size alone. Soak the balls in water to them into a pasty mass, and then add the size. Lay on as evenly as possible. I believe ght almost bring red-hot coke against wood otected without setting it on fire. Try a covered in a fire.—S. M.

.] — **Nickel Plating.**— The only useful is a patent; but articles of iron, steel, brass, zinc, and lead may be coated with y immersing them in contact with zinc in a neutral solution of chloride of zinc contain- allic nickel in fragments or a plate of that Several processes have been given in this -WOLFRAM.

.]—**Ph. D.**—The qualifications depend en- the university from which the degree is From the needy German universities you btain the degree by a paper on something or which would probably never be read. Letters man's name—except B.A., M.A., M.D., M.B., accompanied by the name of the university— tle value, and when tradesmen put F.R.G.S. billheads, it is time the practice was dropped. you see Ph.D. after a man's name, rest he wants to make something out of it, and mething is most likely money.—NUN. DOR.

2.]—**Solid Ink.**—Vegetable black and gum up well, and dried in moulds.—NEMO.

.]—**Indiarubber Coat.**—The only remedy sticky" indiarubber coat is to buy a new one, that you get a good one. You might mend overing the parts with a solution of pure in mineral naphtha or bisulphide of carbon. would not be worth while, for the "disease" able.—S. M.

5.]—**Marking Ink.**—The ordinary marking ckened with gum and some powder, such as ck or whiting, will do for marking with types. o.

1.]—**Drying Oil.**—What are known as dry- possess the property of absorbing oxygen pidly than the non-drying oils, and so become d resin-like; boiling with litharge and other nces facilitates the absorption of oxygen by g from the oil substances which would tend it liquid. Litharge is the best dryer, but f lead or white copperas is better for oils ıst be light-coloured.—S. L.

8.]—**Cupola.**—I am much obliged to Mr. nd to "F. W. S." for their answers to my but in order that my wants may be better cod I will try to make them clearer. I use nt a No. 4 Root's blower, which gives me a e of air of about 12oz. per square inch, and suit well were it not frequently breaking d causing me considerable annoyance and , as of course it always breaks down just is most needed, compelling me to work all or repairs. I have been told the "Baker" is superior to the "Root's," as it is con- entirely of metal, whereas the Root's is constructed of wood. I have thought of a gine, but hesitated doing anything in that n on account of the cost, although I believe correct thing for a large works. The cupolas ave at present, and which will require re- shortly, are 13ft. high from the bottom of the to the bottom of the charging door, and . diameter inside, and parallel when newly There are 8 tuyeres, and with a blast of from 10oz. to 12oz. I get 5 tons of metal melted per hour in each. I use 13cwt. of coke to fill the cupola up to about 21in above the tuyeres. I then charge the cupola with iron and coke at the rate of 1cwt. of coke per ton of iron continuously for any quantity I may have to melt, which frequently amounts to 20 tons, and sometimes 30 tons per day. Now, as the theoretical amount of coke necessary to melt the iron is less than this, I think there is room for improvement. Although I have tried, by reducing the coke, I have failed to obtain a permanent reduction from what I believe to be the variation in the quality of the coke. I have found its composition vary from 80 to 90 per cent. of carbon, and with such variable coke I have not been able to reduce the coke consumption below 1cwt. per ton of iron. From the experiments I have made I have arrived at the conclusion that any further improvement in the economy of coke must be obtained by heating the blast. There is another advantage to be derived from the heating of the air, which I believe to be a very important one. It is often a source of trouble to the founder to find the action of his cupola impeded by the solidification of the slag above and in front of the tuyeres, caused by the slag dropping down in front of them and the cold air pouring into the furnace. This is often a serious trouble, especially in a cupola running 10 or 12 hours at a stretch, as in the case of pipe and chair foundries, where if we had hot blast, say at a temperature of 600° to 800°, this annoyance would cease. It would also enable us to get hotter metal and melt quicker. Cast iron requires an average of 478 units of heat to melt it, and as carbon burning to carbonic acid develops 12.906 heat units, then as coke contains an average of 85 per cent. of carbon, a ton of iron will require $\frac{2,240 \times 478}{12,906 \times \cdot 85} =$ 98lb. to melt it, so that, in my case, there is a margin of 14lb. for loss of heat due to radiation and waste, &c. "F. W. S." states that Messrs. J. Abbott and Co. make an average of 2¼cwt. per ton of castings. Can he not give as if in terms of per ton of metal melted? Theirs is rather an unsatisfactory way of arriving at the consumption. In all large foundries there are a large quantity of "plates" and "boxes" made which are used in the process of moulding, and as the quantity varies with the description of the work done, it is difficult, if not impossible, to get at correct consumption of coke per ton of finished castings. Then there is the element of bad castings. This is not a constant quantity, and affects, more or less, the result. It certainly appears to me to be a much better plan to divide the total amount of coke into the cupola by the total amount of iron. I have always adopted this method, and my present consumption is 147lb. per ton, including the filling of the cupola up to and above the tuyeres. I shall be extremely glad if "F. W. S." or Mr. Allen can throw some light on this subject. I find great difficulty in getting information from founders, not from their unwillingness to give it, but I believe there is really not much known upon the subject.—CUPOLA.

[33177.] — **Watch Tools.** — This query I had hoped would have been replied to by an amateur who had experienced the starting and success in his endeavour at watch-repairing. I feel that, before I can properly aid "W. B.," I should know whether he has attempted to make anything approaching usefulness for a watch. If he will place such information before me, I shall be glad to reply to him, although I repeat that I consider a reply from one who has accomplished the task would be equally—if not more—useful to him than from me.—SECONDS' PRACTICAL WATCHMAKER.

[33181.]—**Life of a Watch.**—This curious question may be disposed of as follows:—There are, and have been for several years, various qualities of foreign watches, the majority of such being small and compactly made; but such flat and neatly-finished ones are not all of Geneva make. A Geneva watch, manufactured at Geneva, is a superior and enduring instrument, and many are in excellent condition after twenty or thirty years' wear, whereas the majority of watches similar in appearance to the Geneva, but manufactured in Switzerland, of lower price and quality than the "Geneva," have some of their pieces so much worn after three or four years' wearing as to require fresh parts introducing. Many workmen, taking little notice of such wearings, "patch up" the worn parts, instead of at the onset putting new ones, and hence, in the majority of instances, wearers of watches are troubled. A good Geneva watch will continue to be reliable and useful for a period of twenty years or more, and a Swiss one of ordinary manufacture little more than half that period, provided that they are placed in the hands of competent repairers, and not kept going for three or four years without being attended to.—SECONDS' PRACTICAL WATCHMAKER.

[33212.]—**Prussiate of Potash.**—I am sorry that I, though not unacquainted with the manufacture of this article, am ignorant of its working, and, consequently, cannot give "Daghbert" much assistance in the details. I had occasion some time ago to visit a prussiate works, and took some notes of its working, together with a rough plan of the general arrangement, but I cannot at this moment lay hands on either. The proportions of horn and potashes vary with different makers, some using 75 of the albuminoid substance to 100 of potashes, while others, according to Runge, 400 of calcined horn to 100 of potashes, the amount of iron turnings being generally $^1/_{10}$th that of the potashes. The ingredients, iron, potashes, horn, wool, old leather, or any other form of nitrogenous carbon, are mixed in the right proportions, introduced into a pear-shaped iron vessel, having a closely-fitting lid to exclude the air, the whole so arranged as to allow free circulation of the flames and hot gases on all sides, and the contents heated to fusion. I do not think there is any danger of over-heating. The product is then lixiviated with water, the solution evaporated on pans heated by the waste heat from the retorts. When sufficiently concentrated the liquid is placed in vats, into which are hung pieces of rope round which the crystals form—the black mud which remains at the bottom of the lixiviating vessel being used for manure, and for deodorising. A sample of it gave on analysis—

Water	30·510
Organic and volatile matters ...	4·520*
Carbon	22·790*
Sand and insoluble matter	16·300
Oxide of iron and alumina	12·660
Lime	2·110
Magnesia	·500
Sulphuric acid	5·330
Potash	3·117
Soda	·759
Ferrocyanic acid	·315†
Traces of phosphoric acid, carbonic acid, and loss	1·059
	100·000

* Containing nitrogen equal to ammonia 1·035.

† Existing as Prussian blue.

One serious drawback to this method is the expense entailed by the wear and tear of the iron vessels, which soon become honey-combed. On account of this, I believe, reverberatory furnaces are coming into use. The most generally accepted theory of the formation of this substance is as follows: The carbonate of potash and the sulphate of potash (contained in the crude ashes), the nitrogenous coal and the iron re-acting on each other, form, first, sulphide of potassium, which converts the iron into sulphide, while the nitrogen in the charcoal unites under the influence of the potassium with the carbon, which again combines with the potassium, forming cyanide of potassium. • When treated with water the cyanide and the iron sulphide decompose each other, forming ferrocyanide of potassium. Baron Liebig has, however, proved, since the promulgation of this theory that potassium cyanide and metallic iron are alone contained in the fused mass, and that the ferrocyanide is only formed on the addition of water, or slowly by exposure to moist air.—J. M. W., Manchester.

[33212.]—**Prussiate of Potash.**—Old leather is sometimes used for the production of this salt. The materials employed are mixed in the following proportions:—1 ton of proper nitrogenised matter, such as hoof parings, dried blood, woollen rags or clippings, or animal matter of any kind which is rich in nitrogen. This is mixed with 3½ cwt. of pearlash in the form of powder, and 50 to 60lb. of scrap iron in the state of filings, turnings, thin sheets, or clippings. These materials are put in small quantities at a time into a strong iron pot which has previously been raised to a bright cherry-red heat, and after every addition of the mixture the mass in the pot must be stirred with an iron rod until it assumes a pasty appearance, when more of the mixture is added, and treated in the same manner until the pot is half full. It is maintained at this temperature for 20 minutes. The old leather or horns are generally cut up into small pieces before they are mixed with the other materials. It is not advisable to wash the old leather or parings before using, except they are very filthy. The drier the nitrogenous matter is the greater will be the amount of salt obtained. After fusion, the contents of the crucible should be protected from the air as much as possible. The fused mass is treated with water in open boilers, the solution filtered and evaporated till the salt crystallises out. The crystals are generally contaminated with a little potassium sulphate and potassium carbonate. These impurities may be removed by re-dissolving in water and re-crystallising. The following equations represent the chemical changes which occur:—

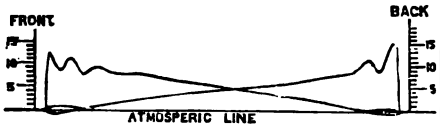
1. $K_2CO_3 + C_4 + N_2 = 2KCN + 3CO$
   $138 + 48 + 28 = 130 + 84$
2. $6KCN + Fe + O = K_4FeC6N_6 + K_2O$
   $390 + 56 + 16 = 368 + 94$

—H. G.

[33215.]—**Arsenic in Violet Powder.**—As Mr. A. H. Allen, on p. 421, refers to my answer as to the detection of arsenic in violet powder (p. 402), perhaps you will allow me to say that my authority for the test given is Dr. Ure (see 6th edition of "Ure's Dictionary," p. 198). With regard to the impossibility of heating a fluid in a tube open at both ends, it is clear that Mr. Allen must have written without thinking, as it is obvious that there could be no difficulty in using a U-shaped tube open at both ends. Mr. Allen is in error in supposing that a small quantity of arsenic was present in the violet powder in question, for it contained 38 per cent., and 6½ grains were found in a child poisoned by it. Nobody would be foolish enough to suppose, as Mr. Allen appears to think I did, that violet powder is usually employed for internal application. No doubt the child licked the powder off its lips. The antidote is mentioned by Kane and other eminent authorities. No doubt Mr. Allen may be right, and they wrong; but, as there may be some doubt about that, it hardly follows that they "talked rubbish."—R. P. G.

[33248.]—**White Rats.**—"Jumper" should give them plenty of food, boiled potatoes, nuts, bread, corn, and sometimes a piece of sugar, and for drink only water, milk, only not too often of the latter, as milk does not quench the thirst. The white rats seem to be feeble; they dislike the daylight, and it is best to see them and teach them to bear the daylight by giving the food from 11 to 2 o'clock mid-day, for the first time. Keep the rats in a cage with a small dark box inside for bedroom, and the cage with movable bottom; put pieces of paper, straw, hay, in the cage, as they will make themselves a nest. Keep the cage and bottom of it very clean, or you may lose your rats as I have mine, not knowing how to treat them.—A. Purgia.

[33250.]—**High-pressure Horizontal Engine.**—I thank our friends who have replied to this query, and, to enable them better to understand our difficulty, I send diagrams and a few more particulars. The engine was built nine years ago, and recently its work has been reduced by nearly half. The steam pressure is kept at about 30lb. per square inch; but the engine will work up to proper speed with steam so low as 14lb. Steam is cut off at about two-thirds the stroke. The cylinder and valve-chest are cast together, so that we could not replace one without the other. The boiler is by Galloways, and is in very good order. The feed-water is heated by the exhaust steam. Bushing the cylinder was recommended by a practical man; but we have some doubts as to whether it would answer. The diagram is taken with Hopkinson's indicator; boiler pressure at time of indicating, 28lb. per square inch.—H. L.



[33274.]—**Telephone.**—I am much obliged to Mr. Powell for his interesting answer to this query, and regret that I could not accept his kind invitation to inspect the arrangement. Was a call-bell used, and if not, what means were employed instead?—Wm. John Grey.

[33275.]—**Dispersion of Sound.**—Many thanks to Mr. Grey for his courteous explanation. The term being used, as I understood, in opposition to convergence, the mistake was natural, the more so that it is obviously impossible to decompose a monotone, that being in itself elementary. But as a combination is now instanced I should not like to say its reduction is impossible. The greatest relative difference in the quickness of vibration in light waves being not quite two to one, while the difference in that of the lowest and highest sound wave is 2,000 to one, would seem to render this feat easier of accomplishment. I do not know if a sound prism has been tried, and should like to hear. One great difficulty would be to prevent the re mingling of the tones after separation. I am obliged to Mr. Allen for his suggestion; that of the concave lens I had tried, but as it was not satisfactory I concluded that the rarefaction of the carbonic acid had reduced the specific gravity too near that of the air. The other will be useful.—W. H. Davies.

[33277.]—**Blast Furnace Slag.**—Mr. Allen hardly answers this query, I submit, in his reply on p. 421. I trust he will kindly look at it again, and help me further—unless, indeed, these very rough products of iron smelting are not sufficiently interesting to the chemist. The cinder I mentioned was said to be a "very limy cinder" until analysed, and was aimed at in producing iron for extra strong rails, &c.—F. W. S.

[33285.]—**Cutting Grindstones.**—The best plan is to true them up with a tool made of the black diamond or carbonado. It is the only thing that will touch the emery wheels now so much in use, and cuts away a Bilston grindstone like so much chalk. It may be obtained ready mounted from, I believe, Selig's, in Queen Victoria-street; but any one can purchase a fragment for himself, and mount it as follows: Take a piece of ½in. bar iron and taper one end, then recess the tapered end. Fill the recess with solder. Fix the tool with the recessed end uppermost, first heating it sufficiently to make the solder liquid, and to keep it so for a few minutes. Then put the piece of carbonado in the solder (it will float) and guide it so as to get a corner nicely protruding when the solder sets. The diamond will practically wear for ever. T. Clark, in his answer to this query, expresses a wish to know why all grindstones driven by manual labour have the same fault as that of "H." It is because they all, either owing to the weight of the handle, or to the weight of the treadle, which ever is used, stop with always the same side downwards. The water absorbed while the stone is being used, then sinks to the lower side of the stone, and softens that side, which thus wears away most. The substance of the information about obtaining and setting carbonado has before appeared under another signature — that of "B. P. A.," but I prefer giving it again to looking it up and giving the reference.—Law Student.

[33289.]—**Fiji Islands.**—"Young Scotsman" has a good chance of getting a passage to New Zealand on board a packet-ship, by working for the same in *the capacity of carpenter's mate; his* present trade fits him for such a situation. Let him apply for a berth of this kind to any of the companies trading to New Zealand. From them he can easily get a passage to the Fiji Islands by the regular sailing steam packets, or mail boat. "Young Scotsman" will find Captain Farquhar, of the mail boat, a gentleman able and willing to give him every information about his chance of work in the Fiji Islands.—Pioneer.

[33290.]—**Nodules in Limestone.**—At the building now in progress of the Manchester Hotel, Aldersgate-street, the masons in sawing a huge block of Fleetwood Bath stone, about 8ft. by 4ft., came across a perfectly spherical bullet in the centre of this large mass. I must confess I was a little taken aback when it was reported to me that a rifle bullet had been found in this position, as my mind reverted as to whether the volunteer force, rifle butts, &c., were in full swing during vast geological ages. Upon obtaining possession of this specimen in its matrix I felt as pleased and puzzled as Mr. Pickwick did over his treasure. How did it get there is the question? It is ⅜ of an inch in diameter. From the appearance of the cut surface I should say it is composed of ironstone—the above is the term given by the clerk of the works for the composition of the block, but I believe it is what is known by the name of Shelley limestone. Now, I can only account for it one way, and that is by a meteoric origin. Will Mr. Lancaster, or any other reader, kindly say if this is correct? There is another thing I cannot make out. If I refer to Page's "Handbook of Geological Terms," under the head "Bath stone" it refers me to the great oolitic formation, whereas the composition of Bath stone appears to be Shelley limestone of a much more recent and different formation from the Oolite or Roe stone specimen in my possession.—Theo. Izod.

[33301.]—**Telephonic.**—It is possible that you have wound the coils wrongly, so that the current is neutralised. If this is the case, reversing one of the bobbins on its core will set matters right.—W. B.

[33321.]—**L. and N. W. Engines.**—As your correspondent, "Murano," wants to know the numbers of five engines, and as he says 2,183 has been claimed for the first three—Precedent, Alma, and Antelope—I give the correct number of as many of that class as I know:—

Precedent ...	... 2,175	Penrith Beacon	... 2,187
Robert Benson	... 2,176	Chillington...	... 2,188
Buffalo ...	... 2,181	Avon... ...	... 2,189
Giraffe ...	... 2,182	Princess Beatrice...	2,190
Antelope ...	... 2,183	Snowdon ...	... 2,191
Raynard ...	... 2,184	Caradoc ...	... 2,192
Alma ...	... 2,185	Salopian ...	... 2,193
Lowther ...	... 2,186	Cambrian ...	... 2,194

The number of the Princess Louise is 1,177.—Tamerlane.

[33315.]—**Distance Indicator.**—I send sketch of a bicycle distance indicator, which I think Mr. Pilgrim, with a little trouble, will be able to make. A is the handle which is carried by the spindle, B, on which is fixed the spur wheel, C. This spur wheel revolves once in half a mile, and has just half as many teeth in it as the bicycle-wheel has to give revolutions in a mile. For the sake of an example, we will suppose a bicycle driving-wheel to be 5 yards in circumference, then it would have to make 352 in a mile. The wheel, C, would have 176 teeth. The dial, E E, revolves, being driven by the spur wheel, F, which has just one more tooth in it than the wheel, C, so that when the hand has made one revolution, the dial has made one, all but the pitch of one tooth, which space on the dial represents half a mile. The hand being driven by the wheel with 176 teeth, it follows that the dial would be marked with half that number of miles. H H is the driving arrangement. It is made of four little wedges, represented in an end view by Fig. 2. It is fixed on the end of a lever, which works on a hinge at K. At each revolution of the driving wheel, this lever works once up and once down, moving the wheels round one tooth. M is a brass bearing for the spindle; it fits into a hole drilled through the glass. When it is required to set the hand, a pin is dropped through the little hole in this bearing at O, and the bearing is turned round. The pin projecting through at the dial side carries the hand round with it. If it is required to measure short distances, a graduated ring can be put under the glass on the ledge at P P, and marked into yards. If the hand makes one revolution to half a mile, this ring might have 176 divisions, each representing 5 yards. Mr. Pilgrim may think 176 teeth too many for the wheels to have. In that case, he could construct it to make one revolution in a quarter of a mile instead of a half. But it really does not matter much how many teeth these wheels have, only care must be taken that the top wheel has one more tooth than the bottom one, as the dial can be marked out accordingly. Mr. Pilgrim will observe that the plane of the dial is at right angles to that of the bicycle wheel, so that the distance can be read from the saddle.—A. A. Watkins.

FIG. 2

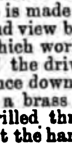
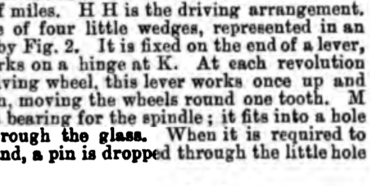


FIG. 1



[33328.]—**Sign Language.**—I only know of two deaf and dumb alphabets—the one usually taught in our asylums and schools for the deaf and dumb, which requires two hands to form the letters; the other recently imported, I believe, from America, which can be formed with one hand only—the latter being, I think, only used as a supplementary one when one hand is engaged. Of course, there are many signs which represent words which could only be acquired at a school, or from some one who has been taught at a school, and would only be of use in talking to those similarly instructed. However, if "A Sufferer" could call on the Secretary of the Deaf and Dumb Asylum, at the offices in Cannon-street, London, E.C., he could purchase at a trifling cost a sheet with the alphabet printed on it, and also obtain any further information he might require; but if not resident in London, a letter directed as above would, no doubt, find him. But what I would advise "A Sufferer" to do is, to practise speaking with the lips only—that is, form the words as near as possible with the lips, without uttering any sound. It is surprising how many words can be thus distinctly formed, and for those which cannot recourse must be had to the fingers. It is very difficult indeed to teach this plan to children who have been born deaf or lost their hearing very early, but is easy enough to those who have had the use of speech and hearing. Although I only suffer from partial deafness, which is always worse on catching cold, I have relatives and friends who are totally deaf. One friend in particular, has used this system, and he and I have conversed by the hour together in this manner, with only now and then using the fingers for difficult words or parts of words. It would be best to commence with easy sentences, such as "How are you?" And it would also be a good plan to watch the motion of the lips of any one speaking, for I have found it help me very much in making out what is being said when I could not distinctly catch the sound. Of course, when no sound is uttered or heard, each word should be separately and distinctly formed. "A Sufferer" may not lose his speech, but persons losing their hearing generally talk very low; indeed, one gentleman I know, who has gradually lost his hearing, has nearly lost his speech also, merely making a mumbling sound, and is surprised that his friends cannot understand him. But "A Sufferer" may find much benefit from the above plan, whether he lose his speech or not. Of course, it would be difficult to understand in this manner persons who only talk through their teeth; but, no doubt, friends or relatives would not mind a little trouble for the purpose of making themselves understood.—C. Lark.

[33337.]—**French-Polishing Mahogany.**—You in all probability use too much polish, and rub too hard. First, give work coat of size, rub down, and body in with even circular motion, going over the whole of work, if not too large. After the grain is well filled in, let it get hard, then face up, and when hard finish with spirits. Mind and not use too much spirits; a few rubs is all that is wanted to take off oil, or your polish will all come off.—Joiner.

[33338.]—**Polishing Veneer Wood.**—W. J. Hatch had better buy his polish. After scraping up veneer, first give coat of size for stopping up grain, then colour or stain, and proceed to polish. The previous answer will show the way. It is a great mistake to use too much oil. For all hard woods the polishing is the same, but not for stopping, as size is generally used for dark woods, and plaster or chrome for light. I might mention that putty-lime is a good stain for Honduras mahogany, chestnut, and other woods.—Joiner.

[33348.]—**Hay Fever.**—This is a misnomer—the disorder being no more than the ordinary asthma, or the closely allied bronchitis, into which it may degenerate. The only difference is that the fit occurs as the effect of changes in the humoral condition of the chest and viscera, caused by the transition to the more genial and developing influences of the spring season. This abnormal humoral condition takes some little time to mature, so that the fit just develops itself about June, (or hay-making time. The bronchial membranes are then in a state of great irritation, which is intensified by any strong odour. Thence ensues dryness, heat (inflammation), and finally "reaction," or softening of the diseased deposit, which is then "eliminated" as a more or less thick irritating mucous, swelling up the mucous membranes, embarrassing the breathing process, and so causing all the distress enumerated. In winter, of course, the asthma "secretion" is more thick and glutinous, and is expelled from the throat glands by coughing and expectoration; but, the fit occurring here more in high summer, the secretion is more thin (gummy-like), and is thus enabled to flow upward and over the palate to the nostrils, the membranes of which are thus in a state of irritation. The further irritation of any pungent odour produces a fit of sneezing, followed by a discharge of the irritating mucous. What I may term a "siphon" action is thus set up, and the flow of secretion continues until the offending humoral stream is exhausted. In my answer to "A. S." I spoke of the effete matters "stored up" (by mistake printed "stirred up") in the body. "The disagreeable heat of the body after the attack" (of "F. W. S.") is the nion of the animal heat with the concreted deposit ı the tissues of the body, by which they are softened : "broken down," thence taken up by "absorp- on," and conveyed upwards for elimination in fits" and intermissions forming the phases of the sease. Thus developing, about the season of hay, ıe simple asthma of winter becomes, and is termed hay asthma or summer bronchitis," and continues ll the "constitutional" source is exhausted. I ıve no personal experience of the disease, the ıthmatic attacks of which I have formerly spoken ıing more of "fog asthma," being developed by the ɪst fog of autumn, however slight; yet once arted, and the first bulk of "phlegm" cleared ray, I have been exposed to some of the densest ter-fogs with scarcely any inconvenience. I have and this "nasal" elimination of disease very ominent in several cases I have treated—two, tably, of consumption, where the prevalent elimi- ıtion passed upwards and outwards entirely rough the nasal glands, so that the exhaustion of e usual expellent "cough" action was entirely perseded. The change is the result of judicious d active thermal treatment; so that we may see w winter asthma may become "hay fever" or mmer bronchitis, with the same genial influences temperature and season. This is all I can give the result of my own experience and observation, t it will help the sufferer to understand the disorder he has got, and what is right and wrong in the eatment. Of late years the disease has come to be nsidered "as caused by animalcular life" (Tyn- ll on "Dust and Disease") the opinion being based the observations of Professor Helmholtz, of Ger- any, a sufferer from "the peculiar catarrh called y fever from the year 1847." Examining the nasal scharges under the microscope he regularly found, the last five years (to 1868), certain vibrio-like dies (organisms) in them, which at other times he uld not observe. Learning the poisonous action quinine upon infusoria he determined to make the periment of a weak infusion of it up the nostrils, e repetition of which three times a day, he says, der the most unfavourable circumstances, was fficient to keep himself entirely free. Two other rman physicians were equally successful in curing y fever by the same means. From this the infu- ria or organisms have come to be considered as the use of the disease. More than this, the fact pears to have been laid hold of as a foundation for at has been lately much advocated as the "germ eory" of disease, more particularly as related to idemic disorders, often so frequently and suddenly evalent in extreme "season" conditions and anges. The infusoria here present I believe erely to be the product of the corrupt secretions emselves, as in the case of ascarides and other orms, which only breed in the slime of disordered testines, and the vermin which breed in what is rmed "louse cancer," and even on the bodies of rsons in certain stages of ill health and foul per- irations. The injection of quassia into the intes- nes destroys the ascarides wholesale, by virtue of e "tannin" of the remedy. The larger species are stroyed in the same way by the male fern, koussu, megranate, turpentine, and calomel, which dry up ese "animal juices" as well as the humidity of e diseased secretions. The quinine acts in a simi- r way on the germs of the "hay fever." "F. W. S.," wever, gives evidence of a further action, which pears to have escaped the notice of physicians—the prompt flow of a peculiarly tenacious gummy ucous from the nose and throat." This is the real re of the disorder, the "germs," and their destruc- on being alike collateral effects of the disease and e remedy. Possibly this crude sketch may enable e querist, as well as other sufferers, to understand e disease. As to prevention: Well, it is the fort of nature to remove the effete matter from e system; the disease, the "process." To prevent , therefore, only to make further mischief to lay e foundation for future insidious disorders. All at can be done is to "assist nature," and by suit- le remedies make the "process" as short and sy as possible. As to the quinine, knowing its ncretive or "tanning" action, I had doubts as to e consolidation of the secretions in the cellular sue of the nose and palate, and the thence possi- e creation of tumefaction and polypus in the ucous membranes. This doubt "F. W. S." dis- ls, the solidification of the membrane being accom- anied by the separation of the diseased products ere deposited as a "peculiarly gummy mucus," ly rendered tenacious in itself by the tannin or tringency of the quinine. Whatever is behind in e system will occupy its place, and, if removed in s turn by the quinine, will so continue till the urce is exhausted. And this is the "cure" which s author and others have effected. All that can be rther done is to aid the more free solution of the ncrete and resinous matters at their source. Gums d resins are soluble in alcohol, albuminous and latinous matters in alkalis (and solutive acids). Hence brandy and soda water (potass) were observed be beneficial. Externally alkali (soda) was seemingly of decided power over it." These, there- re, point out the nature of the treatment to facili- ate the "extractive" local action of the quinine. If u need an alkali there is none so powerful in its ction on albuminous concretive matter, none so entle and non-depressing (the frequent effect of lkalis) as the chlorate of potass (2 drachms dis- lved in a gill of hot water). By gargling with this e mucus will in all probability be dissolved in the throat, and got rid of by interception, and so supersede the nasal irritation and discharge. Taken in 2 teaspoonful doses, 3 to 4 times a day, it will be absorbed, resolving the disease at its source, and destroying its acrid properties. As an external application to the nostrils, I think, a combination of 1 part olive oil with 2 parts benzoline (the common "lamp spirit" of domestic use) would be much more efficacious as a local resolvent than the glycerine. This is a rubefacient not to be found in the pharmacopœia. I was induced to try it from seeing the singular action of paraffin over the clogged oil and impurities of a sewing machine, which ran out like water. I therefore thought it should have an equal effect in a case of throat deafness (from induration of the ear glands and congestion in the neck tissues), which did not get on very fast. I used it to rub round the neck and ear, and soon got the hearing as well as ever, the indurated wax softening like butter. I added the oil as an emollient, and to prevent the too free evaporation of the spirit. It thus becomes an excellent solvent of particular efficacy in any tumefactive congestion, indurated glands, rheumatic or stiff joints. Of course, you will not take the candle to see if you have rubbed it in well! Be content with knowing you have done it, and, I think, you will not regret it. Well, this is all I dare offer in the way of philosophy or suggestion—too much, I fear, for the patience of "our" editor—but I hope that what I have written will convey to the querist and other chronic sufferers some idea of the unity of disease as applied to this and similar affections. Two more remedies will yet be required—time and perseverance. Professor Helmholtz, himself a physician, suffered with it for 21 years. "F. W. S." must not, therefore, expect a cure at once. Most of such diseases, especially of the asthmatic and bronchitic type, are processes of structural purification and renewal, and all that can well be done is to make that process attendant with as little danger and suffering as possible, and make each periodical return weaker and weaker by the gradual exhaustion of the matter of disease, often the accumulation of years.—INCOG.

[33349.]—**Running.**—I suppose that "B. C. A." means to be a long distance runner. If so, let him begin by running as far as he can, and as fast as he can, without drawing breath, which, I think, will be about 120 yards. Then let him stop and rest, then try again, until he finds he can do it quite easily, and then he can practise longer distances. The fewer times you breathe the longer you will be able to run. As for training, a great deal depends upon the diet. Take very little sugar or butter, take plenty of dry toast, have your meat a little under done, use sparingly of potatoes, as they cause in some people shortness of breath, and, above all, when done practice be well rubbed down, and then have a bath, shower, if possible, then another good rub down, until you feel yourself all of a glow. Then muffle well up, and take a walk, but do not allow yourself to get chilled. Keep good hours and rise early, and have another walk (never run before breakfast); then have another bath. Never run shortly after meals, avoid all stimulants such as ale, porter, spirits, and wines. You will find yourself far better without them. Don't tire yourself when you commence to train—have yourself timed as accurately as possible, and at the month's end time yourself again, and mark the improvement. These are the mere outlines of training only.—THOS. CLARKE.

[33358.]—**Chemist and Druggist's Receipt Book.**—"Cooley's Cyclopædia of Practical Receipts," now publishing in 1s. parts by J. and A. Churchill, 11, New Burlington-street, W., is the best. The 5th edition may be purchased second-hand for about 14s. or 15s. The next best is "Beasley's Book of Receipts," published by the same firm at 6s. 6d. What receipts does "T. H. A." want? If they are likely to be interesting to the readers of the ENGLISH MECHANIC, and are not too many, I shall be happy to supply him with them.—CHARLES W. QUIN.

[33358.]—**Chemist and Druggist's Recipe Books.**—I think H. Beasley's "Druggist's General Recipe Book" is what "T. H. A." requires. It is published by J. and A. Churchill, and costs 6s. By the same author, "Pocket Formulary and Synopsis of the British and Foreign Pharmacopœias;" also the "Book of Prescriptions," containing more than 3,000 prescriptions.—D. STRATHEARN, Medical Student.

[33359.]—**Unfermented Bread.**—The dough of all unfermented bread should be made weak, like thick batter, and not stirred more than is necessary to mix it. If light, the gas is either stirred out (of course it is too thin to knead it) or escapes in the baking, without expanding the dough.—PIMPERNEL.

[33359.]—**Unfermented Bread.**—For some time past I have had bread made on the system recommended by "A Physician" and others, but it was found that the quantity of water named was too small. Also I think I use more soda and acid. My plan is this for 4lb. flour (whole wheat-meal, home ground):—6 drachms Howard's bicarbonate of soda, which, of course, is well mixed with the flour, then stir in 1oz. hydrochloric acid in 3 pints of water. With the above proportions I do not find salt required, but that is a matter of taste. The brown bread is nicer when baked in small loaves or cakes, and the same may apply to white, which I have not tried. I hope R. M. Summer will meet with as great success as I have done; the bread is delicious. Thanks to "A Physician" for first calling attention to the matter.—B. BOOTHROYD, Southport.

[33359.]—**Unfermented Bread.**—I hope "A Physician" will see and answer your query; but, meantime, you might read further on the subject in subsequent numbers of this journal. As one who has eaten this bread for years, I strongly advise you not to give it up on a single failure, or even a dozen. Perhaps you mixed it too "stiff" or too wet, or the flour was not first-rate, or the oven not right. Such bread is never so "light" as baker's. It should resemble that made with "baking powder." But if you could get aërated bread, and find it to your taste, it would be scarcely worth while making the above. *That* is the (theoretically) perfect article.—DAGHBERT.

[33359.]—**Unfermented Bread.**—The reason you failed is most likely in the mixing of the bread. It should not be worked or kneaded at all, but simply mixed, and put into the oven right away.—CONFECTIONER.

[33359.]—**Unfermented Bread.**—Mr. Summer's "sad" failure as a baker was probably due to too much kneading of the dough, which is fatal to the lightness of the bread. I am sure that his good wife will let him try again.—A PHYSICIAN.

[33360.]—**Willows.**—If "Semaj" planted larger cuttings next winter, too large for children to take away, I believe they would root. I have seen large posts of willow, planted as piles against an embankment, transformed into pollards.—AMERICUS.

[33360.]—**Willows.**—I would recommend "Semat" to discard cuttings altogether, and plant instead large branches or rooted stems. Those will grow with even more certainty than his willow cuttings, and the school children will not be able to drag them up.—E. B. F.

[33361.]—**Shutting Cast Steel.**—Borax, 10; sal-ammoniac, 2; flowers of sulphur, 1 part. Grind or pound them roughly together, then fuse them in a metal pot over a clear fire, taking care to continue the heat until all scum has disappeared from the surface. When the liquid appears clear the composition is ready to be poured out to cool and concrete. Being ground to a fine powder it is ready for use. The steel to be welded is raised to a "bright yellow" heat; it is then dipped into the welding powder, and again placed in the fire until it attains the same degree of heat as before; it is then ready to be placed under the hammer.—From an old No. of the ENGLISH MECHANIC.—W. P. IRON.

[33364.]—**Blueing Steel, &c.**—If "Lodovic" will use clean brass filings instead of powdered charcoal, he will find that bring his work up to a nice even blue colour. He can see when it is blue by just removing a little of the filings. If not blue enough, cover over again. He will be able to get it any shade of blue. He must be sure to have his work clean, and also the brass filings, and use it in just the same manner as he did the powdered charcoal.—EXON.

[33364.]—**Blueing.**—The query concerning the fine black blue obtained on the "furniture" of the best gun work has several times been asked in the ENGLISH MECHANIC but has not met with any satisfactory reply. The heel-plate and trigger-guard of fowling-pieces is not generally case-hardened but merely soft iron, and the blue is a scale obtained at a high temperature, similar to that on rolled steel or Russian iron plates. The surface of the work is first polished to the highest degree by means of buffs and emery. As the least trace of grease or oil from the polisher would mar the beauty of the surface, this is first well rubbed with powdered quicklime. The work is then held over a clear fire of cinders or, preferably, of charcoal, till it uniformly acquires a very dull red heat, barely visible. This scale is very hard in places where it is not worn or scratched through, resists damp, and prevents rust. In cases where ironwork is not polished, but finished by smooth filing, a very durable black may be obtained by holding it over the forge in the smoke from raw coal till the surface is covered with condensed tar. This is then burnt in at a higher temperature, well rubbing it during the heat with a piece of cotton waste slightly saturated with linseed oil. The work is then set by to cool.—F. H. WENHAM.

[33369.]—**Stamping Foreign Goods.**—Your correspondent, "Puzzled," should be very thankful to his Continental friend for pointing out the illegality of acting in the way described; it has saved him much anxiety, trouble, and expense. The stamping of the name and address of a British manufacturer upon goods made abroad is prima-facie a gross deception, highly improper, and merits the strongest condemnation—this from a moral point of view; and upon reference to the Customs Consolidation Act it is found that the legal view is far more severe and comprehensive. A clause in the Act anent importations, *inter alia*, reads thus:—"Goods, the importation of which are prohibited—viz:—Articles of foreign manufacture bearing the name, brand, or mark purporting to be the name, brand, or mark of a manufacturer resident within the United Kingdom." Where is the expediency of this enactment? Its obvious intention is to protect and maintain the high character in which goods of British manufacture are held, and to prevent articles of foreign make and inferior quality being spuriously represented as of British origin. The mere marking of the name and address of a British manufacturer upon goods of foreign make clearly tends to such a

British character; the regulation, however, has been modified, for an amendment of the Act allows the names *only* of known British makers to be used. Your friend need not fear the Board of Trade, nor in fact any one, for it is questionable whether the law on his side the stream prohibits the exportation of articles so marked. The matter is within the jurisdiction of the Board of Customs here; therefore, the importer would suffer the penalty, and to this extent: the Board of Customs have the power of absolutely confiscating all goods marked illegally; they would certainly seize such, and it would not avail to show that no deception was intended, because the British marks themselves could only suggest to an outsider British manufacture; and although they might not enforce the maximum penalty—viz., forfeiture and fine—yet they would require compliance with the law before releasing. The Board would have to be petitioned, and would of course take all the circumstances into consideration, and the result might be favourable. In any case, however, the objectionable word or words would have to be erased, and a fine of some degree inflicted, or the Board might possibly waive this altogether.—Bartlett.

[33370.]—**Clock Stopping.**—With such little acquaintance with the clock of "Telescope Tele's," I will suggest a probable cause to bring about the stopping of it in winter more than in the summer. During summer time the warm weather has a tendency to keep the oil limpid—hence the freedom of its even worn parts to continue its "tick, tick." In the colder weather the oil becomes thickened and clogged, by which, to some extent, the freedom of the action is impeded. Now, if the clock should be a trifle "off beat"—*i.e.*, unequal in its "tick"—it may "come to rest." To test proceed as follows:—Supposing that it is securely fixed, lead the pendulum slowly until the "tick" is heard, and at that instant move it no further, but let it fall from the hand, and notice if the clock continues to "go," if so repeat the trial of the pendulum on the other side for the "tick" again, releasing it as before. If the clock does not continue to go there is the fault. If the pendulum "goes off" on both sides I am unable to judge without knowing more about it. To alter:—At the back of the clock frame there is a rod of steel, at the bottom of which is a slotted piece, in which the pendulum-rod acts. By bending that rod of steel a trifle towards either side it will have the effect of correcting the defect. A few trials will soon enable the operator to judge whether it beats and "falls off" correctly.—Seconds' Practical Watchmaker.

[33371.]—**Yacht Designs.**—In the back vols. of "Hunt's Yachting Magazine."—W.

[33376.]—**Measuring Focus.**—I believe it is customary to measure from the outer side. This is most easily done by measuring from the edge of the lens to the focus point.—F. C. Dennett.

[33378.]—**Works on Chemistry.**—The very best work for "F. C. F." is "Chemistry—Theoretical, Practical, and Analytical," by eminent writers, published by Mackenzie and Co.—C. J. Leaper.

[33379.]—**The Zodiacal Light**—Was seen here (near Southampton) as usual this spring. I generally notice its first appearance in the S.W. on favourable evenings, in the beginning of December, but it seems brightest at about the vernal equinox, after which it is speedily obscured by the lengthening twilight. I cannot speak as to its appearance before sunrise.—A. H. S.

[33379.]—**The Zodiacal Light.**—Surely "X." has not read his English Mechanic very carefully, or he would not have skipped over letter 14098, p. 16, of the present volume.—F. C. Dennett.

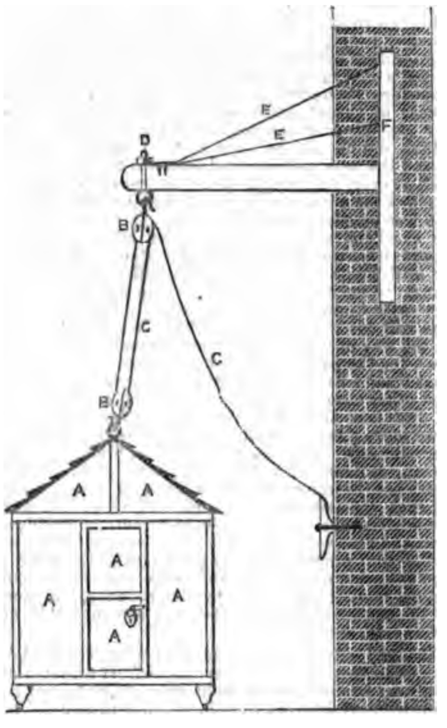
[33380.]—**Daniell's Cell.**—The local action is probably caused by some of the solution of cupric sulphate percolating through the porous pot, the sulphuric acid of which combines with the zinc, forming zinc sulphate, the copper being deposited on the zinc plate in the form of black oxide.—E. J. Marshall.

[33384.]—**Microscopic.**—Bring down the tube of the microscope to a horizontal position; accurately focus your object; then place a screen before the eyepiece. Now, by means of the concave reflector, catch the bright glare of a Silber paraffin lamp. Work it about until you get a sharp and illuminated image. At the same time move the screen back so as to get the proper size. Prevent the direct rays of the lamp from falling upon the disc. I have often thought that if some more convenient arrangement of this kind could be obtained it would be an improvement upon the ordinary neutral tint and Pepper's ghost plan for drawing, as it would not be so fatiguing to the eyes.—Theo. Izod.

[33385.]—**Painting.**—Any kind of tar varnish for wood is much inferior to a coating of oil paint: it soon gets washed off. For outdoor purposes, where a large quantity may be required for rough boarding, tar varnish may be greatly improved by an additional process, possibly made to last as well as oil paint, and cost less. After coating the wood with tar varnish, when dry let "Stretton" cover the same with a coat of Portland cement, fine sand, and water, mixed up to the consistency of paint; to be put on with a brush.—Pioneer.

[33386.]—**Noise in Water Pipes.**—About 18in. of 1in. lead pipe, branched in supply pipe a few inches from ball-tap, will cure the evil you complain of.—*J. A. P.*

[33388.]—**Larder.**—If you have a very high wall handy, so much the better. Providing there is a draught, proceed as per rough sketch. The parts marked A in sketch are to be covered with perforated zinc; B B are double pulleys; C C, the rope; D is a bolt, with eye at one end, and nut on the other; E E are pieces of bar iron, forged flat at both ends, and one end turned up so as to fasten on the block that is on the wall, marked F. With this arrangement, I have never found anything to beat it. I forgot to say that the perforated zinc goes all round the four sides. The size of mine was 4ft. wide and long, and 5ft. deep; there are cross rails along the inside, under the roof, on which to fix hooks, &c., and several shelves not shown in sketch.—Telescope Tele.

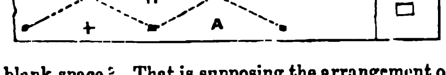


[33389.]—**School Board Education.**—I think the book Mr. C. Hamilton Moore refers to must be one entitled the "Education Craze," published by Harrison, Pall Mall. I have a copy, and found it a most interesting and amusing work. It is admirably written, and in a style that forcibly reminds one of old Sydney Smith. It exposes with an unsparing hand the shameful extravagance of the generality of School Boards, and it gives page after page of instances showing the absolute and utter waste of time on the part of a large proportion of those who attend those schools. The replies, given to examiners, in innumerable cases, demonstrate conclusively the worthlessness of the trumpery knowledge imparted in Board schools. The small volume in question cannot but have a most beneficial effect in showing up the stupendous national folly perpetrated by the Education Act of 1870.—E. Harold Gray.

[33391.]—**Canary.**—Read my reply on p. 274 (query 32804) of present volume, which case applies exactly to yours. The wheezing and panting arises from a cold generally.—Telescope Tele.

[33394.]—**Piano.**—The frame containing the action is not in its place very likely, or perhaps something has got under the keys; or, more important, the little brass screws near the end of the keys and under the stickers want regulating. Try them by turning them inwards or outwards until the hammer has a good spring backwards, and does not block the string.—Fiddler.

[33396.]—**Organ.**—From your sketch and your description I have come to the conclusion that you must have bored your holes side by side up the length of your slide, or else, if not, how is it possible, upon drawing the slide B (which you mention), for the hole, E, to cover the hole, F, which ought to be a blank space? That is supposing the arrangement of your pipes to be semitonal, which I think your sketch shows. If you have thus bored, you will only have the thickness of your soundboard bars between the holes; consequently it will be impossible to entirely shut off the wind when your slider is pushed in. If you bore your holes like the rough sketch here given, which is supposed to be part of a slider, with the holes following their natural progression (that is, semitonally) you will be helped out of your difficulty. The planting, you will see, is in a zigzag appearance, so that, you see, when the slider is drawn the hole, E, covers the blank where I have marked the +, and so with all the other notes up the slide, the hole, F, would cover the space marked H. The hole, Fg, would cover the blank marked A. In boring your holes make one boring do for the whole lot—viz., upper boards, sliders, and soundboard. Prepare your slider and bearers, and arrange them where intended to slide; screw down your upper boards down on them; mark your holes out on the top of these, and bore right through the whole of them. Some bore them separately, but all at once saves time as well as giving greater exactitude in the holes.—Horace.



[33398.]—**Lime Juice or Lime Cream.**—I do not know the composition of Letchford's lime cream, but perhaps the following will suit him:—Glycerine and lime cream: Glycerine, 8oz.; almond oil (sweet), 8oz.; lime water, 8oz.; perfume as desired. If "J. T. W." should require any more recipes for lime cream, I will be only too happy to forward them. —D. Strathearn, Medical Student.

[33399.]—**Polypus.**—I am afraid that any treatment other than surgical will avail "Polypus" but little. Other means, however, such as escharotics, astringents, &c., have been tried, but the results have not been very satisfactory. A solution of alum may be used as an astringent injection, but recently the insufflation of tannic acid in powder has been advocated. These produce a more decided effect if used as the after treatment of an operation.—E. J. Marshall.

[33390.]—**Polypus.**—Much of what I have said in answer to 33368 may be applied to this query, the source of the affection being also of internal origin; hence the inefficiency of the surgical operation, which will have to be renewed as the deposit invades fresh tissue, the tumefaction not being "peduncular." In such cases as these it is usual, apart from surgical operation, to resort to astringents, the "blood-root"—a very powerful one—being sometimes resorted to as a specific. Alum-water is also much used. In this case I should not recommend them, for the reasons given in my other reply. I should rather recommend, first, the snuffing up of a little of the chlorate potassa solution as a solvent and cleanser, and then following up with the same administration of a decoction of marsh mallow, or the roots thereof, adding half a teaspoonful of tincture of myrrh to a cupful of the decoction. This would heal the ulceration, and mature new tissue. Gargling, as in the other case, might also have the same advantage, in intercepting the flow of humours; otherwise, keep up the discharge as long as possible. Constitutionally, I think a teacupful daily of coca infusion would be of benefit. Rub the part outside with the benzoline and oil as I have given. This will help to dissolve the old formation, and prevent fresh tumefaction setting in. Should headache or pain follow this, drop the use of the mallow decoction to the nostrils, or, at any rate, the myrrh tincture therein, but not if the discharge flows freely, as the headache will be indicative of some existing coagulation in the membranes lining the cavities of the head, where the root of the disease may be.—Incog.

[33399.]—**Polypus.**—This is a query, in my opinion, incapable of being fully answered in "our" columns. A medical man must be allowed to be the best operator. However, as you seem to be in a perplexed state, I will advise you as to your best manner of procedure. If the discharge you speak of is pus, I should be inclined to believe it is not a nasal polypus at all, for nasal polypi, as a rule, do not cause or secrete pus, unless for a few days, and that is when the polypus has been removed, and a violent caustic has been applied. Seeing the rapidity of growth of the polypus in so short a time, it might be one of those fungoid or carcinomatous polypi, which is cancerous, and evulsion must not be attempted with the forceps, for it must be remembered that soft cancer, originating within the cranium, may come down through the ethmoid bone into the nose. In the meantime, let "Polypus" get 1 ounce of glycerine and 1½ drams of tannin; mix and dissolve by a gentle heat; next take a camel's-hair brush, and well wash the nostrils three or four times daily with the lotion. If he should be successful in stopping the suppuration (which, I think, should not be longer than a week), he may proceed to the next step, which is as follows:—Get 1oz. of laudanum, and into it put 3drs. of solid opium. This quantity put in will not be dissolved; but you are not to mind that. Let the bottle and its contents stand for three days, shaking it occasionally. This time having expired, take a small brush, and well daub the polypus four or five times daily; but, previous to applying the tincture, you must vigorously shake the bottle, and insert the brush when the solid particles are suspended in the liquid. This is the treatment I gave a young lady who was afraid of the operation of removing the tumour, and it was successful: it caused it to wither away. Now a parting word to "Polypus." If the suppuraton does not stop at the end of a week, after using the tannin and glycerine lotion, I should advise him to go to some hospital where they make diseases of this kind their specialty or study. But he may bear in mind that he cannot get through our pages anything that will be of much account for him, because he cannot state his case here as he would to a surgeon; therefore it remains without being diagnosed, and consequently without proper remedies.—D. Strathearn, Medical Student.

[33400.]—**Weirs.**—"Lancashire Fitter" may consult "Tracts on Hydraulics," by Thomas Tredgold, civil engineer: "The Elements of Practical Hydraulics," by Samuel Downing, M.A.; "Hydraulic Tables," by Nathaniel Beardmore; and other engineering works—some of Mr. Weale's and Messrs. Spon's, for instance.—8½IN. O.-G.

[33402.] — **Rough Powerful Battery.**— Keep your zincs to replace those consumed. It is dreadfully wasteful to have more zinc surfaces than are doing useful work, while increasing the carbon surface is an advantage, and has nothing against it except the first cost.—SIGMA.

[33402.]—**Rough Powerful Battery.**—"Stannous" can make one at a cost of about 4d. or 6d. per cell, and fully as powerful as large bichromate carbon batteries, by using one plate each of cast-iron and amalgamated zinc in common tumblers or jars, using the ordinary bichromate solution. The zinc in one cell may be connected to the iron in the next by a thick copper wire soldered across. Four cells will give a steady spot of light between carbon points. The objection to this battery is that the iron is acted on by the solution, which, in consequence, gets exhausted quickly. For short experiments requiring great power, the battery is extremely powerful, simple, and cheap, and is one I use frequently.—THOS. FLETCHER, Museum-street, Warrington.

[33403.]—**Glass Cutting.**—By first boring a hole with a drill, moistened with spirits of turpentine, and then enlarging with a rat-tail file, also moistened with spirits of turpentine, "An Old Mechanic" will find no difficulty in making the aperture in the piece of glass.—C. J. LEAPER.

[33409.]—**Oxygen Gas Bag.**—In a tin case with a tight-fitting cover, in company with a small piece of camphor.—C. J. LEAPER.

[33410.]—**Chemical.**—Citric acid $C_6H_8O_7$, tartaric acid $C_4H_6O_6$. F. W. Woodman will find every information about Weldon's process in "Theoretical and Practical Chemistry," published by Mackenzie and Co. If he has not access to this I will (with the Editor's kind permission) describe the process for him through the ENGLISH MECHANIC.—C. J. LEAPER.

[33410.]—**Chemical.**—Tartaric acid, which is remarkable for existing in four modifications differing chiefly in their action on polarised light, has the formula:—

$$\left\{\begin{array}{l}\mathrm{CO\,Ho}\\ \mathrm{CH\,Ho}\\ \mathrm{CH\,Ho}\\ \mathrm{CO\,Ho}\end{array}\right.$$

This formula is obviously capable of isomeric modification. Citric acid, which may be regarded as the lactic acid of tricarballylic acid, has the formula:—

$$\left\{\begin{array}{l}\mathrm{CH\,Ho\,(CO\,Ho)}\\ \mathrm{CH\,(CO\,Ho)}\\ \mathrm{CH_2\,(CO\,Ho)}\end{array}\right.$$

There has been much discussion as to the chemical change which occurs in Deacon's process for the manufacture of chlorine. If cupric chloride be used; it has been suggested that this first loses half its chlorine, thus:—

$$\begin{array}{ccccc}2\,\mathrm{Cu\,Cl_2} & = & \mathrm{Cu_2Cl_2} & + & \mathrm{Cl_2}\\ 269 & & 198 & & 71\end{array}$$

and then the cuprous chloride takes chlorine from the hydrochloric acid.

$$\begin{array}{ccccccccc}\mathrm{Cu_2\,Cl_2} & + & 2\,\mathrm{H\,Cl} & + & \mathrm{O} & = & 2\,\mathrm{CuCl_2} & + & \mathrm{OH_2}\\ 198 & & 73 & & 16 & & 269 & & 18\end{array}$$

forming cupric chloride, which in its turn is decomposed as before. This view is, however, not very satisfactory.—WM. JOHN GREY.

[33415.]—**Pith Balls.**—If "Electrician" searches amongst the elder branches he will find some dead and decaying amongst them. Cutting these open he will find the pith separated from the wood. It should be dried in an oven, and cut into balls with a sharp knife; simply rolling these balls in the palms of the hands will press them into a better shape. The pith of the rush is lighter. The skin of the rush may be easily peeled off, the pith may then be dried and cut into shape.—E. B. F.

[33415.]—**Pith Balls.**—I have always found that the wood of the elderberry tree formed one of the most, if not the most suitable source of pith for electric purposes.—J. M. W., Manchester.

[33418.]—**Distillation of Tar.**—The principal compounds in tar are acids—bases, solid and liquid hydrocarbons, alcohols, and ethers—together with resins and empyreumatic products of indeterminate composition. When tar is distilled the more volatile and liquid hydrocarbons pass over first, together with the alcohols and ethers, while the less volatile oils consist chiefly of acid and basic compounds, and the last portions which distil over contain the solid hydrocarbons. The residue left after about half the tar has distilled over—called pitch, and likewise asphalt, when obtained from coal tar—also contains solid hydrocarbons, together with resinous compounds. The chief liquid constituents of wood tar are methylic acetate, acetone, hydrocarbons—namely, toluene, xylene, and cumene-methol (a mixture of volatile oils boiling between 100° and 250° C.), eupione, creosote, and a number of indefinite oxidised compounds, including picamar and capnomar. Amongst the solid portions are resinous matters more or less resembling colophony, also paraffin, naphthalene, anthracene, chrysene, retene, pyroxanthin, pittacal, and cedridet. The more volatile portions of coal tar consist mainly of benzine and its homologues, together with a number of bases, beginning with pyridine. The naphtha from cannel and boghead coal is chiefly composed of alcoholic hydrides, homologues with marsh gas, together with olefines and homologues of benzine. The less volatile oil or dead oil of coal tar contains phenol and cresol, also aniline, picoline, chinoline, and other volatile bases, and a number of solid hydrocarbons, including anthracene, naphthalene, chrysene, &c. The preparation of tar from coal, lignite, and bituminous shale has acquired great importance of late years for obtaining paraffin and paraffin oils for illumination and lubrication. Coal tar has also acquired great value as the source of aniline colours, phenol, picric acid, &c. Heavy coal oil or dead oil is used for preserving timber for railway sleepers, &c., also for burning into lamp-black. Wood tar possesses powerful antiseptic qualities; hence it is used for preserving timber. It is due to the creosote which it contains. The uses of the other various products are too lengthy for description here; but I shall be glad to communicate further with "Ambitious," if he desires it.—A. E. MENKE.

[33420.]—**Nitric Acid Stains on Cloth.**—If the stains have only been caused by dilute nitric acid the stain may often be partially removed by washing first with water, and then with dilute ammonia. All depends, however, on the colour and material of the injured fabric. I have never heard of any substance for removing strong nitric acid stains.—J. M. W., Manchester.

[33424.]—**Water Raising.**—I should think that W. Adamson would be obliged to any one who would invent and impart to him a scheme of perpetual motion. Nothing short of this will be any good to him, as a jet from the upper aquarium will not even be able to get back again itself, much less to take any water from the lower aquarium with it.—LAW STUDENT.

[33425.]—**Mortising Machine.**— Write for an engineer's catalogue, where you will see it to perfection. It is a regular mortising chisel that is used, and is pressed into the wood direct by a long lever, weighted at one end, and it does its work admirably.—TELESCOPE TELE.

[33425.]—**Mortising Machine.**—This machine, or part of a machine, as shown in one of the London International Exhibitions, acted by chisels, not by boring tools.—DAGHBERT.

[33426.]—**Chemical.**—Mr. J. H. Collins says pyrites, yellow or white (FeS_2), is "slowly soluble in HNO_3." I suppose F. W. Woodman does not mean a solvent that will not decompose the mineral.—DAGHBERT.

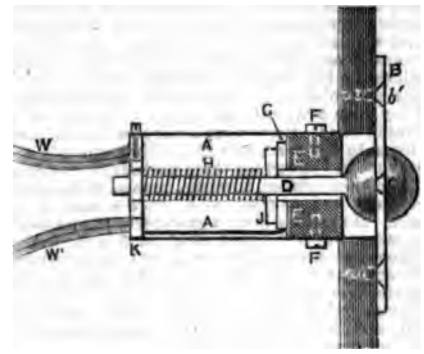
[33427.]—**Crucibles.**—I expect the cause of your failure is because you have made the material too moist. Dry in the air before placing in the oven, and apply a gentle heat at first.—TELESCOPE TELE.

[33429.] — **Soda Water Machines.**—"Ambitious" should get one of the illustrated catalogues issued by soda water machine makers, which will contain all the information he requires. I doubt whether "Ambitious" would be able to make one, and if he did the result would most likely be a tremendous explosion, which might cause death or severe injury.—R. P. G.

[33431.]—**Tables of Weights and Symbols.**—I do not know if there be any "tables giving the molecular weight and symbols of the commonly-occurring chemical substances" published in a separate form. There are, however, at the end of one of the editions of Fresenius' "Quantitative Chemical Analysis," four tables intended for use in calculations, which I think would answer all "Orfila's" purposes. They are, however, in the old notation. The tables in question are:—1. Equivalents of the elements. 2. Composition of the bases and oxygen acids. 3. Reduction of compounds found to constituents sought by simple multiplication or division. 4. Showing the amount of the constituents sought for every number of the compound found. I must confess, however, I do not see the actual necessity of such tables as he asks for. No doubt they are handy for beginners, but only as a saving of time, as if he were to read the chapters on "Quantivalence," &c., in any chemical primer—*e.g.*, Roscoe, and then learn the symbols for the elements in common occurrence, he cannot fail to identify any formula, at least, inorganic, with the substance intended; or, on the other hand, if he knows the name in full, and the formula be the desideratum, that can easily be ascertained by turning up, which slight exertion will be repaid by the retention in his memory of the formula so dug out. As a help to a thorough acquaintance with formulæ in general I would suggest—if he works in a laboratory—to use labels on his bottles which have underneath the full name, its formula, and its combining weight. He thus, in reading one, cannot fail to see the other, and as a consequence of this method the mention of the one will, in his mind, be associated with the thought of the other.—J. M. W., Manchester.

[33434.]—**Sanitary.**—Pure water acts as a powerful solvent upon leaden pipes, and water caught from roofs being almost pure, except from impurities contracted in its passage to the earth, and during its collection has a greater effect than water which contains salts of lime, iron, &c. I imagine that hard waters (waters containing a large proportion of carbonate and sulphate of lime, &c.) have less action upon the pipes, because they deposit some of the matters held in solution by them upon the inner surface of the pipes, and thus protect them from the solvent action. To have (if such a thing were possible) a constant supply of pure (absolutely pure) water with the existing arrangements of leaden pipes would certainly be very prejudicial to the health of those who had to drink the water, and the absence or partial absence of the salts above-mentioned is one of the objections to the Manchester (Thirlwall) water scheme, and also to the product obtained by Clark's water-softening process.—LAW STUDENT.

[33438.]—**House Electric Alarm.**—Having just completed such a job myself the following may be useful to "Jonah:"—The following was the contact-maker I used. The drawing is full size: A A is a small piece of brass tubing, having a brass disc, B, soldered on to one end of it. This is drilled and countersunk for screws, as at b^1. C is a small brass knob, either screwed or soldered on to the brass rods. C protrudes about half way through a hole in the disc, B. E is a circular disc of ebony fitting into the tube, A, and having a hole through its centre to allow D to slide freely. The ebony is held in its place by screws. To one end of the ebony disc a brass circle, G, is fitted, of rather smaller diameter than E, also having a central hole to admit of D sliding. H is a spiral spring which keeps the cross piece, J, of brass (passing through a hole on D) in contact with the brass circle, G. K is a brass disc closing the end of the tube, and also allowing D to slide. One wire, *w*, is attached to this; the other wire, w_1, passes through a hole in K, and is attached to the brass circle, G. I hope it is now plain that on pressure being applied to C the points of contact are forced apart, and no current can pass. Immediately, however, on the pressure being removed (as by opening a door or window) the spring recovers itself, and brings the cross-piece into connection with G, thus closing the contact. These contact-makers are sunk in the lintel of the door, or in the groove of the window, as shown in the figure. One of these must be used for each door or window to be guarded. The wires, W^1 and W, should be guttapercha-covered, as, in fact, all wires used in this job should be. The rest of your work is comparatively easy. You must have an indicator in your bedroom to show which room is attacked. This will be precisely similar to those used in ordinary electric-bell work. At some point in the battery wire which goes to the indicator you may insert an interrupter, which is merely a brass arm pivoted at one end and resting on a brass stud at the other. When you desire to throw the arrangement out of gear, which I presume you will in the daytime, you have only to remove the arm from the stud, and on retiring to rest it may be replaced. I shall be very glad to give you more help on this subject should you need it.—ROPEMAKER.



[33441.]—**Reflector.**—No doubt, under the circumstances mentioned, a complete covering of waterproof cloth would answer; but I would suggest that on fine days it would be removed, so that both it and the instrument might become aired.—E. B. F

[33445.]—**Determination of Blood to the Head.**—The only remedies with which I am acquainted are remedies of negation. For instance, the briar-root pipe and the continual "glassing" of "bitter" throughout the day, are fruitful causes. With respect to the dirty briar-root the *Lancet*, a few years ago, in several articles, pointed out the injury to both head and stomach from the "filthy habit" of smoking briar-root, or indeed, any short pipe. The poisonous nicotine is in continual contact with the salivary glands—so the rest may be understood. Observe the short-pipe men; they are "everlastingly" spitting, whilst some of them, on account of this, are too unpleasant to sit beside. I am a smoker myself, but although I have both cigars and tobacco at my command I never smoke at home, nor in the day-time, unless it be a cigar after dinner on Sunday. I have had several short pipes—briar-roots and others—presented to me, but being aware of their pernicious character, I have simply put them away with the names of the donors and the dates, but have never used them. The briar-root is to me a stinking abomination, and how such unbearable foulness can be called "sweet" its devotees only can comprehend. I go in for a long clay, with a fresh clean one every night, at my favourite "parlour," and, in consequence, I never spit at all whilst smoking. Furthermore, when I have been asked by a friendly briar-root, or "cutty," why I moved away when they "lighted up," my answer has invariably been, "My head won't stand the stygian fumes of your pipe; you don't know the choking stink it is to me, although I am smoking myself." With respect to the "bitter" part of the question, it may not be generally known that all that class of ale is far too strong for a beverage. The usual tavern bitter beer contains, on an average, about 10 per cent. of alcohol, therefore it need not be wondered at that the bitter and the briar-root combined, during frequent daily meetings, will cause determination of blood to the head. When malt liquor goes beyond 6 per cent. alcohol it should be passed by as something unfit for drinking for those who wish to keep cool in the upper regions. Several gentlemen connected with ale breweries have told me that the two ales which I take at a shilling and sixteenpence a gallon respectively, are, when mixed, quite strong enough for ordinary drinking. "Beyond that you get into the heady stuff." Having now touched upon smoking and drinking let me deal with eating. Persons subject to dizziness are generally those of full habit of body. They should, therefore, be careful about the food that they eat. Long fasts through the business time of the day, followed by a "regular gorge" when they get home in the evening, are especially dangerous. The stomach being impoverished for so many hours is suddenly filled to repletion, and the affiliated organs being thrust out of their proper places by the distension of the stomach and its over-load, all act most injuriously upon the circulation of the blood. Hot plethoric suppers, too, produce the same effect. I knew a gentleman of some note in the banking world who, although he belonged to a City club, had a mansion and park of his own, and was carried to business in his two-horse carriage, yet, in order to enjoy his 8 o'clock dinner at home, starved himself all day upon a biscuit and a glass of sherry in his private room! He, too, suffered from determination of blood to the head, and at one time was laid up in my house in London for three weeks from this cause. Our 5 o'clock dinner, however, coupled with medical treatment and nursing, soon made a man of him again. He had his biscuit and sherry at mid-day all the same, but a rational meal at 5 p.m., without fatigue, was a very different affair to an exhausting "devour" at 8 p.m. He had several warnings, and was strongly advised to continue in the, at any rate, 6 o'clock style; but living in a "swell" neighbourhood, and being a bit of a tuft-hunter besides—his wife and daughters being also fond of their dinner-parties and handle-to-name company, of which they had plenty—poor gentleman, he had not the moral courage to shift his camp, and so one evening, after dinner, he leaned back in his chair, gave a soft sigh, and—he *had* lived. He was no longer in the present. I was fond of the morning cold bath, but carefully watched its effects, until the fingers deadened, and giddiness came on, when the cold bath became a warm tepid, and comfort returned. When a person enters a cold bath the blood is pursuing its course at a regular rate, but the chill water suddenly compresses the blood vessels; hence the blood that is then in the head is dammed up, and cannot get away, on account of the contraction of the speed of the circulation. There is, therefore, a pressure on the vessels of the brain, which pressure produces giddiness, and has produced death. The same fatal results have followed the flow of too much blood in the same direction. The golden mean is what is wanted in such a case. When I was subject to the complaint mentioned I had a treatment of slight purgatives and cooling medicine, and carefully avoided all rapid blood-making food or drink, and high alcoholic stimulants, such as port wine, brandy, whiskey, &c. Even sherry I mixed with water, for almost all sherry has from 36 to 46 per cent. of pure alcohol in it—a nice "soother" for either head or stomach! As I constantly lean over a desk or table all day all my shirt collars are made at least an inch beyond the ordinary wearing size, which gives bending room to the neck without "throttling" the blood vessels around. The appearance may not be very elegant, but as I only wear these collars at work that does not much matter. I put other more closely-fitting ones on when I visit anywhere. "F. W.'s" doctor was quite right about the cold bath, and perhaps some other ideas may be gleaned from these "dots" of a —PHYSIOLOGIST.

[33453.]—**Explosive Force.**—The boiling point of water in a bottle with the cork tight in is, of course, much above the boiling point of water under no pressure but that of the atmosphere; and this may furnish the reason why the bottle does not burst until the water has "boiled." Boiling point is simply that temperature (varying with the pressure on the surface of the liquid) at which the bubbles of steam rise to the surface and break. But if the bottle be a weak one, or the cork insecurely fastened, the water will burst the bottle or drive out the cork, as the case may be, if the bottle is heated; and this long before the water "boils." The reason why a bottle full of water, and heated, bursts at once on cold water touching the outside, is this:—By the application of heat the glass of the bottle is expanded. The application of cold water to one part of the circumference suddenly causes that part to contract. The result is that the resistance of the bottle to the pressure from within is rendered unequal round the bottle, and the bottle is therefore much more liable to fracture. Another reason is that the sudden contraction of one part whilst the other part remains expanded often cracks glass vessels, as well as rendering them less capable of withstanding pressure from within.—LAW STUDENT.

[33456.]—**Heating Kilns.**—The temperature of kilns may be determined by Wedgwood's pyrometer, whereby an approximation of the correct temperature is ascertained by the contraction of clay cylinders. The pyrometers cannot, however, be graduated with any degree of certainty, and it is only by indirect means that a comparison has been instituted between it and the mercurial thermometer. The zero of Wedgwood registers 1,076° F. (580° C.), and each additional degree about 130° F., the greatest heat being between 19,800 and 21,600 F. (11,000° and 12,000° C.). Better and more modern registrars of high temperatures are manufactured in considerable variety for various purposes by W. H. Bailey and Co. These are worked, I believe, by the differential expansions of porcelain and metal.—J. M. W., Manchester.

[33459.]—**Alumina**—Is obtained in the state of hydrate from common alum (KO,SO^3; $Al^2O^3,3SO^3 + Q_4HO$) by adding a solution of ammonia (or better, carbonate of ammonia) to the latter salt, and boiling. The precipitate is white, and gelatinous in a high degree, and retains the salts, in the presence of which it has been formed, with a remarkable pertinacity, so that it is very difficult to wash. Anhydrous alumina is obtained by heating ammonia-alum. See Ure's "Dictionary."—R. P. G.

[33459.]—**Alumina.**—Corundum and emery are crystallised varieties of alumina, exceedingly hard and insoluble. When clay is boiled with sulphuric acid aluminium sulphate is formed, and on adding ammonia, ammonic sulphide, or carbonate, potash, or the like, to the clear solution, a precipitate of aluminic hydrate is obtained, which, when ignited, parts with water, and becomes Al_2O_3 (alumina). Common alum, or any other aluminic salt may be used, with the same result. Alumina may also be obtained by heating ammonia alum. If "P. S. J." requires pure alumina he must, of course, use pure materials.—DAGHBERT.

UNANSWERED QUERIES.

The numbers and titles of queries which remain unanswered for five weeks are inserted in this list, and if still unanswered are repeated four weeks afterwards. We trust our readers will look over the list, and send what information they can for the benefit of their fellow-contributors.

Since our last "Pimpernel" has replied to 32773, 32928; "Telescope Tele," 32814, 32967, 32980.

32871.	Reed Organ Pipes, p. 226.
32872.	Making Steel Rifle Barrels, 226.
32873.	Flue for Brickyard, 226.
32884.	Water Engines for Organ Blowing, 226.
32887.	Heat Regulator, 226.
32907.	Attaching Red Rubber to Iron and Ebonite, 226.

33101.	Injector Condensor, p. 325.
33103.	Wheelmaking, 325.
33124.	Screw Boat, 326.
33125.	Painting on Silk, 326.
33129.	Aeronautics, 326.
33132.	Lathe, 326.
33140.	Decimals, 326.
33146.	Honeysuckle, 326.
33148.	S.E. and G.W.R. Train Service, 326.
33157.	Locomotive, 326.
33158.	Colouring Photos, 326.

QUERIES.

[33462.]—**Harmony.**—Will some correspondent kindly inform me if harmony can be learned without a master? If it can, please state title of a good and simple work on the subject.—POOR MUSICIAN.

[33463.]—**The Lemon Cure.**—Will the correspondent who published the lemon cure in your valuable MECHANIC a few weeks ago kindly inform me how the citric acid is to be taken, and what quantity daily?—CLARA BUSSELL.

[33464.]—**Dirty Filter (Lipscombe's).**—Will any of "ours" kindly say how above are cleaned? I have been told they must be sent to the maker, but as I live at a great distance the carriage would be expensive.—G. M. P. D.

[33465.]—**Acoustics.**—Will some one kindly answer these questions? 1. Does a sound of high or low pitch travel the quicker, or do they both travel at the same rate? 2. Why, when a band is playing in the distance, do you only hear the lowest base instrument such as the bombardon in a brass band or the double bass in a string band, while all the other instruments are inaudible, though all are being played? 3. What is the best length of string to have in a monochord for acoustical experiments? 4. In "Tyndall's Sound," speaking of the velocity of sound in gases, liquids, and solids, it is stated that "other things remaining the same, an augmentation of density always produces a diminution of velocity." Why then, in water whose elasticity is so much less than air, and density so much greater, does sound travel more than four times quicker than in air?—LEDNAM.

[33466.]—**Sizarships, Trinity College, Dublin.**—I should be very glad if any of the readers of the ENGLISH MECHANIC would give me information as to the sizarships as above, in reference to age of candidates, minimum annual expenses there, and other necessary information for a—CANDIDATE.

[33467.]—**Engine for Boat.**—I have an engine that I want to fit into a boat; it has two double-acting cylinders, 2in. bore, 3in. stroke. I want to know what pressure I must work at to drive a boat 18ft. long, and to carry about five persons at a moderate speed.—B. T.

[33468.]—**Purification of Manganese Chloride.**—I am much obliged to Mr. Allen for his reply to my last query (14543, p. 421), but, from his last two sentences, I think he has slightly misunderstood part of the query. The "ignition" described in the question was part of the purifying process, not merely the crystallisation of the salt. Heating to redness, it is said, expels the iron of aluminium as volatile chlorides, or changes them into insoluble oxides. The method does not remove the Ca, nor does Mr. Allen's. Will he kindly give his opinion of this plan? Also at what temperature is $MnCl_2$ volatilised or decomposed? Is there no other good method of getting the pure MnO_2? I am unable to use much Br. here. Heating $MnCO_3$, it is said, gives a mixture of MnO_2 and MnO.—DAGHBERT.

[33469.]—**Distillation of Shale.**—Can any of your readers tell me the name of the latest and best work or works on the distillation of shales and other oil-producing minerals? Also give the requisite information as to the fractionation of the resulting oils and their conversion into marketable products.—P. H.

[33470.]—**Equatorial.**—Would Mr. Lancaster tell me whether my equatorial is much out of the meridian, and whether it is out of the meridian and latitude both? When I set the clock with the telescope on the moon when it has past the meridian two hours and a half, the lower limb moves upwards vertically to the top of the eyepiece in seven minutes. Should it be moved E. or W. in azimuth?—BRICKWALL.

[33471.]—**Rheumatism.**—I have had rheumatic fever, but have recovered so far that I am able to walk about with the exception that my ankles are very weak and give me a hobbling appearance; my breathing also is very bad, and at intervals I can scarcely get breath at all. Can any of "ours" oblige by telling me the best thing to do under the circumstance? Age, 18.—J. M.

[33472.]—**Making Herb Essences.**—Can any of "ours" kindly tell me how to distil the essences of horehound, yarrow, and vervain? The common way of using these herbs is to infuse a handful of them in a quart of water. I want to make the essence so that an ounce of it in water will make a preparation equal to a quart of the infused herbs. Must the herbs be left in water any time before being distilled? Information will oblige—POOR PILLICODY.

[33473.]—**Microphone and Phonoscope.**—Will any electrical correspondent kindly give me a description of the necessary apparatus to make the microphone audible in a large room to a good number of people? Also state what battery power is necessary. I understand that an induction coil and a telephone of different construction to the ordinary ones are used for the receiving apparatus. Also any information as to the construction of a phonoscope for making sound waves visible, with an induction coil, will be thankfully received. One was described on p. 411.—R. E. F.

[33474.]—**Adulteration of Whiskey.**—Suspecting some artificial flavouring in whiskey, such as creosote, would any contributor, having some knowledge of the matter, inform me if small quantities of that substance would have any deleterious effect on the system, and if so what the symptoms would be? Also any test to discover same or other substance introduced to give the smoky taste to inferior spirit.—W. W. B.

[33475.]—**Telephonic.**—Will any reader kindly inform me as to which is the most perfect instrument yet invented for transmitting the human voice, and also whether there has yet been found an apparatus which will convey, distinctly and intelligibly, an ordinary whisper?—SOUPIRE.

[33476.]—**Trotting Machine.**—Would some English mechanic let me know how to make a four-wheeled trotting machine (such as is in general use in America), suitable for a pony about 13 hands high? Expense is an object. I wish it to hold two persons.—B. A., Trinity College, Dublin.

[33477.]—**Mercury.**—I cannot get the mercury to distil at all; all the vapour condenses on the glass retort and runs back to the dirty mercury. I have tried to distil indoors and outdoors, with low heat and high heat, all with the same result. The contents of my retort are nearly one pint; is it too big? Will "Ferrum" kindly help me?—A. PURGIA.

[33478.]—**Electrical Indicator.**—Could I employ an arrangement made after the description on page 375, No. 691, to show the rise and fall of a river with satisfactory result? But, one thing, will not the change of the temperature of the water and the pressure of the atmosphere interfere with its accurate indication?—A. PURGIA.

[33479.—**Poppy Oil.**—I should be pleased if some kind correspondent would give me full information respecting poppy oil, especially as to the best variety of poppy, the soil required, mode of extraction, and uses in England.—A. G. E.

[33480.]—**Seasickness.**—Will any reader of the ENGLISH MECHANIC be so kind as to recommend me some means of preventing this? I should like to spend my summer holidays at sea, but I dread the sickness. Please don't quote references to back numbers (if any).—WOULD-BE SAILOR.

[33481.]—**Daniell's Battery.**—I want to make half a dozen cells of some kind of galvanic battery, and I have come to the conclusion to make Daniell's, because I see all kinds of complaints of defective working or action made of every kind of battery but Daniell's. Am I right in coming to this conclusion—that it is the most constant and reliable of any, and easily made, and the copper worth two-thirds of the money if you ever get tired of it, and that it is fully equal in power to half the number of Grove's?—DR. SYNTAX.

[33482.]—**Bett's Patent Capsules.**—Can any of your readers oblige me with instructions for putting on these capsules without a machine? I understand those who are into the way of it prefer a string to the hine. I would like to know the *modus operandi.*—ERT.

483.]—**London Carriage-way and Foot-ements.**—Perhaps some of your correspondents be able to inform me of the cost of carriage-way ments as put down in the principal thoroughfares in lon, and the difference in price of granite blocks and atent wood blocks now coming into use. I wish to r the average price per superficial yard of each kind, something of their lasting properties in localities e the street traffic is heaviest. Likewise some inforon as to the cost of foot-pavement per square yard, the most approved method at present in use for such. ther asphalte and Portland cement be still used for pavement, or if the portable flagstones of the best , Scotch or English, are used and approved of in prece. Give some information as to the lasting proper-f the different kinds?—Pioneer.

484.]—**Organ Stops.**—Can any one give a good for a really imitative concert-flute? I should think abe flute would give rather too rich and heavy a as it is such a very large scale. Also will any one ly give a thorough description of the flageolet and flute, with scale, and, if possible, a diagram of each? can find out about them is that the flageolet is a 2ft. wood stop of smaller and sharper tone than the lo, and that the oboe flute is a 4ft. wood (I believe), of small scale and very delicate reedy tone, very but not quite so strong as, the viol de gamba.— Metal.

485.]—**Bleaching Organ Keys.**—Can any spondent tell me how I can bleach a set of organ that have become slightly discoloured? Is there any od of doing it without taking off the ivories? A search ugh old numbers has failed to yield any information. pe Metal.

486.]—**Polishing Organ Pipes.**—Can any one ne how I can brighten up and clean dull metal pipes? eve they are chiefly lead. I should like them to look uch like tin as possible.—Pipe Metal.

487.]—**Management of Birds.**—Will some of readers inform me the best work to get upon the gement of English birds?—C. K.

488.]—**Greenhouse.**—Can any brother-reader in-me if I should be allowed to build a greenhouse of (glazed) without interference by the district sur-?—Nemo.

489.]—**Patagonia.**—Can any one give any infor-on regarding this country, its climate, soil, inhabi-, fauna, flora, and minerals?—Nemo.

490.]—**Flexible Composition.**—Some three or weeks ago "Americus" very kindly gave me some in-ation relating to this substance. Not being aquainted the manner of mixing, will he give fuller instruc-?—New Subscriber.

491.]—**Spirit used by Glove Cleaners.**— any one kindly tell me in the next issue of the anic what is the spirit used by professional urers" for cleaning light-coloured gloves? It is not ntine and must be something cheaper than benzine , and such like preparations.—Delta.

492.]—**Atmospheric v. Ordinary Burner.**— "Sigma" or T. Fletcher explain how it is that from nsen burner, in which the combustion is supposed to rfect, we always get more or less unpleasant smell, from an ordinary burner, in which the combustion perfect, we get little or none? Also the ratio een the heat generated from a cubic foot of gas burnt spherically, and the same quantity burnt in the ary manner.—H. B.

493.]—**Writer's Cramp.**—I am a victim to what ieve is called "writer's cramp." Will any correspon-of the Mechanic advise me as to what contrivance I adopt, in the way of a pencil and penholder, to e me when writing to dispense with the use of my b and forefinger? Any advice as to treatment, &c., also be gratefully received by—Scrivener.

494.]—**Cliffs.**—I have lately stood on the cliffs of r, on the west coast of Ireland; they rise perpen-arly from the sea to a height of almost 700ft. Even this great height the sea horizon appeared sharp and defined, and I will thank Mr. Lancaster, or any of our valued correspondents, to tell me how far this horizon was and by what rule to determine such tance.—E. B. F.

495.]—**Harmonium Reeds.**—Will Henri Etienne whether the broad and bent reeds will work with the pressure of wind and same size channels?—T. B.

496.]—**Sick Dog.**—I have a small Pomeranian dog h, during the hot weather at the end of June, fell The symptoms are seeming weakness in the hind when walking or "sitting up," entire loss of appetite, rence for water to milk, which is not usually the with her, and dullness as if in pain. Can any one e as to treatment?—Penderella.

497.]—**Printing on Glass.**—I shall feel obliged y correspondent will explain the process of printing ass, and advise me of the best method to accomplish -J. L.

498.]—**Harmonium Tremolo.**—Will some kind d inform me the best way of making a tremolo for a harmonium?—Diapason.

499.]—**Metal Flute.**—About two years ago I read cheap metal flute—I thought it was in the English anic, but after looking through the last five vols. ot find it. I shall, therefore, be obliged if any one nform me if an 8-keyed metal flute is to be had, and the old system of fingering? If I remember right, rice for the 6-keyed was 21s.—Eldnar.

500.]—**Communication between Passenger Guard.**—I shall be glad to be informed whether ord system of communication has been discontinued any and what lines, and whether any other system as that in use on the South-Eastern Railway has yet introduced?—C. S.

501.]—**Street Tramways.**—I shall be glad if any rs can give me information on the following points: Where the first street tramway was laid down in pe, and the date of its commencement. 2. The of the engineer who carried out the work. 3. The of the inventor of the grooved rail. 4. The names towns in Europe in which steam or compressed air is used as a motive power for propelling tram cars. 5. When and by whom were tram cars introduced into England?—Lyons.

[33502.]—**The Ladies' Tricycle.**—About 8 months back I saw in a shop window, somewhere in the city a tricycle. The driving-wheel was on one side of the framework supporting the seat; and two smaller wheels, each about the size of the back wheel of a bicycle, on the other side of the frame. It was ticketed the "Ladies' Tricycle." I have, during the past month, unsuccessfully searched for this tricycle. Will any reader kindly give a description of the machine, and oblige?—Llewon.

[33503.]—**Injection Water.**—Mr. R. Crickmer, in his letter on "Air Surface Condensation" (page 370, No. 691), says, in reference to injection water from a well 22ft. deep, that "there is no power required to raise this water, as it flowed into a vacuum." Can this be so? It seems to me that as a certain amount of work is done in lifting the required injection water 22ft. vertical height, this power must be derived from the engine, and its effective force for other purposes this much diminished. It can scarcely be the same as if the water flowed into the condenser by gravity. Will Mr. Crickmer kindly explain if there is any difficulty in starting the engine, as at first there is no vacuum but rather the reverse in the condenser? Also if he uses a foot valve at the bottom of the ascension pipe to prevent its emptying itself during stoppages? The apparatus described is scarcely a condenser, but rather a cooler, and I should be obliged if Mr. Crickmer would give particulars of results, as temperature and quantity of water from hot-well, temperature of injection water at bottom of well, or the amount of cooling (loss of heat) in falling the 22ft., and quantity and temperature of additional water required to make up for loss. The bottom of the air-shaft or stand-pipe is shown closed, which I presume is scarcely the case in practice. For situations where contracted space prevails, this plan, if thoroughly practical, would be very serviceable; but the question of loss of power, difficulty of starting, and effective cooling capacity, may need some further explanation, which I should be glad if Mr. Crickmer would kindly give.—E. W. A.

[33504.]—**Honey Dew.**—Can any of your scientific readers inform me what is the cause of honey dew? Is it from above or below? It came in perceptible drops against our window this year. Also of the small feathery specks of white which sometimes disfigure larch trees? This year, in North Yorkshire, many are quite white with it.—Chas. Robinson.

[33505.]—**Black Drop.**—Would some astronomer kindly give an outline of what is considered the best theory that accounts for the "black drop" in transits? —R. J. Theakston.

[33506.]—**Mineralogy — Wavellite.**—I wish to know whether this mineral is obtainable in large quantities cheaply; and, if so, where? Also what temperature will fuse it; and whether its fusibility is much increased by addition of silicates, clays, &c.? Does it vary much in colour, or affect the colour of any substance it is added to, say a clay?—F. W. S.

[33507.]—**Midland Engines.**—Can any readers inform me where I can obtain a photograph of one of the class you illustrate in the last number of your valuable paper (July 5, 1878, No. 693): or one of the Bogie engines in use on the Great Northern Railway?—R. H. G.

[33508.]—**Violin.**—I have a violin which some minute insects (I presume, as I have seen several perambulating on the outside) are devouring by wholesale. Will some one kindly tell me how I can stop the destruction? They burrow under the wood, and leave a mere shell.—Aug. F. Perren.

[33509.]—**Photographic.**—I think I was not sufficiently plain enough in my last query. What I want to do is that I may take the prints of ferns so that I may have a jet black ground and the fern standing out white; I know the whole *modus operandi* save this. My warmest thanks to Mr. Lancaster, "G. O.," and "C. S." for their very prompt replies to my query.—D. Strathearn, Medical Student.

[33510.]—**Snoring.**—I have a young untrained horse which has become affected with some disease said to be prevalent in many parts of England, and, if so, some brother reader may tell me how to cure him. He is apparently swelled about the throat, and when he breathes snores long and loudly. I have consulted a "vet.," and, adopting his advice, blistered the throat, but this does not give relief. What am I to do? The "vet." says this disease is epidemic in London, and one-half the horses there have got it. I live 500 miles from London, so must take him at his word; but if he speaks truth some London reader will know a remedy.—E. B. F.

[33511.]—**Ink Stains in Leather.**—What will take ink stains out of the real leather top of a writing table? —Tsenre.

[33512.]—**Magnetic Engine.**—I have a small magnetic engine which I wish to run, if possible, without a battery. Is it practicable to do this from a permanent magnet? If it cannot be done from a stationary magnet, can a motion be got by connecting with such a magnetic machine as is used for medical purposes, and turned with a handle? Any information as to how to get a high speed (without much power) without the use of a battery will greatly oblige—Sartor.

[33513.]—**Purgative for Dogs.**—In treating a dog for mange I have printed instructions to give him a dose of equal parts of castor oil, syrup of buckthorn, and syrup of white poppies. It is very difficult to make the animal swallow even a portion of this. Can any correspondent recommend an equally efficacious purgative in the form of pills, there being no difficulty in having them swallowed in a little food?—A.

[33514.]—**Firearms.**—Will any reader inform me the title of any books or pamphlet, and where sold, on the construction of firearms—say guns, rifles, revolvers, and their various parts, and tools used in making them?—Carlos.

[33515.]—**Defective Speech.**—A poor but worthy boy known to me is unable to make himself understood. His grandfather says there is something wrong with the roof of his mouth. Can any one tell me if there is an institution in London that takes such cases in hand gratuitously or can suggest a mode by which this boy may be rescued from a life of inconvenience?—Penance Point.

[33516.]—**Mildew on Grapes and Rose Trees.** —Will any reader give the cause and remedy for mildew on grapes and rose trees?—J. B. H. S.

[33517.]—**Pianoforte Tuning.**—Will some one please tell me of a good book upon the above? I have up to the present time worked without any real system and am not satisfied.—Pimpernel.

[33518.]—**Pancratic Eyepiece.**—Can any one inform me how to calculate the power of the telescope by the pancratic eyepiece?—Scotland.

[33519.]—**Civil Service Examinations, &c.**— Would any one give me particulars of a book on the above, also of any paper published by the department?—Xit.

[33520.]—**Bronzing Plaster Ornaments.**—I have some plaster of Paris ornaments which are rather discoloured. Would any kind reader please to tell me the best way to bronze them?—Owen Jones.

[33521.]—**Photographic.**—Will "Finem Respice," with your permission, Mr. Editor, kindly favour us with his gelatine emulsion process referred to in his answer to "Photo," 33128? I, with many other readers of "ours," have been anxiously looking for the information.—Gelatine.

[33522.]—**Cracked Gong.**—I have a gong which is cracked and emits a jarring buzzing sound which quite spoils it. Can any one tell me of a remedy or whether it can be recast, and if the latter what would be the approximate expense for one 18 inches in diameter?—Emu Park.

[33523.]—**The Isle of Man.**—I should be obliged if some of the correspondents of the English Mechanic would give me a general description of the island as a place of residence, the climate, and cost of living. I am predisposed for asthma. Could a single man live there on £50 per year? Is it very cold in winter? Is the climate better than Jersey? I want to escape the London fogs and gloomy skies. What are the chief products of the island?—A Handy Man.

[33524.]—**Photographs.**—I wish to take some good ones off their cardboard mounts so as to put them in an album. I do not know what they are mounted with, but I tried an inferior one with cold and then hot water, and not succeeding, I then tried immersion in cold water all night; still I could not move them without tearing. Can some one say how safely to accomplish this?—John.

[33525.]—**Lathe Tools and Boring.**—As an amateur blacksmith I want to be told how to forge a hand-turning heel tool. In bending a piece of steel over the anvil I cannot get a heel. I get the inside corner tolerable sharp, but the outer is only a curve. 2. Having a ¾ round bar of iron I want to bore, say, a ⅛th hole through it, on its diameter, not lengthways. What is the proper way to do this in either a lathe or a small boring machine? I can start it all right in the latter, but although clamped it generally comes out a little on one side or other of the diameter.—John.

[33526.]—**Minotti's Battery.**—Please tell how to make Minotti's modification of Daniell's battery; also, if the sand or sawdust used will remain uninjured if the battery be laid by for months; also, if coarse plaster of Paris cells ¼in. thick are as good as what you buy. —Inquirer.

[33527.]—**Gold Fish.**—I intend to make a fresh-water aquarium for gold fish. Can any of "ours" answer the following questions? 1. What sort of wood am I to make it of? 2. What sort of joint for bottom? 3. What sort of putty am I to make for the grooves that the glass fits in? —G. J. P. C.

[33528.]—**Telescope.**—I wish to construct, as cheaply as possibly, a small telescope; it must show Jupiter's Satellites; I should like it also to show Saturn's ring, and divide wide doubles such as Zeta Lyræ. Will some optical friend kindly tell me of what focus the lenses must be, at what distance they must be placed from each other, and give hints for the construction? I do not require it to be achromatic nor of more than 2in. aperture of O.G. —Carolus.

[33529.]—**Tank.**—I wish to make a tank in the ground 12ft. long and 6ft. wide, and about the same in depth. As the ground is very swampy in winter, and it is of importance to keep the water out, can any of "ours" tell me a cheap way of doing it? An iron tank would be much too expensive.—Waterlogged.

[33530.]—**Telephone and Æolian Harp.**—Will a correspondent assist with advice, suggestion, or diagram? Object, to convey the sounds of an Æolian harp by telephone or other means. My experiments are quite young —hence not worth communicating.—N. Sirch.

[33531.]—**Artificial Stone.**—In various streets in London I have seen blocks of paving about 2ft. square, having the appearance of stone and very hard. Can any of "ours" tell me how they are made?—Alfred Stone.

[33532.]—**Cutting Pebbles, &c.**—Will any one inform me which is the best slicer used for cutting petrified pebbles? The best means of cutting the pebbles—whether with diamond, corundum, or emery powder, will also greatly oblige—Pebbles.

[33533.]—**London University Matriculation Exam.**—Is it necessary to take three languages, besides English, at the matriculation exam. (London), or would two, say Latin and French, be sufficient?—F. Richardson.

[33534.]—**Screw-cutting.**—Will any reader kindly inform me how to cut a worm of three threads to drive a wheel 3-16ths pitch with a common hand lathe; and the description of cutting tool to be used, as I am puzzled how to get a beginning and ending, which, of course, there must be to work the wheel round?—Wm. Carver.

[33535.]—**Geometry.**—Can any one tell me how to solve these riders on Book I., 16 to 26 Prop.?—1. A B C is a triangle, and the angle A is bisected by a straight line which meets B C at D; show that B A is greater than B D, and C A greater than C D? 2. The two sides of a triangle are together greater than twice the straight line drawn from the vertex to the middle point of the base.— C. C. Hawk.

[33536.]—**Lathe Bands.**—What diameter of gut band is best to use with a 6in. backgeard lathe, and is it advisable to have two thicknesses?—G. R.

[33537.]—**Jewellers' or Silver Soap.**—Can any reader tell me how to make jewellers' or silver soap such as is used by jewellers?—Jewel.

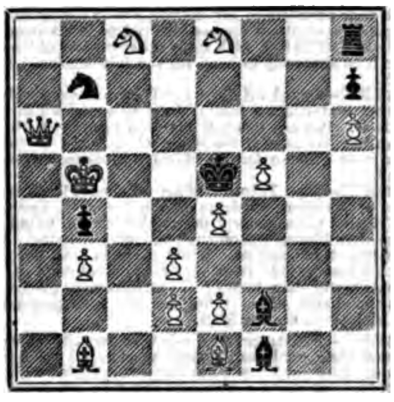
[33538.]—**Lathe Bed.**—Will any correspondent inform me the best height for a lathe bed, and also name the dimensions of a flywheel for a 4½in. lathe; the cone has four grooves, 4¼in. the largest, and 2¾in. the smallest?—TURNER.

CHESS.

ALL Communications intended for this department must be addressed to J. PIERCE, Copthill House, Bedford.

PROBLEM CCCCXXXIV.—BY G. F. ONIONS, Bradford.

Black.



White.

White to play and mate in three moves.

SOLUTION TO 432.

White.	*Black.*
1. Kt to Q Kt 4.	1. Anything.
2. Mates accordingly.	

SOLUTION TO 433.

1. R to Q Kt. 2.	1. Anything.
2. B to K R 6.	2. Anything.
3. R mates.	

CORRECT SOLUTIONS to 432 by "Fusiliers," W. J. Jubb, Arcanum, R. G. and G. D. F., Chowbeit, and J. Dale; to 433, by J. Dale (a very neat problem; the mate is sharp and clear); to 429 by Arcanum.

ANSWERS TO CORRESPONDENTS.

*** *All communications should be addressed to the* EDITOR *of the* ENGLISH MECHANIC, 31, *Tavistock-street, Covent Garden, W.C.*

HINTS TO CORRESPONDENTS.

1. Write on one side of the paper only, and put drawings for illustrations on separate pieces of paper. 2. Put titles to queries, and when answering queries put the numbers as well as the titles of the queries to which the replies refer. 3. No charge is made for inserting letters, queries, or replies. 4. Commercial letters, or queries, or replies are not inserted. 5. No question asking for education or scientific information is answered through the post. 6. Letters sent to correspondents, under cover to the Editor, are not forwarded; and the names of correspondents are not given to inquirers.

The following are the initials, &c., of letters to hand up to Tuesday evening, July 16, and unacknowledged elsewhere:—

F. WEATHERHOGG.—Chas. Macnat.—M. Cohen.—Abbe Eggis.—A. Aythe.—M. Schobbens.—R. Reynett.—J. Rand Capron.—E. W. Blundell.—F. T. Ware.—Asbestos Co.—James Ford.—O. P. Brown.—R. P. G.—C. W. Bank.—Jan.—C.—Enquirer.—C. J. Leaper.—A Subscriber.—R. G. Bennett.—A. A. Watkins.—C. P. O. Un Teinturier.—C. Townley.—E. R. Shipton.—W. Gorse.—Allen Lee.—H. G.—Americus.—Electric C.—Would-be Inventor.—W. J. Lancaster.—J. Lewis.—Dandie Dinmont.—J. W. Gerry.—Egeria.—Aquarius.—H. Garside, jun.—W. W.—M. M. W.—Tyro.—A Constant Reader.—Itsaex.—A Singer.—Ex-Lancer.—T. Mitcheson.—J. F. W.—H. B. F.—Prof. Houston.—A. B.—W. E. H.—J. R.

ANXIOUS. (You must ask direct for the information you now want, or else advertise for it.)—ROSE POMPON. (You can do nothing with them except regilding. 2. Write Hardwicke and Bogue, Piccadilly, for "A Manual of Botanic Terms" by M. C. Cook, price 2s. 6d.)—F. W. B. (Get Mr. Webb's "Celestial Objects," published by Longmans. We know of no maps published separately such as you require. Practice alone will give you the power of making drawings.)—JOINER. (He still writes occasionally under another signature.)—MARKHAM. (We know of no such books, and they would be little likely to help. Join some school of art and you will learn more in a twelvemonth than you would in a lifetime from books.)—E. COXLEY. (You had better advertise for such photographs or working drawings if you want them. We cannot suggest any other plan.)—A SUBSCRIBER FROM THE FIRST. (The expense of obtaining an injunction would depend on the opposition offered, but if the nuisance is as patent as you say, it should be very slight. We are for obvious reasons unable to recommend individual solicitors.)—LEARNER. (The small machine advertised by Mr. M. Cohen would probably suit you, or that advertised a few weeks back by Selig, Sonnenthal, and Co.)—GAUZE WING. (No university grants such a degree in absence worth having, and no one would accept it. Some ignoramuses and impostors *buy* the so-called degree for the purpose of deceiving people as ignorant as themselves.)—W. H. M. (She is probably suffering from hysteria, and a medical man would prescribe change of air and scene, with such other remedies as might suit her case, which neither he nor any one else could properly understand without seeing her.)—A. W. STOKES. (We have no faith in the results the correspondent you refer to forwarded, and we do not think your query would be likely to elicit any useful information.)—DEVASTATION. (We hardly think you would find what you want at South Kensington. You might at the arsenal at Woolwich.)—J. W. VALLE. (An illustration and description of a small smith's forge suitable for an amateur will be found on p. 41, No. 523.)—F. W. M. (The evidence is on the whole in favour of the theory that the ancient Egyptians had a knowledge of steel. Sir John Hawkshaw gave some interesting particulars on this subject in his presidential address to the British Association in 1875, which was fully reported by us in the ENGLISH MECHANIC of August 27th of that year.)—VALETUDINARIAN. (The sample is not brandy at all, nor is it even a distilled spirit. In Griffin's "Chemical Testing of Wines and Spirits" will be found an instance of a similar imposition, for it is nothing else. The author was as puzzled as yourself at the large quantity of tannin contained in a sample he analysed till he came across the following instructions in a German book for "Manufacturing Cognac":—"Take of acetic ether ¾lb., spirit of nitric ether ¼lb., French wine 8 quarts, oak bark tincture (made with ¼lb. of oak bark and a pint of spirit) 1 pint. Add enough purified spirit to bring the whole to 150 quarts." Very much of the "Public-house brandy" sold, is, we suspect, made by some similar process.)—NEVER TIRED. (Black flux is made by mixing thoroughly two parts of pulverised tartar (bitartrate of potassium) and deflagrating the mixture in successive portions in an iron ladle or in a crucible.)—H. H. (Many have been given in back volumes of the *Building News*. A capital design for a pair of middle-class cottages appears in to-day's number of that journal. They are designed with a view to erection in a new slab-concrete recently brought out, which may be worth your attention, but they can be built just as well in brick.)—AMERICUS. (We do not consider it probable; if the problem of aërial navigation is ever solved practically it will be by altogether different means. Your further communications with "Incog" must be made privately if at all. The coca leaves are advertised from time to time in our columns.)—WOULD-BE EMIGRANT. (The best way would be to advertise in the colonial papers. We believe files are to be seen, and advertisements are to be received at the office of G. Street, 30, Cornhill.)—W. WILSON, LL.D. (As a matter of fact the readers *have* decided. Against your single plea for the continuation of the controversy we have received repeated and numerous protests against the occupation of our space by the subject, which, as more than one reader reminds us, was really disposed of long since, though the propounder of the theories referred to cannot see it, and never will.)—VERNEK. (You will find Mr. Williamson's microphone advertised in the back page of No. 691.)—J. F., Liverpool. (Leyton is in Essex, reached in a few minutes from London by the G.E.R.)—YOUNG PAINTER. (Write Lockwood and Co., 7, Stationers' Hall-court, E.C.)—J. D. T. (Another correspondent has already made a similar suggestion, and we should be glad to see it carried out. Some instructions on tuning brass instruments were given on p. 355, No. 534.)

BLACKEYMOOR, Esnake, A Beginner.—See indices to back volumes.

PEGASUS ON SHANK'S PONY.—Your query is an advt.

An Excellent Field for Experiment.—Most practical mechanics have met with instances in which a bearing or slide of cast iron gave continuous trouble from heating or abrading, without any apparent cause therefor. Now the prismoids in the granular formation of cast iron lie lengthwise in the direction in which the heat passes from the casting when cooling in the mould; hence, if the casting cools with the working face upwards, the bearing surface of that face will be (in a flat surface) at a right angle to the length of the prismoids, while if the casting cools with the working face vertical, the abrasion will be parallel with the length of the prismoids, and in what direction (with relation to the working face or surface) the prismoids should lie, to obtain the best wearing results, our theorists and experimenters have, so far, given us no information; hence we call their attention to the subject as an excellent field for experiment.—*Scientific News.*

Rendering Corks Air and Water Tight.—The *Chem. Zeitung* suggests the use of paraffin as the best method of making porous corks gas and water tight. Allow the corks to remain for about five minutes beneath the surface of melted paraffin in a suitable vessel, the corks being held down either by a perforated lid, wire screen, or similar device. Corks thus prepared can be easily cut and bored, have a perfectly smooth exterior, may be introduced and removed from the neck of a flask with ease, and make a perfect seal.

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English Mechanic
AND
D OF SCIENCE AND ART.

FRIDAY, JULY 26, 1878.

ARTICLES.

DU MONCEL ON THE INVEN-
N OF THE MICROPHONE.

ıve received more American news-
)ers from Menlo Park, including a
.he *New York Tribune* for June 27,
g a letter signed T. A. Edison,
intended to be a refutation of the
s contained in the telegram sent
reece. It is, however, in no sense
on of those statements, but serves
lace the writer in a worse position
held before. It is a pity for the
n of Mr. Edison that he did not
hear what could be said on the
ide;" but having spoken in error
has now gone further and brought
against Prof. Hughes, which is
nusing from the simplicity dis-
y the writer. We must quote ver-
"Mr. Hughes has addressed a
cation to the French Academy of
in which he adds to his pirated
the induction coil which I have
ed in combination therewith, and
ne makes it a practical instrument,
perhaps that, under cover of a
nguage and before a society whose
gs are not generally known in this
he would gain for himself the
this combination. He makes no
of this all-important factor in
where it would be at once known,
hich country it has been patented
year." French is a "foreign"
alike to Americans and Britons,
t educated people nowadays can,
read French; and, if Prof. Hughes
o hide his iniquity, he acted in a
nge manner by addressing a com-
on to the French Academy of
whose proceedings are carefully
in the scientific press of every
country. If it be true that they
generally known in the United
much the worse for American
but, as a matter of fact, we know
Journal of the Franklin Institute
carefully compiled notes of every-
value appearing in the *Comptes*
he journal of the Académie des

In Prof. Hughes' letter, which
ed on page 442, Mr. Edison will
explanation of his mistake as to
nopile, and nothing more need be
rding the obvious misconceptions
d in his "refutation." It has been
supposed that Mr. Edison dis-
he remarkable property possessed
n of changing its resistance with
of pressure, and, so far, we believe,
as denied that he may have dis-
that phenomenon; but when Mr.
ssumes that he was the original
er, and that every instrument con-
on that principle is a piracy of his
elephone, he must expect to have
reduced to its proper level. The
u Moncel, one of the most distin-
of French physicists, whose com-
ions to the Academy of Sciences
known in the United States, has
an article on the dispute in the
of *La Nature* dated July 20. In
icle the Comte du Moncel, after
ing that he has taken no part in the
and expressing his regret at the
of Mr. Edison, proceeds to recount the facts, and the conclusions to be deduced from them, in an impartial manner, which is, however, not entirely free from occasional sarcasms. According to Du Moncel—and no one is better acquainted with the facts—shortly after the invention of the speaking telephones of Gray and Bell, in the first half of 1876, Mr. Edison thought of combining a telephone with a battery in which the variations of intensity of current, on which the production of articulate speech depends, were effected by means of a conducting body placed in the circuit. For this purpose, as we know, Mr. Edison employed carbon, and by its means was enabled to operate perfectly the magneto-electric telephone of Bell, especially when he subsequently added an induction coil to the transmitting instrument. Now, as to the property which certain conducting bodies, and in this connection more especially powdered carbon, possess of varying electrical resistance when subjected to pressure, so far from that property having been discovered by Mr. Edison, it has, says Du Moncel, long been known. M. Clerac, in 1866, applied it in the construction of a cheap rheostat, consisting of a tube filled with plumbago or powdered carbon upon which a piston was pressed by a screw. Since 1856 M. Th. du Moncel has investigated the phenomena of resistance offered by electric contacts, and has shown that the intensity of the currents transmitted by the bodies included in the circuit varied with the degree of pressure between the two contact pieces; he made use of that knowledge in his investigations on the conductibility of divided conducting bodies, and has mentioned the fact in several memoirs addressed to the Academy of Sciences. M. Pollard, too, constructed a telephone with a pencil of plumbago resting against the diaphragm, and has shown that the principle applied to hard-carbonised as well as to soft-carbonised bodies. As to the employment of an induction coil for converting the galvanic currents into induced currents during telephonic transmissions, that was attempted in 1873 by Mr. Elisha Gray, and has been since utilised by MM. Pollard, Garnier, and Col. Naver. These facts, says Du Moncel, prove incontestably that Mr. Edison has only made an ingenious and useful application of a well-known principle, and in converting the currents of the battery into variable currents has merely repeated what others had previously tried.

The Comte du Moncel then proceeds to describe the discovery of Prof. Hughes, but we need not follow him through his abstract of the paper which we printed on page 235. He points out that the theory advanced by Prof. Hughes is open to discussion, but assuming that the effects witnessed in connection with the microphone are the results of increase and decrease of pressure at the points of contact of the conducting bodies, it does not follow that the microphone is merely a copy of the carbon telephone. Du Moncel speaks of the vibrating diaphragm of the latter, apparently unaware that Mr. Edison says that the vibrating diaphragm is dispensed with in the latest form of transmitter. The value of the statement depends on the meaning of the word "vibrating;" the diaphragm is still employed in Edison's instrument, and though it may be ⅛in. thick, it still vibrates. As Comte du Moncel points out, however, the effects produced in the Hughes microphone and the Edison telephone are not the same; for in the latter the variations in the resistance of the circuit are determined by increase or decrease in pressure—*i.e.*, by differential action; but in the microphone the contacts are what is known as "multiple." They are very light, and the moving portion is in such a state, so closely bordering on unstable equilibrium, that the variations in pressure produce great variations in the resistance; and, consequently, the sounds are magnified or, to speak more correctly, amplified.

It has already been pointed out that the properties of carbon, of which Mr. Edison claims to be the discoverer, were known to M. Clerac in 1866, and that apparatus, constructed in accordance with that knowledge, were supplied by him to leading electricians. It is strange that Mr. Edison was in complete ignorance of that fact, especially when we learn from one of his most fulsome flatterers in the American press that it is his "chronic habit" to purchase every newly-discovered substance; and it is stranger still, as pointed out by the Comte du Moncel with a fine touch of sarcasm, that an instrument which in so short a time has obtained such fame should have all the time been buried in Mr. Edison's laboratory, especially as so large a crowd of American "interviewers" have visited his "shrine," and have found there, for his greater glorification, many things that never existed. The host of varied and important experiments which the microphone renders possible would not, Du Moncel thinks, have escaped the smartness of Mr. Edison if he had ever really imagined anything about the apparatus; whereas the claim he advances as to the property of the microphone to serve as a thermopile shows that he does not comprehend the nature of the subject. The microphone might be used as a thermoscope, because, as will be found by reference to a memoir, by M. Th. du Moncel, in the *Comptes Rendus* of Nov. 2, 1875, the effect of the first application of heat upon imperfect conductors, such as carbon, plumbago, metal in a fine state of division, &c., is to diminish their conductibility. A very slight increment of heat greatly increases the resistance of the carbon to the passage of the current—a resistance which can be measured on a galvanometer; but in Edison's instrument, the microtasimeter, the effects of heat are indicated by the pressure of the expanding body on a carbon disc (see page 414), an entirely different arrangement to the phenomenon investigated by M. Th. du Moncel and utilised by Prof. Hughes. It is not at all an uncommon thing for Americans to rediscover old discoveries; it is not at all unusual for them to borrow ideas which they affect to disdain, but upon which they work until they feel convinced that they are the originators or discoverers. The Comte has some pithy remarks on this part of the subject, and he does not resist the opportunity of pointing out that, in Prescott's work on electric telegraphy, entire pages have been taken from the works of MM. Du Moncel and Blavier, with their accompanying engravings, without the slightest acknowledgment, and without even a correction of the errors. It is a pity that Mr. Edison has not some friend with the courage to point out the mistake in his method of attacking the honesty of other inventors—a method which is, to say the least, unusual in the world of science.

CAN THE PHONOGRAPH RECORD BE READ?

SEVERAL attempts have been recently made to decipher the indentations made in the tinfoil of the phonograph, in the same way as the stenographer reads his shorthand writing. On page 310 we gave an illustration of the appearance of the marks made by the point of the recording diaphragm of the phonograph, in connection with a paper on the subject presented to the Franklin Institute by Mr. Persifor Frazer, jun. Many attempts have been made in this country to read the phonographic characters; but, as might have been expected, the result can scarcely be regarded as practically successful. It is not impossible to decipher the marks when the words spoken are known, but the investigator usually fails when he is called upon to translate a piece of strange phonographic foil. Mr. Edison has been devoting a little time to the elucidation of the question, because he had formed the opinion that careful study would enable experts to translate the indentations in the foil into words. He is now acquainted with what has been done in this country in that direction, and has made a series of experiments which are to be continued as opportunity offers. The method employed is to repeat the vowel and consonant sounds separately, say three times, so as to test the uniformity of the markings for any given sound. It is obvious that if the sounds were always indicated by characteristic markings there would be practically little difficulty in translating the foil; but so far as experiment has yet gone the record of any sound is found to vary, sometimes very widely. Nothwithstanding this difference in the form of the characteristic marking, however, it is believed to be still possible to determine the sound which has given rise to the indentation. Mr. Edison has been repeating some of the experiments made in this country and in the United States, and found that when the sounds by which the identations had been made were known beforehand, he could recognise them on the foil, 'and count the number of times they had been repeated, but he discovered that it was impossible to recognise the markings made by similar sounds when uttered by some other person. The indentations were found to vary not only with different sounds, but also with the manner in which they were spoken; thus the shape of the mark depends primarily on the sound uttered, but it is varied by the speed at which the phonograph barrel is turned, the force with which the sound is uttered, and the distance of the speaker's mouth from the diaphragm. The simple placing of the hand against the cheek whilst speaking was sufficient, in Mr. Edison's experience, to change the shape of the characters recorded for the same sound upon the tin-foil. Between the vowel sounds there is little difference in appearance, and they are less liable to diversity from changes in the manner of uttering them. The deepest indentations were made by consonant sounds, on account of the explosive force with which they are usually uttered, and words beginning with *p* are especially noticeable from the deep indentation with which they commence. It seems, therefore, that apart from the great difficulty of accurately observing the marks on a sheet of bright tin-foil, there is little likelihood of any one translating the record without the services of the phonograph. We have not, however, seen the best instrument that can be produced, and a new departure in phonography may reveal greater wonders than have yet been seen.

ASTRONOMICAL NOTES FOR AUGUST.

The Sun.

Day of Month.	Souths.				At Greenwich Mean Noon.								
					Right Ascension.			Declination North.			Sidereal Time.		
	h.	m.	s.		h.	m.	s.	°	′	″	h.	m.	s.
1	0	6	5·60	p.m	8	45	56	18	0	27	8	39	50·67
6	0	5	40·44	„	9	5	14	16	41	8	8	59	33·46
11	0	5	0·11	„	9	24	16	15	15	8	9	19	16·23
16	0	4	5·56	„	9	43	5	13	43	2	9	38	59·01
21	0	2	58·33	„	10	1	40	12	5	28	9	58	41·79
26	0	1	40·02	„	10	20	5	10	23	4	10	18	24·56
31	0	0	12·09	„	10	38	19	8	36	30	10	38	[illegible]

Indications of Solar activity in the shape of spots, &c., are still extremely rare, and no definite indications are yet apparent that the present remarkably protracted period of minima has terminated.

The Moon

Enters her First Quarter at 1h. 19·2m. p.m. on the 5th; and is Full 16·1 minutes after midnight on the 12th. She will enter her Last Quarter at 4h. 7·7m. in the early morning of the 21st; and be New at 5h. 59·6m. a.m. on the 28th.

Day of Month.	Moon's Age at Noon.	Souths.
	Days.	h. m.
1	2·6	2 23·5 p.m.
6	7·6	6 45·3 „
11	12·6	11 18·2 „
16	17·6	2 6·1 a.m.
21	22·6	5 43·5 „
26	27·6	10 24·2 „
31	3·3	2 47·6 p.m.

The Moon will be in conjunction with Jupiter at 9 a.m. on the 11th; with Saturn at 6 p.m. on the 16th; with Venus at 9 a.m. on the 26th; with Mars at 8 p.m. on the 28th; and with Mercury at 3 p.m. on the 29th.

There will be a partial

Eclipse of the Moon

visible in this country on the night of August 12th, and the early morning of the 13th.

	h. m.	
First Contact with Penumbra, August 12th	9 22·5p.m.	M.T. at Greenwich.
First Contact with Shadow, August 12th	10 42·6 „	
Middle of Eclipse, August 12	12 8·2 „	
Last Contact with Shadow, August 13th	1 33·8a.m.	
Last Contact with Penumbra, August 18th	2 53·9 „	

Magnitude of the Eclipse (Moon's diameter = 1) 0·59.

The first contact with the Earth's shadow occurs at 109° from the N. Point of the Moon's limb, reckoned towards the East: and the last contact at 157° towards the West; in each case as seen with the naked eye.

Occultations of (and Near Approaches to) Fixed Stars by the Moon.

month.	Name of Star.	Mag.	Disappearance.	Moon's Limb.	Angle from N. Point.	Angle from Vertex.	Reappearance.	Moon's Limb.	Angle from N. Point.	Angle from Vertex.
			h. m.		°	°	h. m.		°	°
6	4 Scorpii	6	7 34 p.m.	Dark	140	147	8 10 p.m.	Bright	196	209
8	B.A.C. 6063	6½	7 49 „	Dark	118	110	9 1 „	Bright	248	251
9	σ Sagittarii	2½	†8 40 „	N by W	190	181				
16	B.A.C. 8276	6½	1 16 a.m.	Bright	167	157	2 17 a.m.	Dark	268	270
16	22 Piscium	6	†4 32 „	NW	215	241				
21	16 Tauri	5½	2 59 „	Bright	49	11	3 35 a.m.	Dark	353	319
21	19 Tauri	5	3 3 „	Bright	90	52	4 14 „	Dark	311	286
21	20 Tauri	5	3 37 „	Bright	45	12	4 10 „	Dark	355	329
26	B.A.C. 2854	6	‡1 51 „	Bright	42	11	2 31 „	Dark	293	259

† A near approach. ‡ Star below the horizon.

The occultations of some of the Pleiades, during the early morning of the 21st, will present a pretty and interesting spectacle to the observer with the telescope.

Mercury

Is an Evening Star during the entire month. He attains his greatest elongation East (27° 23′) at 10 p.m. on the 13th. About this time he may probably be detected by the naked eye, after sunset, close to the horizon to the N. of W.

Day of Month.	Right Ascension.	Declination	Souths.
	h. m.	° ′	h. m.
1	10 21·9	10 26·6 N	1 41·8 p.m.
6	10 45·9	7 14·9	1 46·0 „
11	11 6·1	4 14·4	1 46·5 „
16	11 22·3	1 34·3	1 43·0 „
21	11 33·4	0 33·9 S	1 34·5 „
26	11 38·3	1 53·9	1 19·7 „
31	11 35·4	2 4·4	0 57·1 „

It will appear from the above Ephemeris that Mercury never leaves the Constellation Leo during August. The only star in it to which he makes a very near approach is the 4th mag. one ρ, some 8′ South of which he will be found on the 2nd.

Venus

Is a morning Star during the entire month; but, continuing to approach the Sun, and decrease in her angular diameter, becomes month by month of less interest as a telescopic object.

Day of month.	Right Ascension.	Declination North.	Souths
	h. m.	° ′	h. m.
1	6 31·5	22 27·9	9 52·0 a.m.
6	6 57·4	22 15·3	9 58·1 „
11	7 23·2	21 46·8	10 4·2 „
16	7 48·9	21 2·8	10 10·2 „
21	8 14·4	20 3·6	10 16·0 „
26	8 39·6	18 50·0	10 21·5 „
31	9 4·6	17 22·9	10 26·7 „

Venus thus travels from Gemini into Cancer. On the morning of the 9th she will be only 15′ S. of δ Geminorum; and rather more than 1° S. of η Cancri on that of the 23rd. These are the only two stars of any size near which the planet will pass.

Mars

Is invisible.

Juno

Comes into opposition on August 28. She may now be seen during the greater part of the night.

Day of Month.	Right Ascension.	Declination South.	Souths.
	h. m.	° ′	h. m.
10	22 34·8	0 56·4	1 21·3 a.m.
19	22 28·4	2 21·4	12 35·5 p.m.
29	22 20·9	4 4·3	11 48·7 „

During the month of August Juno will travel in a South-Westerly direction through the part of Aquarius to the South of ι and ζ in that constellation. She will be between 1° and 2° S. of η on the night of the 18th, shining as an orange-coloured 8th mag. Star.

Jupiter

Is an Evening Star, and is above the horizon during all the working hours of the night. His position, however, is very bad indeed, as his great and increasing South Declination interferes exceedingly with definition.

Day of Month.	Right Ascension.	Declination. South.	Souths.
	h. m.	° ′	h. m.
1	20 14·6	20 31·9	11 32·9 p.m.
6	20 12·0	20 40·6	11 10·7 „
11	20 9·6	20 48·7	10 48·5 „
16	20 7·2	20 56·1	10 26·5 „
21	20 5·1	21 2·8	10 4·8 „
26	20 3·2	21 8·6	9 43·1 „
31	20 1·6	21 13·4	9 21·9 „

nce it will be seen that Jupiter decribes a ›rt retrograde path from Capricornus into the ıfines of Sagittarius. He will be a little re than 1° S. of the 5½ mag. Star σ Capricorni the night of the 5th; but he otherwise vels through a singularly barren region of sky.

Jupiter's Satellites.

y of nth	Satellite.	Phenomenon.	——
			h. m. s.
1	*I*	*Oc D*	3 8 0 a.m.
1	I	Tr I	12 17 0 p.m.
1	I	Sh I	12 29 0 "
2	*I*	*Tr E*	2 37 0 a.m.
2	*I*	*Sh E*	2 49 0 "
2	I	Oc D	9 34 0 p.m.
2	I	Ec R	12 5 21 "
3	I	Tr I	9 3 0 "
3	I	Sh E	9 18 0 "
3	II	Tr I	11 37 0 "
3	II	Sh I	12 7 0 "
4	*II*	*Tr E*	2 34 0 a.m.
4	*II*	*Sh E*	3 3 0 "
5	II	Ec R	9 17 10 p.m.
7	IV	Sh I	8 36 0 "
7	IV	Tr E	10 6 0 "
8	IV	Sh E	1 11 0 a.m.
9	*I*	*Tr I*	2 1 0 "
9	*I*	*Sh I*	2 23 0 "
9	III	Tr E	9 14 0 p.m.
9	III	Sh E	10 48 0 "
9	I	Oc D	11 19 0 "
10	*I*	*Ec R*	2 0 17 a.m.
10	*I*	*Tr I*	8 27 0 p.m.
10	I	Sh I	8 52 0 "
10	I	Tr E	10 47 0 "
10	I	Sh E	11 12 0 "
11	*II*	*Tr I*	1 54 0 a.m.
11	*II*	*Sh I*	2 44 0 "
11	I	Ec R	8 29 6 p.m.
12	*II*	*Oc D*	8 4 0 "
12	II	Ec R	11 52 39 "
15	IV	Oc D	11 42 0 "
16	III	Tr I	8 58 0 "
16	III	Sh I	11 12 0 "
16	III	Tr E	12 34 0 "
17	I	Oc D	1 4 0 a.m.
17	I	Tr I	10 12 0 p.m.
17	I	Sh I	10 47 0 "
17	I	Tr E	12 32 0 "
18	I	Sh E	1 7 0 a.m.
18	*I*	*Oc D*	7 30 0 p.m.
18	I	Ec R	10 24 10 "
19	*I*	*Sh E*	7 35 0 "
19	II	Oc D	10 21 0 "
21	II	Tr E	8 18 0 "
21	II	Sh E	9 37 0 "
23	III	Tr I	12 20 0 "
24	*IV*	*Sh E*	7 24 0 "
24	I	Tr I	11 57 0 "
24	I	Sh I	12 41 0 "
25	I	Oc D	9 16 0 "
25	I	Ec R	12 19 18 "
26	*I*	*Sh I*	7 10 0 "
26	I	Tr E	8 44 0 "
26	I	Sh E	9 30 0 "
26	*II*	*Oc D*	12 39 0 "
27	III	Ec R	8 45 54 "
28	*II*	*Tr I*	7 41 0 "
28	II	Sh I	9 18 0 "
28	II	Tr E	10 38 0 "
28	II	Sh E	12 14 0 "

Eclipse; Oc. Occultation; Tr. Transit of ıllite; Sh. Transit of Shadow; D. Disap-ıance; R. Reappearance; I. Ingress; E. ress. The printing of a phenomenon in lics indicates that its visibility is rendered ıbtful, either by the brightness of the twi-ht or by Jupiter's proximity to the horizon.

Uranus and Neptune,

r reasons recently explained, are both risible.

Saturn

ll Souths after Midnight during the whole ath of August; but he rises a little after p.m. at the beginning of it, and between ıd 8 o'clock in the evening towards the end it. A very slight closing up of his ring stem may be detected under adequate power the careful observer.

Day of Month.	Right Ascension	Declination South.	Souths.
	h. m.	° ′	h. m.
1	0 13·6	1 9·7	3 35·1 a.m.
6	0 13·0	1 14·7	3 14·9 "
11	0 12·3	1 20·6	2 54·5 "
16	0 11·5	1 27·2	2 34·0 "
21	0 10·5	1 34·6	2 13·4 "
26	0 9·4	1 42·5	1 52·7 "
31	0 8·3	1 51·0	1 31·9 "

A retrograde path described in the perfectly barren region to the S.E. of the First point of Aries.

Shooting Stars,

As is popularly known, are particularly abundant on August the 10th, on which night their apparition has long been familiar under the name of "St. Laurence's Tears." Their radiant point being situated somewhere near „ Persei they are now designated the Perseids; and the veriest tyro is acquainted with their connection with Comet II. of 1862, established by Schiaparelli. Watch should be kept on every night from the 5th to the 12th of August, and particularly on those of the 9th, 10th, and 11th.

Greenwich Mean Time of Southing of Ten of the Principal Fixed Stars, on the Night of August 1st, 1878.

Star.	Souths.
	h. m. s.
α¹ Herculis	8 27 54·20 p.m.
α Ophiuchi	8 48 2·17 "
γ Draconis	9 12 27·82 "
Vega	9 51 23·80 "
h² Sagittarii	10 47 44·01 "
Altair	11 3 13·97 "
α² Capricorni	11 29 37·28 "
α Cygni	11 55 31·08 "
α Cephei	12 33 48·25 "
ι Pegasi	12 56 16·62 "

The Method of determining the Local Mean Time of Transit of either of the Stars in the above list will be found on p. 60 of Vol. XXIII., and that of finding the instant of its Meridian passage at Greenwich for any other night in August on p. 393 of Vol. XXII.

ARTIFICIAL MARBLE.

A PROCESS of making artificial marble has been recently patented in this country on behalf of Harriet G. Hosmer, of Rome, which differs from previous processes in the fact that limestone in the solid state is employed as the base instead of a mixture of plaster and cement. The limestone is worked by any suitable means to the desired form, and is then placed in a boiler furnished with a safety-valve and manometer, so that the pressure therein may be noted and controlled as may be required. The boiler is then filled with pure water at the ordinary temperature, care being taken that there is no mineral deposit introduced with the water. Care must also be taken that the water completely covers the objects placed within the boiler. The boiler is then hermetically sealed, and fire applied, and the water allowed to boil until the manometer indicates five "degrees" of atmospheric pressure if the objects are small, and six or seven degrees of pressure if the objects are large. When the heat reaches the above-mentioned point the water is allowed to cool until the pressure indicated by the manometer returns to zero. The water is then taken out of the boiler, either by means of a pump or a siphon, and the objects are removed from the boiler preparatory to being placed in the alum or coloured bath. If, however, steam alone can be introduced into the boiler (always maintaining the above-mentioned degree of heat and pressure) the result attained will be the same, the action of steam, not the presence of water, being necessary for acting on the stone. When it is desired that the objects should retain the natural colour of the stone, the alum bath should consist of pure water containing five degrees of alum, as indicated by the areometer. The articles must remain in this bath at least twenty-four hours, but they may be left in the same bath for a week, or for a month even, by which time they will acquire still greater hardness. The stone will, however, have become sufficiently petrified for all ordinary purposes in twenty-four hours. If pure water be used in the boiler, according to the process first described, instead of steam, the alum bath may be effected in the boiler itself, thus avoiding the necessity of removing the objects; but it must be remembered that the application of alum is only admissible when it is intended to preserve the natural colour of the stone. In such case the alum is put in the water before the boiling commences, and the objects must remain in the boiler for 24 hours after the pressure, as indicated by the manometer, returns to zero. The articles, when taken from the alum bath, may pass into the hands of the polisher if in the form of plain blocks, slabs, or flat pieces, but if they be in the form of statues, busts, vases, columns, or other ornamental works of art, they may be placed in the hands of an artist to finish, if required, as the stone does not attain its greatest hardness until it has become perfectly dry, which will require a fortnight, more or less, according to the size of the object. When it is desired to impart colour to the stone the coloured baths are prepared in the manner indicated below, in which the objects must be immersed, and must remain therein at least 24 hours. The coloured baths must be boiling, or very nearly so, and it is better to remove the objects to be coloured from the first boiler and place them in the coloured liquid while they are still warm from the steam or water. There is no danger, however, of injuring the stone, even if it should be put into boiling liquid while cold, or into cold water while the articles are still heated, but the colour penetrates deeper when both stone and bath are in a heated state. If it be desired to place an object a second time in the coloured bath in order that it may acquire a deeper colour it should first be placed in an oven at a temperature of from 80 to 90 degrees, in which it may remain ten minutes, after which it may be immersed in the coloured bath. To produce black or dark grey colour take of pure water 2 litres; red wood, 300 grammes; fustic wood, 120 grammes; sulphate of iron, 10 grammes; sulphate of copper, 2½ grammes. Boil the red wood and fustic wood for an hour and a half, then add the sulphates, and continue the boiling until all the salts are dissolved. Three or four minutes will probably be sufficient for this purpose, the solution may then be passed through a sieve, and half a tumbler of acetic tincture of iron added. Stone colour or lighter grey is obtained in the same manner, with a weaker solution. In order to prepare a red colouring solution take of pure water 3 litres; Brazil wood, 330 grammes; Scotaus (*sic*), 5 grammes; cream of tartar, 1 gramme; alum, 1 gramme. Boil the mixture until all the colour of the wood is extracted, and then pass the solution through the sieve in order to remove therefrom any solid matters that may be held in suspension therein. A yellow colour is obtained by adding to three litres of pure water extract of yellow wood of Cuba, 20 grammes; sulphite of magnesia or alum, 10 grammes. The mixture must be boiled until complete solution of extract is effected. In order to obtain a green colour dissolve in three litres of pure water extract of yellow wood of Cuba, 20 grammes; and 10 grammes of alum. Boil the ingredients as above, and then add carefully (by means of a wooden spoon, and keeping at a certain distance) as many drops of acid sulphate of indigo (Saxon blue) as may be necessary to give tone of colour desired. To ascertain the depth of colour pour a few drops upon white paper, or dip a piece of dry plaster of Paris in the solution. For a blue colour dissolve alum, 10 grammes; acid sulphite of indigo, 20 grammes in 8 litres of water, until the desired colour is obtained. As all the varied colours of aniline penetrate the stone perfectly, they may be used at pleasure. It is only necessary to dissolve the colour selected in a little alcohol, which is afterwards diluted with warm water, in which alum is dissolved in the proportion of 24 grains of alum to every litre of water. The solution may be even stronger in alum; this is for colours which are insoluble in water. For such aniline colours as are soluble in water no alcohol is necessary. They may be dissolved in boiling water in which a little alum or sulphate of magnesia is introduced. Care must be taken to select only those colours which are durable. The same colours which are permanent in cloth are permanent in stone, and in general the same rules which apply to the art of dyeing cloth may be appiied to the art of dyeing stone. Pavements which are coloured, particularly if the colour is very delicate, and if there be fear of dampness, are better laid down in cement of a light colour. For the darker colours the cheaper darker cement is equally good. For the stone, of which the natural colour is preserved, no cement is absolutely necessary unless the place in which they are to be laid is particularly damp. After the objects have been taken out of their respective baths they are allowed to dry, during which process the work may be re-touched, if necessary. When dry they are reduced to a fine surface by means of pumice stone, after which a still finer surface may be given by means of a piece of slate, or still better, of lead, after which they may be rubbed with oil. When the oil is dry the articles may be rubbed with phosphate of lime, and the lustre will be rendered perfect. The ordinary methods of polishing marble will apply to the polishing of petrified marbles prepared by the above process.

THE WATCH AND HOW TO REPAIR IT.

By Seconds' Practical Watchmaker.

(*Continued from p.* 207.)

The Lever Escapement.

THE watch, in its entirety, may be considered as consisting of three parts—the *train*, the *escapement*, and the *balance-spring*.

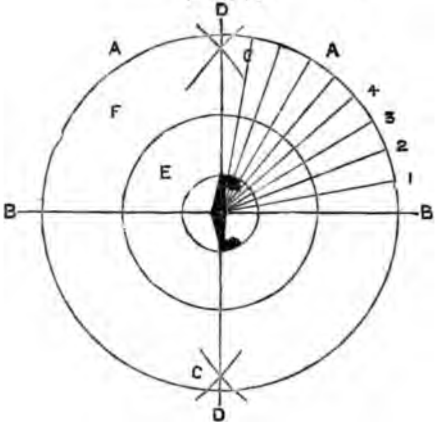
Heretofore the series of papers treating upon the defects and repairs of "the watch," have chiefly referred to that portion of it termed "the train," and although many items have been placed before the "general jobber," many others of a kindred type yet remain for future consideration. As the *lever escapement* is a study, independent of the train, its introduction until now has been deferred, in order that its defects and corrections might more completely be connected and placed together. It is intended, therefore, to leave the more commonplace defects of the watch—*i.e.*, such as are connected with the *train*, for a short time, and confine our attention to the lever-escapement, its defects, and corrections. The purport of the present series of papers will be similar to those which have preceded them—namely, fragmentary; practical in their character, and in no way put forth with an intention of being "an essay," in connection with lever escapement-*making*. The subject will be dealt with entirely in a "watch-jobbing" point of view, aiming at enabling "young hands" to improve that which had been left imperfect by the manufacturer, and on the other hand, to restore to soundness bad or incorrect repairing of the lever escapement.

It is no uncommon circumstance that lever watches — professedly cleaned — have little attention bestowed upon their escapements; the cleaner in many instances assuming that irregularity of timekeeping or stopping complained of is connected with the dirty condition or in the requirement of some repair of freedoms, pivots, depths or holes of the train: whereas there are as many defects connected with the lever escapement as there are with other portions of the watch.

Before introducing examples it will be necessary that workmen become acquainted with a few important points connected with this "escapement," a knowledge of which will assist them in detecting causes for alteration and improvement of the watch; therefore their attention has to be directed to a few conditions necessary to a sound lever escapement. There are several varieties of this escapement, the introduction of our first example being a well-known model termed the "table-roller" frame escapement, which is usually applied to watches of moderate price; although not having the "*long angle*" pallets, which are mostly put to common and low-priced watches, but having pallets of "*short angle*"—that is, eight degrees and a half, which will be referred to under the heading "Pallet's angle."

In proceeding with a preliminary introduction of this escapement, it is to be assumed that *its first examination* will be best carried out by *having the movement as it is taken* from its case, because the mainspring power is natural to the motions of the pieces forming the escapement, whereby no undue pressure upon its parts results, as might be produced by persons unaccustomed to such special trial when the escapement is tried without the intervention of the train. What is meant by this remark is that, as a general rule the escapement can be more conveniently tried by "young hands" when the watch is together, than it can be when the escapement only is in the frame, although exceptional instances may occur when it cannot be so tried—as an instance, the train being blocked by corroded and thickened oil, dirt, and such like. Again, it is intended that in all the early trials of this escapement, the sizes of pivots and holes be not referred to.

FIG. 1



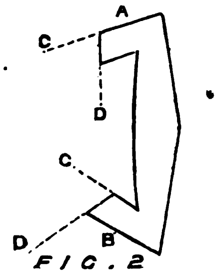


FIG. 2

A Few Conditions Necessary to a Good Escapement.

The movement being held horizontally in the left hand, and the end-shakes of the balance-staff, escape-wheel pinion, and pallets' staff being quite free, the escape-wheel being a trifle above the centre of the space between the pillar and upper plates—the pallets' stones and the points of the escape-wheel teeth level and central with them; the balance-staff, escape-wheel, and pallets' staff upright, and the face of the roller perfectly free of the lever fork, but not more distant from it than is necessary for sound freedom. The action of the escapement should next come under examination; and to do so with convenience, the movement should be changed in its position—namely, the edges of the plates should be upward—still held in the left hand, with its balance towards the right, where the "*locking*" of the escape-wheel teeth on the pallets claim attention. By means of a nicely-cut peg, somewhat pointed, not a thin flexible one, but rather rigid, with the right hand the balance should be led, so that the roller pin be brought into the lever fork, and when therein, the outer or poise end of the lever should be pressed from side to side, in order to test if the roller pin has freedom in the lever fork, but not so much as to be considered *side-shake.* These determined, and correct, by leading the balance backward and forward, the escape-wheel teeth will alternately lock and unlock upon the pallets' stones. The depth of such locking should be one degree and a half on each pallet, with another degree of "run" to the bankings, which should be equal on each side; also the freedom or shake of the guard-pin upon the roller edge should likewise be equal on each side. The roller pin should enter the lever fork without striking either corner of it, and the guard pin perfectly free of the roller crescent. Another point which is of
portance connected with this escap
that there should be perfect freed
escape-wheel teeth "inside" and "o
the pallets, having a trifling exce
outside. Lever escapements posse
few points here set forth produce
that may be required, provided that
sizes of its various parts are intro
the previous remarks upon the
degrees the escape wheel teeth shou
and "run" upon the pallets, it is s
"the depth of such 'locking' shou
degree and a half on each pallet, an
degree of 'run' to each banking,"
first consideration will be to becom
with the terms "degrees" and "ang

All the parts of a watch partake
motion: therefore they are connecte
circle. Every circle, large or small,
into 360 degrees. The degrees con
small circle, will necessarily be mo
than those of a larger one. Now,
lever escape-wheel is such a small cir
tains 360 degrees; the balance
circle much larger, is made up of
number of degrees. This very sim
tion I feel bound to introduce, kno
experience that its meaning and ut
but a small place in most watch-job
shops.

By the term "locking," it is und
refer to the alternate resting of t
wheel teeth upon the pallets' stone
point connected with the lever escap
quiring a little thought to become t
acquainted with.

When remarking upon the adva
disadvantages of escapements which
to act at certain *angles* and *deg*
"young hands" will require an expl
such terms; therefore figure 1 is intr
assist such. Form a circle, A A, th
centre of which draw the diameter,
the leg of the compasses on the cir
diameter at B, and with any openin
intersect the circle at C C, through w
the perpendicular, D D, by which the
D A B, are produced, containing 90°

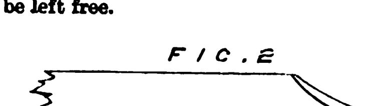
Supposing that by means of a rul
are drawn from the centre, similarly
at D A B, 1, 2, 3, &c., and a correspon
ber in the left-hand quadrant of the
scale would be formed of 180°, by
value in degrees of any angle may
tained. An instrument termed a p
and usually made of brass, is formed
principle, which has to be noticed he
connection with the value of "locking
It will be observed that the quadran
has only 9 divisions formed; in a co
strument each division, 1, 2, 3, &c.,
subdivided into 10, being 90, such su
being omitted in the diagram in orde
overcrowding the figure, at the s
illustrating that the divisions of a sm
are more minute than those of th
though being of relative value to
Assuming that a rudimentary knowle
term "degrees" is established in t
the introduction of the "lever pallets"
necessary, so as to put into practic
vious considerations. Fig. 2 represe
of pallets, A B. The escape-whe
advance will lock, say, on the short
limb, A. Pallets consist of *locking-fa*
and *inclines* or *drives* D D, the dot
guide to such. Now, when a tooth of
wheel falls on a pallet, it should rest
part of the stone, C C, to which th
lines direct the mind's eye, not
driving-planes, D D, which is freque
case, because, should it do so, the w
continually stop, from the guard-p
pressed against the edge of the roller,
more hereafter. Again, if the teet
escape-wheel "lock" on the pallet
and "lock" at a *deep* depth, say four
there will also be a probability of t
stopping; should it not stop, workme
cated in this matter will fail to get th
to vibrate even decently. It is laid d
rule that "one degree and a half" is t
to be recognised to pallets of short an
properly made. The student asks:
way is he to determine that exact qu
locking? By referring again to Fig

g what a small space represents *ten*
by recognising the small circle, E, as
e the circle out of which the pallet's
ere formed, the inquiry for the present
ius. Until the subject has advanced
it further, the amount of one degree
lf may be considered to be the *least*
that can be conceived *beyond* the safe
of the wheel-teeth upon the pallets'
But those who wish to follow up the
with the object of becoming thoroughly
ed with it, should possess a "protrac-
which the eye would be assisted.
y forming a pair of pallets of card to
nd with the Fig. 2, and placing them
eir centre E on the centre of B B,
g. 1), the quantity of "one degree and
can be read off and judged of.
ar we have been considering the subject
escape-wheel "locking" at the shal-
epth admissible, and it has to be borne
that to insure such the pallets must
perior make, for when inferior ones of
ngle" are made use of, it is no uncom-
umstance for the locking to miss, and
h to fall on the incline, and an imper-
pement result.
s stage of our inquiry workmen having
slightly acquainted with the value of
s" relative to the motions of the
g" of the escape-wheel upon the pallets
ever escapement, &c., the movement
e taken to pieces in order to more criti-
st the correctness of other points con-
ith it, and the error of its planting and
ent. Therefore, our next inquiry will be
ng defects relative to the want of free
is of the balance, and other imperfec-
ich so frequently appear, and cause
of the watch.

O MAKE A PIANOFORTE.—II.

ext step will be the "bellying;" but,
ore describing this, I will premise that
e, as the reader is no doubt aware,
ethods both of making and fixing the
ard—the one selected, from its simpli-
tructure and freedom from dangerous
, being, in my opinion, the best adapted
he circumstances. We will begin by
g the back to receive it. As the
re at present level with the bracings,
ist be raised by means of hardwood
the proper height, the length of the
being of the full depth of the sound-
nd of the same width as the lining;
ckness commencing from under the
t ¼in. graduates to ⅜in. at the middle,
n again to ⅜in. at the bottom; the
lip being less than 9in. in length, the
can be dispensed with; it will suffice
in a straight line from ¼in. at the top to
ere it joins the bent side; the wedges
to be reduced so that a straight edge,
ting at each end of the slips, will just
em.
oundboard is usually made of Swiss
it as an amateur will probably find this
procure dry, I think it will be better to
e the best quality ⅜in. American pine,
reful to select it dry, sound, and free
ots. The appearance of this may not
so clean as the Swiss, but in all other
I think the two will be found equal;
e boards being much wider, the num-
oints will be less. Before cutting into
(which run parallel to the wrest plank)
er to reject the first 6in. or so at the
this part is usually faulty. Rubbing
s will hardly be found practicable with
n boards; it will, therefore, be better
g them together. This is done by
two lengths of wood firmly down,
the space between about ⅛in. less than
th of the soundboard. This, when
ith both sides touching, will of course
l in the middle, so that from a small
d an immense lateral pressure is
, and all superfluous glue will be forced
e soundboard will then be ready for
to a thickness. Hardly two opinions
to what this should be. Without
ng to decide so knotty a point, I think
m thickness of from $\frac{3}{16}$in. to ¼in. will
l as good as any, allowing it to be
lf anywhere, just above the plate,
where it will be left without support. It can then be fitted, allowing a space of ⅛in. all round the bent side and under the wrest plank. While it is in position it will be better to tack temporary stops occasionally, or to screw the four corners so that it may be replaced exactly after each removal; but, before it is taken out, mark where the bracings come, and strike a middle line evenly between them for the traverse bars; these are of ¾in. spruce, tapered to ⅜in. at the outside edge, 1¼in. wide for eight bracings, and 1¾in. for six bracing backs, and extending fully across the soundboard at their respective positions. The jointed side is usually left about ⅛in. higher in the middle than at the ends. They are chamfered 4in. from each end to ¼in.—see Fig. 2. To glue them on will, I fear, be a difficult task, as the handscrew chops will not reach far enough. Putting screws through the front would pull the bar to a joint, but their weight would affect the vibration. In the trade it is customary to spring a lancewood bar between it and the ceiling; in this way all parts of the soundboard can be reached. Doubtless the ingenuity of the amateur will find a substitute, it being important that the joints should be close everywhere. A "bent side slip" is next required to support the soundboard at that part between the bracings. This is cut to the curve of the bent side out of ¾in. beech of similar width, and graduating in thickness from ⅜in. where it leaves the treble lining to ⅛in. under the plate, from which position to the bass lining the soundboard can be left free.

FIG. 2



END OF TRAVERSE BAR.

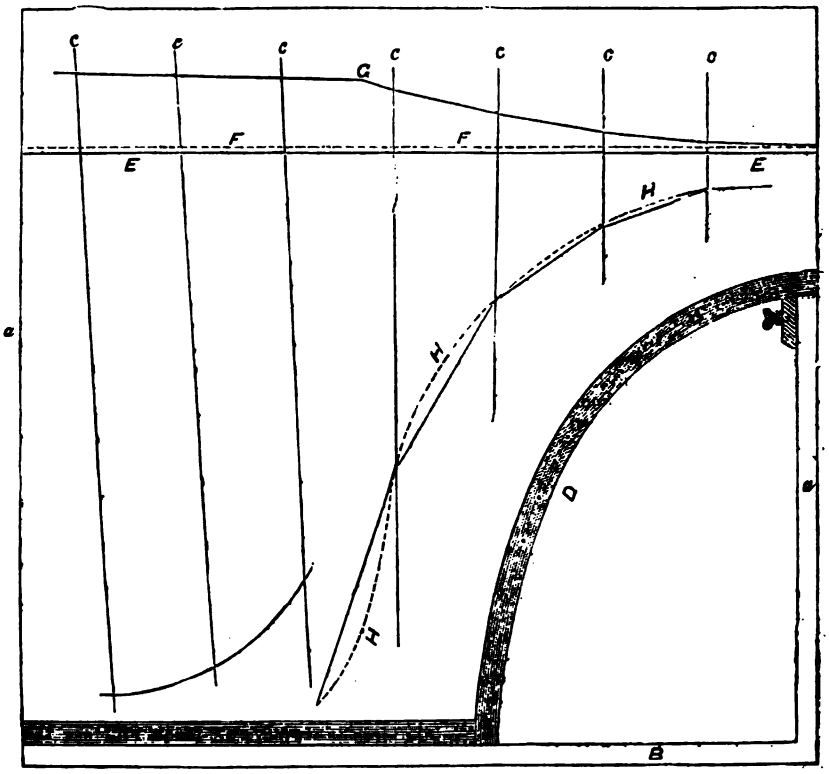
We will now turn our attention to the fitting up of an iron back. The frames are generally made for a 9in. wrest plank, but as about 7½in. only of that is necessary for pinning, the 8in. plank can be widened by jointing to it at the top a piece of any hard wood; this, being covered with the bolt bar, will not show.

The linings, *a*, Fig. 1, are first to be bolted on, allowing them to rise ¾in. above the iron; they can then be marked and trimmed for the wrest plank and bottom, B, the latter being dovetailed as described for a wooden back. In preparing for the soundboard the linings can themselves be taken to the requisite height. A similar curved slip is also required at the bent pinning edge, D, Fig. 1, and as the bed, E, for the top of the soundboard is continuous, a slip will be necessary here also. These slips are only ⅛in. thick, the insulating felt making up the difference. This felt can be at option either continuous like the slips, or only in small pieces for the screws to pass through, leaving the intervening spaces free. I may here mention that I have tried indiarubber instead of felt, but with no improvement to the tone.

The next thing will be to ascertain the shape of the bridges. These are better of beech, though for the soundboard either close-grained birch or American maple will answer nearly as well. The top or plank bridges must be selected with the flowery side up and cut, especially where the pins are in a straight line, a little across the grain. The scale and shape of bridges are set out at one and the same operation. The first step is to rule a line about ¼in. above the bottom of wrest plank (see dotted line, F, Fig. 1), to serve as a basis of measurement. As to give the lengths and striking distance of every string would tend rather to confuse than assist, I will confine myself to that of the C's, the top bridge being taken first. Commencing from the treble C, the distances above are ⅜in., ¾in., 1¼in., and 2¾in., and the G one-fourth below 3¾in. Lines ruled between each of these measurements will suggest the necessary curve of the treble bridge, the remainder being continued in a straight line parallel to the plank. Measuring from the striking distance of each C respectively 3in., 6in., 11¼in., and 23in. will give that of the lower bridge (see dotted line, H, Fig. 1), the remaining part, it will be noticed, now taking a hollow curve so as to rapidly increase the vibrating length to the extreme limits of the back; the next C, being the first covered string, will be on the bass bridge; its length is 33in.—this bridge, like the last, being carried as low as possible.

As at this stage the operator will probably not have provided himself with a hammer rail from which to take the top scale, it may assist him to know that the first bridge pin being 2¼in. from the outside of treble lining, the first C will be 7¼in., the remainder having a space of $6\frac{1}{16}$in. between them along the line of strike. The bottom scale, which it will be seen is con-

FIG. 1
PLAN OF BRIDGES.



tracted, can be obtained by counting the pins on the iron back. The bridge can next be glued—that of the soundboard being fastened with ¼in. screws from the back, as their weight here will be rather an advantage, and it is essential to have the bridge firmly fixed. The next process, after gluing down the soundboard, will be "marking off" for the pins. As, to do this, a top scale will be found necessary, I shall be happy, for the convenience of such as require it, to send one on pricked paper for 1d. stamp. This can be tacked on a slip of wood, and the holes bored through for the marking-off pins to rest in, care being taken not to damp the paper as this would lengthen it to an extent that would throw all wrong.

Liverpool. **W. H. Davies.**

THE ORGAN: A COMPREHENSIVE TREATISE ON ITS MANUFACTURE, PROCURAL, AND LODGMENT.*

By John Watson Warman,

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PART I.—GENERAL TREATMENT IN MANUFACTURE.

c. The only objections that can possibly be brought against the Gas Engine are—1a, Large prime cost; 2a, Noise (only with "Intermittent"); 3a, elaboration of Fitting; 4a, Automatic control not here possible by cutting off supply; 5a, Cleaning required; 6a, danger from Fire; 7a, Bulkiness in comparison with power evolved; 8a, Smell, and chance of sulphur being given off, to the injury of the Metal-work of the Organ.

d. It will be desirable to say a word or two on these points (commencing with advantages, first named). No. 1 speaks for itself; this, however, is enjoyed in common with Water Motors. No. 2 is very valuable; it will be obvious that what the Water companies undertake to supply is water (the thing), and not pressure (the power); the latter, in fact, must be regarded as an accident, and where it is very low one might have a small river running through and yet get only enough wind for a few Stops; this is gone more into with own Motor (20, q.). Gas, of course, however obtained, is Gas still, and as good for an explosive motor at whatever pressure it is supplied. No. 3 is valuable; many places are without waterworks that have had gas for years; besides this, private Gas can be made—whereas, unless a height of 50ft. or over can be secured, private Water is quite useless, unless a very large quantity is consumed. A caution must here be thrown in with respect to Gas manufactured from Petroleum, &c.—viz., that its explosive property may vary, thus risking misses in the ignitions, and so causing stoppage or retardation that it may be considered out of question. No. 4 is obviously very valuable in cold climates, particularly for Concert or Sanctuary Instruments, which *must* be used at certain fixed times. No. 5 is always of immense value in respect of Cathedral Instruments; and even as regards mere dwelling-houses it is not pleasant to have them blown about one's ears. No. 6 is good; many Water motors leak badly, and are always making a damp, sloppy atmosphere. No. 7 speaks for itself; the veriest urchin demands 2d. per hour, here is a whole horse-power for the same period at 1d. No. 8 is of immense value, as will be directly seen. No. 9 has no advantage over the Hydraulic, but great over the Steam Engine.

e. We have now to consider objections. No. 1a is undeniable; the cheapest Otto at present made (½-H.P.) costs £75; with Water-vessel, £76 10s. Then there are Crank-shaft, Belt, &c., with, perhaps, a little Engine-closet. The fact, however, that over 4,000 have been already (up to, say, end of January, 1877) sold, some of them displacing Steam Engines, shows the great value of the Motor, for the actual cost to the manufacturer is not large, the construction being comparatively simple. It may be added that the price is not likely, for some time to come at least, to be any lower. The ½-H.P. Hugon cost £65. On the other hand, it will be obvious that, if much work is required, the Engine will soon pay for itself. No. 2a is got rid of by using the "Silent," but in any case it is not a serious matter; a small special building or shed outside Crank chamber at once meets every difficulty; and the *necessity* of a Crank or Eccentric Shaft much lessens force of this objection. No. 3a is involved in preceding; the Crank Shaft is here inevitable, for motion of Engine must be rapid, therefore necessary to diminish down to proper blowing-rate, at same time gaining power. No. 4a is real, as the inlet Cocks must not be altered, except with caution, and could in no wise be put in communication with Receiver; but force of this objection is almost neutralised by No. 8 advantage previously noticed, which, however, only applies to the "Intermittent."

f. No. 5a is a very trifling affair; half an hour every morning, that is not till say nine hours *actual* work has been done, and Cylinder cleaned out once a month or so, is all required. No. 6a is not a fair objection; Gas is one of the safest illuminators known, and is already in most houses. The presence of the Engine will not add to the risk; the motor itself is perfectly harmless, and any breakage or leakage of pipes must be properly guarded against in usual way. No. 7a is only true in comparison with the Water Motor, and that only as concerns bulk, for the 3-H.P. Otto will be powerful enough for almost any Organ. The Gas Engine is certainly much more bulky than the Hydraulic, even without reckoning Crank-shaft, but it is nothing in comparison to the space required by a Steam Engine and Boiler, and, *as a fact*, all the room a Gas Engine wants can generally easily be found. No. 8a is of no moment; the Otto, at all events, has no smell, so far as author could discover, and it is manifest that if no Gas is given off no corrosion of metals can from that cause ensue; the Organ will, in the nature of things, be isolated from all gas fumes from the Engine, except to an extent of no practical value whatever. I have not mentioned chance of stoppage, for, with proper attention and cleaning, this need never be dreaded; thus the large Organ in the screen at York Minster has been driven for years by a Hugon, and never given any trouble.

g. The London house in connection with the Otto and Langen has already been given (17, n.).

h. Hand-Blower. The common *Lever Blower* is, take it all in all, the most generally useful in existence; it can be placed anywhere, it takes little room, it has no momentum, the action is nearly direct, therefore a good supply can be maintained, and (a most valuable feature) it can adapt itself to varied powers and *dimensions* of blowist; also two Handles can be placed close together (*see* 18, r.). Its only defect is that, with a careless blowist, it may "shake" very much. The remedy here is simple—employ a lad or man who is not careless or stupid, and teach and see that he does his work properly.

i. The *Winch Blower* is undeniably steadier with a bad blowist, and also allows avoidance of the *Slot*, usual, though not inevitable, with the Lever Blower; these are its only really good points. On the other hand, it has the following very serious disadvantages. 1. Two Handles cannot well be placed close together (*see* 18, s.). 2. With proper action turning in one direction only should be allowed, and to insure this special treatment will be required. 3. Momentum and Inertia are often harmful. 4. The Posit is very much restricted. 5. Considerable expense and elaboration, particularly with two Handles. 6. Additional room required, often a great inconvenience. 7. Loss of direct action. 8. Non-accommodation to various powers and sizes of blowist. 9. Three Feeders are desirable, though not inevitable, and this (*see* 6, d.) lessens the Feeder area, and consequently the wind supply.

j. The increased steadiness requires no comment. As regards the doing away with the Slot, the only advantage is in preventing a careless or mischievous blowist access to the interior. These small persons have a great fancy for whiling away the time occupied by what they, doubtless, would have the impertinence to term a long-winded discourse, by scribbling various matters, generally indecencies, on leaves torn from prayer-books, or other paper; or making the same into boats, &c. A very convenient, and at the same time fascinat-method of getting rid of these proofs of iniquity is by poking them through the Pumping Slot, where they accumulate till quite a nice little bonfire is built up; then a lighted lucifer carelessly thrown down, and dropping through, does the rest, and so the organist may be interrupted in the midst of a performance or a lesson—as the present writer has been—with "Please, sir, the Organ's a-fire," and have to interrupt his professional duties to half-choke himself in putting out the flames, and only succeed at last as by a miracle.

k. Strictness with regard to blowist will, of course, avert this. Bear in mind, however, that, with a Lever centred at the Case, the Slot can with it be got rid of as easily as with the Winch.

l. Nos. 1 and 2 have been sufficiently treated of in Description (18, s.). The best means to prevent the turning in wrong direction is a Rod projecting so that it catches the arms of any one attempting to do so; of course, if Winch close to wall or other barrier, the turning, except in one direction, is at once prevented. No. 3 acts thus: A Fly-wheel is generally attached (with but two Feeders it is almost necessary); suppose the Bellows nearly full, and the organist to soften *suddenly* to pp. the blowist stops turning, but the *momentum* carries on the wheel and shaft for a little while, and the Receiver rises and blows off. Now the force to do this must inevitably have been *first imparted by the blowist*, and thus there is a waste. On the other hand, suppose the playing pp. and the Bellows nearly empty, then the organist suddenly starting full; before the blowist can get the heavy wheel into sufficiently rapid motion to supply the loud organ now in use, the wind goes out. The wind has failed once or twice within the last year or so at the Bow and Bromley Institute performances; and it is very probable, in my opinion, that the foregoing furnishes the secret, these being Winch Blowers. No. 4 is obvious; if the Winch be not actually on the Crank-shaft, it must be still kept at right angles with it, and any great distance off involves a heavy band. No. 5 is also plain; the cost of a Crank-shaft and fittings is a very different thing from that of a simple Lever.

l. l. No. 6 is often vexatious; thus suppose Feeder Lugs close to back wall (which they often are), a Winch could not be applied, unless a large segment were scooped out of the wall. Then, again, the handle sticking out is a very nasty thing, and there is, besides the barrier just spoken of; a recess of a few inches will contain a *Lever* Blower (side-wise), at least 1ft. will be required to contain a Winch. No. 7 will be palpable; however carefully the Centreing be done (and this, as just said, will limit the turning to one direction), the lever-motion—a segment of a very large circle—will be driven by a semicircle of at most no more than about 5in. radius. The radius of blowing is with Lever-action always considerably greater than this. No. 8 is very important. It will be obvious that according to the height and reach of a person will be the radius or semi-diameter of the circle most convenient to him. Now, if the Winch be made to suit a man, a lad cannot reach it without difficulty; and if in addition it was put at the correct *height* for the man, the boy might not be able to turn it at all without either something to stand on or being taken off his legs altogether; in practice this is very inconvenient. It is one of the great advantages of the Lever that while its *sweep* may be made to suit an adult, the power may be light enough for a lad to move easily, taking shorter strokes. No. 9, in addition to lessening of Feeder-surface, renders the economical *square* form of Receiver difficult (*see* 5, m). I have not said anything about loss of power through more motion of the body being necessary; or difficulty in getting over the "points;" although I think there can be no reasonable doubt that such loss does result from both these sources.

m. Hydraulic Engine. The number of distinct forms of these is very great; it may be at once laid down that the Rotatory kinds (three cylinders) are not, except in special cases (*see* 18; w.) required for Organ-blowing, for Feeder motion corresponds with that of iston: of reciprocating Motors—viz., those at merely move the Piston backward and rward, there are many varieties. Joy's , I believe, a good motor, but the one which ems to give the best satisfaction is, as ready said (19 d.), under Duncan's Patent. ren this, however, requires not much under lb. pressure to the square inch. Lea's is also oken highly of as very cheap (*see* 18, v. v.), d capable of working at 24lb. pressure (19, ; but I much doubt if any motor be capable working at lower pressure than the Duncan.

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n. The advantages of the Hydraulic may be ated as follows:—1. Simplicity of affixture d operation. 2. Cleanness. 3. Little or no tention required. 4. Low prime cost. 5. lence. 6. Facility of Automatic government cutting off supply. 7. No noxious exhala- ns given off. 8. Absolute safety as regards re. 9. Small space occupied. 10. Can start stop at a moment's notice.

o. On the other hand, it has the following ry serious defects.—1a. Large cost of work- . 2a. Necessity of a certain "pressure" or ce, this itself wholly dependent on the l or other actuation given it by the com- nies. 3a. Susceptibility to Frost. 4a. eater scarcity of water companies than of companies. 5a. Chance of pressure low or ter itself not being on, as when filling Tanks, , in that particular district. 6a. Chance of kage.

. No. 1 will be apparent; the Motor only uires firmly bolting down in position; the rers, Cranks, &c., required to convey motion Feeders form altogether a very small affair; Crank-shaft required, recollect. No. 2, com- ed with No. 5, renders a separate Chamber Closet quite unnecessary; no cleaning is, so as I am aware, needed, except such as all chines now and then require; in particular, re would seem to be nothing to foul the nder. No. 3 is guaranteed, provided the er and requisite pressure be "on" (*see* 2a 5a). No. 4 is undeniable: Forrester's uncan" ½ H.-P. costs only £26; the smallest , "Lea," costs only £10; set these against for an Otto of same power; and then there lso the saving in the Crank-shaft, &c., and haps Engine-closet. Besides this, it is only derably large instrument that wants a motor his power, and there are two cheaper sizes the Duncan—viz., at £21 and £17 (*see* table Horse-power required, 21, o). No. 5 is, ob- usly valuable in combination with No. 1 and hough of less value in the Gas-engine: the ilent" Otto, remember, destroys this pecu- advantage of the Hydraulic. No. 6 is valu- le; the cutting-off valve can be light enough work with a piece of *twine*, if of proper con- nection. No. 7 is of some value, but partly tralised by 6a. No. 8 is worth little. Most ases have convenient means of setting them a blaze, if desired. No. 9 is good, as Motor be put almost anywhere.

(*To be continued.*)

A MUSICAL TELEPHONE.

MONGST recent inventions in the way of telephones we notice one by Mr. J. Ewing d Prof. Fleeming Jenkin, for which pro- sional protection only was granted. The ject of the inventors is (or was) to produce telephone simple and powerful, and also ted for the transmission of two or more ssages simultaneously in either direction ng the same wire or part of the same wire. e transmitting and receiving instruments similar in construction; they consist in one m of the instrument of a wire or wires, pable of vibrating to definite musical notes, d so stretched, with or without resonators, in magnetic field, as to vibrate when in action ross the lines of magnetic force. The tele- aphic circuit consists of these wires, the line, d the earth; the circuit is never interrupted. e wires are turned so that one wire, or one oup of wires, at each end is in unison with e wire or one group of wires at the other. e electrical currents caused by vibrations of e wire or group pass along the line, and give e to corresponding vibrations in one wire or oup at the receiving end. When one wire group is made to vibrate at the sending end, wire or group tuned in unison will vibrate at the other end, but the other wires or groups will remain practically silent. By having a number of pairs or groups, means are afforded of transmitting independently a number of audible signals at the same time along the same line without interference. The vibrations of the wires at the sending end may be produced either directly by blows or otherwise, or indirectly by causing sounds to be made in their neighbourhood. The telegraphic circuit is constant; the sending and receiving wires are both included in the circuit, and no magnet has its magnetism sensibly changed by the sending of signals.

A second form of the invention is an inversion of the arrangement described above. Instead of a wire or wires vibrating across the lines of magnetic force of a fixed magnet, a magnet in the form of a fork or plate may be caused by a blow or sound in the neighbourhood to vibrate like a tuning-fork, and in such a manner as to carry its lines of force across a wire or wires, fixed and forming part of the circuit. The electrical currents produced in this manner are conveyed to the other end of the line where they pass through an apparatus similar to that at the sending end, and so produce corresponding vibrations of a magnet in the form of a plate or fork at the receiving end. Several instruments may be in circuit at each end of a single line; one magnet at each end being tuned so as to vibrate in unison with one magnet at the other end. By this means several independent sets of signals may be transmitted simultaneously, as by the form of the apparatus previously described. Either form of apparatus may also be used for the transmission of articulate sounds by the use of only one instrument at each end, and by supporting the wires or magnets of that instrument so that they do not vibrate freely and have no special musical note of their own.

CHIEF PHENOMENA OF THE THREE PRIMARY STATES OF MATTER.

By J. Douglas Scoffern.

PART III.

The Liquid State.

THE essential distinction between gaseous fluids and ordinary liquids is by no means so marked as a general conception of the subject might lead us to infer. I have purposely dealt with the former somewhat in detail, it being absolutely necessary that we should start with a clear understanding of the most simple condition with which we are acquainted; and it will be found that the study of both liquids and solids will be greatly facilitated by a correct apprehension of the leading principles associated with gases. We have already seen that any portion of a gas introduced into an empty vessel will at once expand, and fill it in such a way as to exert a degree of pressure upon every equal unit of area, entirely regulated by the temperature and pressure to which the gas is subjected. Common observation shows us that any liquid poured into a bottle or glass jar fills the vessel up to some one point only; also that the fluid invariably maintains a surface situated in the same plane as the line of horizon. It is true that the slightest force impressed upon a gas is instantly and equally transmitted in every conceivable direction. This fact holds good also in a marked degree in regard to fluids generally, as will presently be seen. Gases, we know, expand very rapidly by successive increments of heat, but liquids respond very slightly to this effect. Slight although the actual expansion happens to be in the case of fluids, it exerts a material influence in reference to the increased mobility of their particles, and I need only indicate such bodies as melted fats, treacle, oil, pitch, and resinous substances in general, and my readers will readily admit that their normal condition becomes greatly altered by heat—that is, their "viscosity" becomes much diminished. Even in the case of water itself, the result is noteworthy, and it has been remarked that, in certain instances, the addition of about 100° F. to a fluid has gone far towards doubling its discharge from a pipe during a given time. It will thus be seen that the cohesion between the particles of a fluid is subject to considerable change under special circumstances.

We shall do well to commence with a determinate expression for a fluid generally. It may be defined as follows:—*A fluid is a body of which the contiguous particles act on each other with pressures which are perpendicular to the surfaces separating them.* Now, all forces acting from within and without various bodies are severally designated internal and external pressures or tensions, and to such forces, when situated *within* a substance, the term "stress" is commonly applied. Thus, we speak of the pressure *upon* a supporting column of masonry; but we allude generally to the "stress" or "strain" sustained *by* an iron girder: also, it is usual to refer to the resistance offered by a rope to any weight which it may support as the "tension" it possesses. It will be obvious that a brick in a wall sustains several pressures, and slight consideration will suffice to show that these are three in number, and opposed to each other at right angles. In the first place, the brick experiences a downward pressure, due to the entire weight of the wall above it; in the second place, there is a longitudinal "thrust," due perhaps to an arch which presses against one extremity of the wall; and, finally, we may take into account the atmospheric pressure acting in a direction perpendicular to the surface of the brick. In any solid structure these forces are balanced as a matter of course, but it needs some slight consideration to prove that the internal forces acting upon a liquid are equally maintained *in equilibrio*. The fact that they are so follows clearly from the nature of the definition of a fluid with which we have just started, and it derives additional confirmation from the known degree of mobility possessed by all fluids—for, were the internal forces in a liquid not completely balanced, it would be impossible to obtain a level surface, whereas it is a fundamental principle that liquids preserve such a surface over and above all other bodies. Gases are found to be readily compressible—almost *ad infinitum*—but liquids are susceptible of but very slight decrease by means of pressure, and are therefore said, in general language, to be incompressible. In order to demonstrate the compressibility of water, many experiments have at various times been performed, with greater or less success, and the following plan appeared to furnish good results: A strong iron cylinder, having but one small round opening in its upper surface, was filled with water, and a solid "plunger" furnished with a stiff-fitting metal ring, having been inserted into the orifice, so as to be in actual contact with the fluid surface within, the vessel was submerged in the deep sea. From the alteration in the position of the ring upon the raising of the cylinder, the degree of compression sustained by the water at any given depth was somewhat accurately determined; by means of experiments bearing upon the subject of fluid compressibility, it has been calculated that, at a depth of 1,000 fathoms (1 1-7th mile), water is about 1-20th less in bulk than when measured at the surface.* So great is the power of compression exerted by a deep column of water, that a cork sunk 200ft. never again rises. If we place a cork in a strong bottle filled with water, and then endeavour to force in more, it sinks, on account of the fluid which is forced into the interstices of the cork, greatly augmenting its density; but upon removal of the additional pressure it again rises into the neck of the vessel. In order to prove the equality of pressure in any liquid, we need merely sink an ordinary bottle cork deeply in the sea; it will be found on withdrawal to be compressed in every possible direction—in fact, it will be reduced to what is termed a phial cork in every respect. Again, if we take any kind of vessel having two openings of equal area, situated one in the bottom, and another at the side respectively, and if we apply to each orifice a convenient form of sliding valve plug, kept in close contact with the surface of the vessel by means of a spring-balance arrangement, we shall find that the force with which the fluid seeks to escape from either opening will be equal—provided that in each case the heights of the liquid column above the centres of the orifices be also equal. From this we at once see that any number of openings in the sides or bottom of a vessel require restraining forces externally in the exact proportion of the depth of their centres from the surface of the liquid. Perhaps it may be well to state here that a pipe having a sectional area of 1 sq. in. will hold nearly 1lb. of water in 2ft.—or, to speak technically, it contains half a pound to the "running foot;" from this it follows that the pressure on an immersed body, or the sides and bottom of any containing vessel, will be 1lb. per square inch of area for every 2ft. of depth of the impressed points beneath the surface. If we sink a strong square glass bottle, firmly corked, to a sufficient depth it rarely escapes being crushed in, thus demonstrating the great force with which a column of water presses against any submerged substance. It is well known that the *débris* from a wreck is generally washed ashore, when the disaster occurs in shallow water; but at a great depth the wood is so compressed, and so much water forced between its pores, that the several portions—by reason of their greatly increased density—rarely again rise. So common is it to regard water as an absolutely mobile liquid, that many persons would be surprised did they but know the frictional resistance which it frequently displays. This effect is made up of two causes, for there is on the one hand, the cohesion between the fluid particles themselves; and on the other, the retarding influence due to the more or less uneven nature of the pipe or other conducting channels. It has been found by experiment that a pipe of 1in. diameter, 200ft. long, and placed horizontally, discharges but one-fourth of the volume which would escape from an ordinary aperture of similar area. In the case of air the frictional resistance is much greater. Many years ago, a man of a singularly constructive turn of mind conceived the happy project of supplying the blast to a furnace, two miles distant from a waterfall, by means of an enormous pair of bellows, and his discomfiture was considerable on finding that friction had reduced his air current to *nil!* When the modern system of gas-lighting was first mooted it was strenuously assailed by some engineers of great repute. They feared that the flow of the gas would be totally impeded owing to this cause. On the other hand, the steady flux of water through even orifices, and under relatively uniform conditions, has been, during many centuries, so universally understood that the ancients used it as a ready means for determining successive periods of time. The vessels from which the water was allowed to flow were termed *Clepsydræ*, and one of these water-clocks in particular, invented about 135 B.C., by Ctesibius, a celebrated mathematician of Alexandria, took the form of a figure, from the eyes of which the drops of water welled up after the fashion of tears—in this manner deploring the all too-rapid progress of precious time. These tears being duly received into a suitable reservoir, in their turn floated up another figure, whose function it was to point to the different hours which were marked along an upright scale. This vessel was daily emptied by means of a siphon, and elaborate machinery connected with the discharge flow served further to indicate the day and month. Very uniform, also, is the escape of sand from any orifice, and it was therefore similarly employed. It is a remarkable fact, however, that this substance does not exhibit an increase in the rapidity of its escape on account of an increased height or "head" of sand above the discharging aperture. In this particular it differs greatly from water, as we shall presently see. Suppose that near the bottom of a reservoir, filled, and kept filled, with water, we insert a tube, bending it up on the outside at any angle not too abrupt, and that we press its free extremity somewhat together, so as to form a suitable delivery-tube,* then we know that the jet will spurt to almost the height of the fluid surface in the tank. Were it not for the resistance of the air and friction it would actually attain that exact level, but these effects being "constants," must be deducted. Now it follows, from the motions of falling bodies, that any mass projected to a given height will exactly re-acquire the initial velocity of its discharge upon again reaching the level from which it started, save and except for the resistance of the air, which similarly necessitates a correction. Hence it is evident that the velocity of discharge of a fluid from any orifice must be almost identical with that acquired by a body in falling through a height equal to that of the surface of the liquid above the discharging orifice. We can therefore readily determine this velocity from a knowledge of the above phenomena, and in this way estimate the volume of water which issues from any given orifice during a given number of units of time. In London the force of gravity is 32·19078ft. per second—that is to say, a falling body acquires, *at the end of the first second*, a velocity such that, *during the next second*, it would fall through this distance, but *during the first second* it falls only half that distance, or 16ft. A reservoir, therefore, having an opening of 1 square inch at 16ft. below the water-level, would—*cæteris paribus*—deliver, in a second of time, 32ft. of a column of water having a sectional area of 1 square inch, and we have already seen that the weight of a "running foot" of such a mass of water is half a pound. Thus, the entire weight discharged by such an opening in a second of time would be 16lb. Similarly, we learn that an opening at four times the depth would discharge double this quantity; at nine times the depth a triple volume, and so on. I can but repeat that in order to fully apprehend this part of our subject the reader must of necessity acquire an accurate knowledge of the "laws of motion of falling bodies," and unfortunately these are not a little puzzling at first. When speaking of these with some degree of technical precision it is usual to say:—*The successive spaces traversed by a falling body increase as the squares of the several intervals of time increase.* Whereas the force of gravity at London is 32·19078ft.—that is, a body in falling towards the centre of the earth here acquires a velocity at the end of 1 second, which, were it *not* accelerated, would impel the mass during the next second through that space, at Paris this same force is 32·18255ft. (or 9·8 mètres), and at New York it is 32·15945ft. In either locality the actual space described by the descending mass during the first entire second is only the half of any of these values—say just 16ft. As a fact, then, we say that the *velocities* increase as the simple number 1, 2, 3, 4, 5, &c.; *spaces* during the several periods as the odd numbers 1, 3, 5, 7, 9, &c.; *space* from commencement of fall as the square numbers 1, 4, 9, 16, 25, &c.

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* I do not hold myself responsible for the accuracy of this statement, which is founded on an assertion made at p. 262 of Dr. Neill Arnott's "Elements of Physics" (Vol. I.) At p. 39 we are assured by the author that "it is found that at 1,000 fathoms the water is compressed to a bulk about a hundredth part less than it would have at the surface." Not having by me at present the record of some similar experiments which I undertook in 1878 at Vienna and Pesth, I can only regret so grave a discrepancy occurring. Meanwhile, therefore, my readers will perhaps adopt whichever value may suit them the best!

It will now perhaps be obvious that, in the case of our reservoir above, were the orifice situated at four times the depth the volume discharged in unit of time would be double, at nine times the depth three-fold, and so on.*

A knowledge of these laws, together with the practical application to them of certain "constants," assigning the retarding effects due to friction, curvature of, and irregularities in the interior of the mains, along with dilatation or contraction at portions of the same, furnishes the *rationale* of the various perplexing problems which the hydraulic engineer has continually to solve.

So great is the degree of friction between the particles of water themselves that whole fens have been drained by causing a small stream to traverse them with a velocity sufficient to surmount a ridge or bank at their boundaries. Similarly, a pool can be rapidly emptied by forcing a column of water through and beyond it. Between air and water the friction is extremely great, as witness, in a measure, the generation of waves; we can readily believe, therefore, that there may be much truth in the expression "pouring oil on troubled waters;" indeed, it has been stated on good authority that boats have forced their way through a raging surf by first breaking a number of casks of oil to windward, and then working away on the lee side. When circulating in an all but closed "system" fluids partake of a marvellous uniformity of motion. Such a channel is formed by the varied ramifications of the blood vessels in man and animals, and the following record of experiments will suffice to show how extremely rapid these movements throughout the vascular system are:—

Ferrocyanide of potassium, in solution, having been injected into the right jugular vein of a horse, was readily detected in the same vessel on the left side in from 20 to 30 seconds—this being the mean of 18 experiments; the poisonous effects of strychnia on the nervous centres were manifested in 12 seconds when injected into the jugular vein of a dog; in a fowl, in 6·5 seconds; and in a rabbit in 4·5 seconds. Calculation appears to afford evidence that in the human subject the entire circulation is probably performed in from 43⅓ to 62 and 2-3rd seconds. Confirmatory indications as to this rapidity of flow exist in the disastrous effects which so quickly supervene on absorption of the virus of the *rattlesnake* and *cobra di capello*. The force exerted by a column of fluid circulating in a closed system, and submitted to an impelling agency, is spoken of as a "static pressure;" and in the case of ourselves experiments have shown that in the aorta—or large "main" arising from the upper surface of the left ventricle of the heart—this pressure is equal to nearly 4lb. 4oz.; but in the same artery of the mare it has been proved equal to 11lb. 9oz., while again, at the human wrist—*i.e.*, in the *radial* artery, there is only 4 drams—or half an ounce of so-called static pressure. It is this continued urging forward of the blood column, producing a temporary dilatation of the artery, that constitutes the "pulse"—beloved of doctors; from this the members of the "faculty" derive omens more portentous than any events prognosticated by the augurs of old! Now, it is a fact that the velocity of a fluid current diminishes as the width of the channel increases, and we therefore perceive why, in the ultimate vessels of the human body—the *capillaries*—the movement of the circulation should, and needs must, be extremely sluggish. In this system the vessels are minute tubules having a diameter of about the 1-3000th of an inch; but the whole sectional area of these vessels exceeds that of the main trunks: hence then, the greatly diminished velocity and augmented frictional resistance experienced by their contents. Experiments performed upon frogs gave a mean of 1 inch per minute for the rapidity of flow in the minute vessels; but it is only fair to assume that in warm-blooded creatures the speed must be at least more than three times the above, for froggy is a sadly sluggish fellow all round: even his nervous impulse is calculated at little more than 80ft. per second, thus showing that he is certainly "a slow thinker!" An instrument for determining the static pressure of the circulating blood-column, as determined against a varying height of mercury measured in millimetres or inches, is aptly and pathetically termed a "Hæmadynamometer;" many of my readers also are doubtless familiar with the nature and use of the "Sphygmograph," which is in substance neither more nor less than a delicately made and carefully adjusted lever of the "third order," carrying at its free extremity a pointer for communicating the vibratory or jerking motion of the pulse to a sheet of card, previously smutted by being held over an oil-flame. This instrument, in fact, determines the force of impact with which the blood is propelled along a particular artery. The right lower half (or ventricle) of the heart is assumed to contract with but half the force exerted by the left, of which the walls are much thicker, and it is from the right ventricle that the pulmonary artery arises: hence it is only natural to assume that the static pressure sustained by the lung-column amounts merely to (4lb. 4oz. ÷ 2) = 2lb. 2oz., and this assumption, from a physiological point of view, opens out several problems of considerable interest.

(To be continued.)

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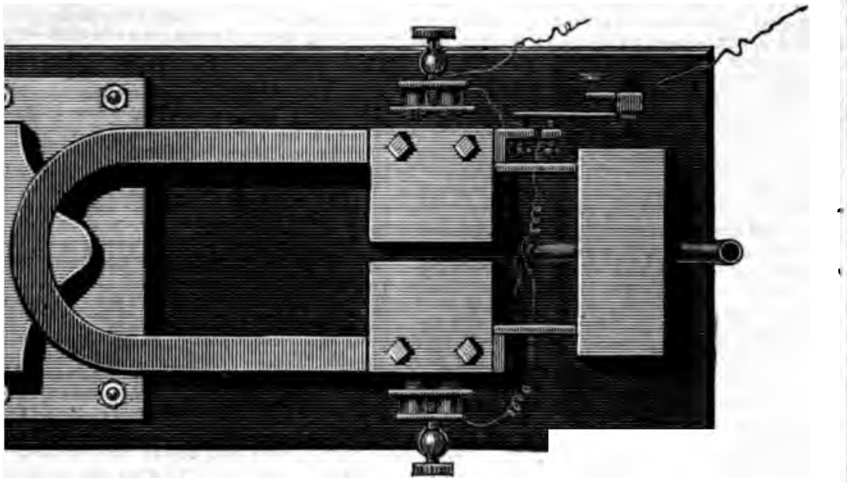
* In the course of some experiments connected with a fountain I invariably found the most satisfactory form of "nozzle" to be that of a plane disc pierced with a central orifice; it always gave the highest jet. This appears to me in accordance with theoretical principles, but demands *a more strictly mathematical* demonstration than could be *adduced in such an elementary paper as the present.*

* Some of my readers may like to possess a formula, evolved from the classic researches of M. Poncelet, and which gives with extreme accuracy the velocity per second, with which water is discharged from a reservoir of given height, = h; through a pipe of length = l; and having a diameter = δ. From it we learn that

$$v = \left(48\sqrt{\frac{h\,d}{l + 54d}}\right).$$

ISON'S HARMONIC ENGINE.

annexed illustration we give a representa- of the magnetic engine of Mr. Edison, s been named "The Harmonic," for what not stated. The details vary according to reporters, but practically we presume, the



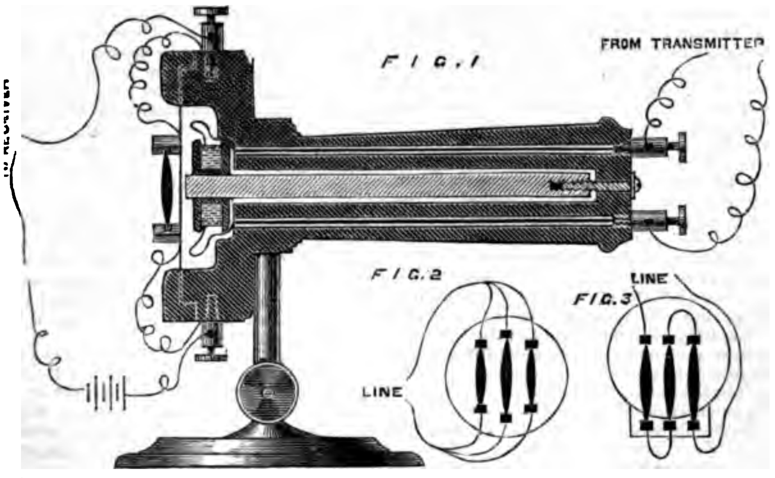
ns are of little moment. The machine in on's laboratory is stated to be capable of ee barrels of water in twenty-four hours up es, at a cost of three cents a day. We "story" would be about 12ft., but state- the kind should always be taken with a fair of salt.

ing to the *Scientific American*, Professor s devised a novel electrical machine, which e Harmonic Engine, in which 90 per cent. wer is realised. With two small electro- and three or four small battery cells, power is generated to drive a sewing or pump water for household purposes. ne (represented in the engraving) consists 2¼ft. long, made of 2in. square steel. The rt of the fork is firmly keyed in a solid lted to a suitable foundation, and to each e fork is secured a 35lb. weight. Outside ar the end of each arm is placed a small gnet. These magnets are connected with , and with a commutator operated by one ms. The arms make 35 vibrations per e amplitude of which is ¼in. Small arms m the fork arms into a box containing a pump having two pistons, one pisten being to each arm. Each stroke of the pump ery small quantity of water, but this is ed for by the rapidity of the strokes. Mr. oposes to compress air with the harmonic d use it as a motive power for propelling chines and other light machinery. The st be taken from the fork arms in some does not affect the synchronism of their —otherwise the engine will not work.

E MICROPHONE RELAY.*

EDWIN J. HOUSTON and ELIHU THOM- the Philadelphia Central High School.

IATELY after the announcement by Bell of his remarkable invention of the g telephone, the authors proposed for the task of relaying this instrument.



mber of different arrangements were tried, to the exceedingly feeble movements of agm of the receiving telephone none of them were very successful. The discovery by Prof. Hughes, however, of the inexpressibly delicate microphone happily afforded us the means of at last solving the problem at which we had been so long engaged. In our application of the microphone for the relaying of the telephone we attach a miniature microphone to the plate of the receiving telephone. The microphone so attached consists essentially of three small pieces of carbon, each beisg about ⅜in. in length. These pieces are arranged exactly as in the manner described by Prof. Hughes—viz., one of the pieces of carbon, which is sharpened at both ends, rests vertically in small cavities near the ends of the two other pieces, as shown in Fig. 1. The two carbon supports for the third piece are cemented at their ends directly to the plate of the telephone.

The microphone so constructed is placed in the new circuit in which it is desired to repeat the message originally transmitted. The method of its operation is evident. The slight movements of the diaphragm of the receiving telephone, which are, in fact, so slight as to render them almost impossible of detection by mechanical means, are nevertheless at once recognised by the marvellously sensitive microphone, and are repeated in the new circuit as variations in the intensity of the electrical current traversing it. The message so relayed or repeated, for it is evident that the instrument can be used either as a relayer or a repeater, may be either received at once by a telephone placed in said circuit, or may be again repeated in a new circuit. By this means we believe that the distance to which a telephone message can be transmitted will be very greatly increased.

Owing to the extreme sensitiveness of the microphone it will be necessary, in the practical application of this instrument as a relay. to carefully shield it from all extraneous sounds, which, weak though they may be, are, nevertheless, very loud when compared with those which would be produced by the feeble movements of the plate of the receiving telephone. This may be obtained in practice in several ways—as, for example, by placing the microphone relay in a box with double or treble hollow walls lined with cotton, wool, or some other non-homogeneous material, or by sinking the instrument in a pit underground. We have found but little difficulty, however, in the trial of our instrument over a city line of some three miles in length, of obtaining the quiet necessary for the working of the instrument, although the latter was placed in a large room in the second story of a building facing a public thoroughfare, and the time of trial was shortly after midday.

The microphone, when properly constructed, has its greatest sensitiveness when the piece of carbon pointed at both ends rests in a nearly vertical position. Its electrical resistance is then at its maximum. In this position the upright carbon is resting on its extreme ends, and the cross section of contact a minimum. So placed the slightest acoustic movement brings portions of the conical surfaces of the upright pieces against the edges of the cavities, and thereby diminishes the resistance by increasing the area of the surfaces in contact. If now it be desired to diminish the sensitiveness of the instrument, it is only necessary that it be so placed, that the upright carbon be no longer supported vertically, but be slightly inclined. In this position more force is required to move the upright piece, and so cause it to vary the electrical resistance. In all the microphones that we have experimented with when the upright piece was held nearly vertically, whispers or other faint sounds were distinctly transmitted, but the voice of a person standing a few feet from the instrument, and speaking as in ordinary conversation, caused such a rattling of the receiving instrument as either to render the sound unintelligible or greatly confused. In all such cases a certain inclination could be obtained, varying slightly in each instrument, at which the rattling of the instrument entirely disappeared, and the sound was distinctly and loudly transmitted.

When the microphone relay is placed in a circuit whose resistance is considerable, as, for example, at the end of a distant station, we increase the sensitiveness of the instrument by attaching a number of minute microphones to the receiving diaphragm, as shown in the figures. These may be connected in series, as in Fig. 3, or in multiple arc as in Fig. 2.

Since the variation in the electrical resistance of the microphone depends mainly on the upper contact of the loose piece with its support, an increased delicacy may be obtained by attaching this support directly to the middle of the diaphragm of the receiving instrument, while the lower support need not necessarily be attached to the diaphragm.

We have measured the resistance of a microphone in which the movable piece was composed of a piece of carbon about 1¼in. long and ¼in. square, and find that, when placed in an upright position, it has about a resistance of 50 ohms, varying, however, in a marked manner, with any sound. The same instrument, when turned at an angle of about 40° from the vertical, was found to have its resistance diminished to about 25 ohms.

It may be mentioned, as an interesting fact in regard to the microphone, that when the upright piece is placed in the position of its greatest sensitiveness, and a moderately loud sound is made near it, although such sound is only transmitted as a confused rattling, yet its resonance can, in most cases, be distinctly heard. This is, probably, the cause of the peculiar ringing sound heard when the microphone transmits mere noises, such as those produced by a person walking.

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n advance sheet of the *Journal* of the Franklin rwarded by the authors.

ENLARGING PHOTOS. BY MEANS OF THE DRUMMOND LIGHT.

ON this subject a paper was read at a recent meeting of the Berlin Photographic Society, and is thus translated by the *Photographic News*. This method, though a long time before the public, has not come into general use, partly on account of the expense of the necessary apparatus, partly because few persons are familiar with the preparation of oxygen as required in the process. On the other hand, it possesses the advantage that no retouching of the negative is necessary, but that a positive copy on paper is obtained with a very short exposure. This is of considerable importance, inasmuch as more than one of these enlarged copies is but seldom ordered, and for this one copy we are not compelled, as in other processes, to prepare first a smaller transparent positive, and then an enlarged negative. Moreover, we can by this method obtain pictures of a size larger than any negative that we possess, and without the inconvenience of coating a large plate —always a troublesome operation. The instrument used is manufactured by Dr. Harnecker, of Wriezen on the Oder, and differs from the ordinary enlarging sciopticon only in the construction of the lamp and the omission of the concave mirror. The lamp is made of sheet brass, and contains a reservoir with an upright brass tube; this tube holds the two wicks. It is filled with absolute alcohol, the wicks being drawn out for about half a centimetre. In front of the wick-tube is a second tube, to the upper part of which is fixed in a slanting position a small bore tube terminating in a fine point. Through this fine tube a strong current of oxygen is injected into the alcohol flame, and this produces a very great heat. The hot flame is directed on to a cylinder of lime, and raises it to a white heat, throwing out an intense light. Dr. Harnecker supplies for his lamps specially constructed cylinders of about 4 c. met. in height, and 2½ c. met. in diameter; these have a hole bored through the axis, by which they can be fastened to a pin attached to the lamp. In practice, however, these cylinders appear not to give satisfaction, as they are liable to fall to pieces when touched; they are sent packed in tin boxes containing six, but it is impossible to unpack them without sacrificing one or more before the others can be got out. Much more to be recommended are the so-called English cylinders of Herr R. Talbot, 68, August Strasse, Berlin, N.; they have a much larger diameter, but are less in height, so that the oxy-alcoholic flame plays in the base of the cylinder, whereas in the first mentioned ones it plays on the side. The lime cylinders of Talbot are cased in sheet brass and if one should split it is kept together by its envelope. For enlargements taken in this way, the negative must be very thin and transparent; the one prepared by Herr Suck for illustrating this paper was developed by a solution diluted with its own weight of water. For this operation a special kind of paper, also prepared by Dr. Harnecker, must be used; the mode of its preparation is as yet a profound secret. A paper manufactured by Dr. Kerrz, of Wernigerode, has been tried by the author of the paper with good effect in sunlight, but without successful result in artificial light. The silver bath must be uncommonly weak, but it must be thoroughly acidulated with glacial acetic acid. A good formula is—

Distilled water	1 kilogr.
Silver nitrate	60 grains.
Glacial acetic acid ...	10 to 15 „

A piece of Harnecker's paper is floated on this bath for about ten minutes, then taken out and exposed while still wet, the exposure lasting from one to ten minutes according to the size of the picture and the intensity of the light. For developing is used:—

Water	500 grams.
Gallic acid	2·5 „

and the exposed picture is left to float on this bath; or it may be laid on a glass plate. The edges are then turned up, and the developing solution flowed over it. Special skill, however, is required to succeed in this last operation. Gilding and fixing are effected as in the albumen process.

THE READY COMPUTATION OF FORCE TRANSMITTED BY BELTS.*

BY ROBERT BRIGGS, C.E.

THE calculation of the amount of power given out by a belt, or of the proper dimensions of the pulley, or the belt to perform a given labour or effort, is greatly embarrassed, to the practical mechanic, by the necessity of reducing several dimensions to some unit compounded of velocity of belt per minute (which velocity of itself has to be derived from the circumference of the pulley in feet, while its diameter is usually taken in inches), multiplied by a certain number of revolutions per minute, the sum being multiplied by the width of the belt, and the whole three referred to an arbitrary figure either in foot pounds or in horse-power. When the result of these figures is admitted to be varied by the angle of contact, and, in cases of much velocity, by the effects of centrifugal force and of the interposition of the air between the pulley and the belt, and especially when the value of the adhesion of belts is not generally accepted and the guesses of any one who will have guessed have been taken to have equal weight with the most carefully made experiments, then the above assertion as to the difficulty in using general data, by a practical man, can be confidently affirmed.

By adopting, however, a very simple unit of value derived directly from the dimensions, of diameters and of widths, in a common measure, and the revolutions per minute of any pulley, wherein the relations of velocities and circumferences disappear, it is possible to have a series of values, which may be compared with the ascertained power transmitted by belts, in these units, directly.

In their best condition, all belts are worked under the least strain which will transmit the desired power with steadiness. An irregularity of motion is the first indication of the slipping of a belt from inability to transmit under a given tension, and the skilled workman will give it no more tightness than just enough to drive by. It has been found by the experiments of Mr. H. R. Towne and the writer, that under such conditions any and all leather belts in good working order exert a frictional hold on their pulleys of about 58 per cent. of the pressure of the belt upon the surface of pulley at any given place, for a maximum, or about 42 per cent. of this pressure in good practice under the ordinary conditions of atmospheric temperature and moisture.

The strain on a single belt can then be taken at 66⅔ pounds per inch of width; or, rather, an ordinary lacing of the lacing holes may be assumed to be durable in service when this strain per inch of width on the tight side of the belt is not exceeded. These figures, derived from experiment, have been corroborated by numerous tests of belts in use, with indicated or measured power, made and compared since the publication of the experiments.

The new unit of value which I propose is that derived by the multiplication of the diameter of a pulley in inches by its width in inches, and the result by the number of revolutions per minute. Diameter × width × revolutions.

The comparison of the relative powers given out by different pulleys of the same system, for transmission, by means of this unit, will be found to be so easy that I can venture to say that no workman who has once applied it understandingly in practice will ever forget the rule or fail to appreciate its utility. For instance, it will be found generally that many, if not most, lathes have their counter-shafting very deficient in belt power on the small diameters of the overhead cone. It may also be stated as a fact that all lathes, both great and small, demand very nearly the same amount of belt power when performing their maximum quantity of work in turning either iron, brass, or steel, the rapidity of cutting, in the smaller lathes, and lighter cuts, compensating for increase of size or swing of the larger tools. The number of 5,000 units represents the least power of the belt proper for lathes of 10-inch to 50-inch swing, and 6,000 gives great ease and long duration in service of the belts, it being assumed that each lathe is operated with a single cutting tool.

The same numbers suffice for medium-size shapers, planers, drills, and boring tools; but, for tapping machines, screwing machines, and the larger tools, where the friction from the weight of parts becomes a great element in the work to be performed by the tool, somewhat larger figures will be demanded; 7,000 to 9,000 may be needful to obtain maximum of work in tapping machines, screwing machines, and heavy lathes or planers, the heaviest of the latter tools demanding yet larger figures. Whatever may be the needed figure for all these tools (where the speeds of the belts are so small that centrifugal force and the effect of the interposition of air may be neglected, and the belts are so long that the arc of contact on the smaller pulley is not less than 160° to 170°), in all cases the multiple of diameter, width, and number of revolutions must be equal to or above these figures, in order that the tool shall be driven certainly with a properly stretched belt.

The effects of different arcs of contact of the belt upon the pulleys can be seen by the following table:—Strain on tight side of belt = 66⅔lb. per inch wide; co-efficient of friction = 0·42.

Arc. of contact.	Foot-lb. transmitted by 1in. diam. × 1in. width per rev. per min.	No. of revs. representing 1 h.-p.
90° ...	8·5 ...	3,900
100 ...	9·1 ...	3,600
110 ...	9·7 ...	3,400
120 ...	10·25 ...	3,200
135 ...	11 ...	3,000
150 ...	11·7 ...	2,825
180 ...	12·8 ...	2,570
210 ...	13·75 ...	2,400
240 ...	14·5 ...	2,280
270 ...	15·06 ...	2,190

In using the above figures, no allowance for centrifugal force or interposition of air need be made for use with ordinary machine tools, and these corrections need only be applied to polishing lathes, centrifugal machines, fans, saws, and similar tools and machines.

THE EXPLANATION OF CERTAIN ACOUSTICAL PHENOMENA.*

MUSICAL sounds have their origin in the vibrations of material systems. In many cases—*e.g.*, the pianoforte—the vibrations are free, and are then necessarily of short duration. In other cases—*e.g.*, organ pipes and instruments of the violin class—the vibrations are maintained, which can only happen when the vibrating body is in connection with a source of energy capable of compensating the loss caused by friction and generation of aërial waves. The theory of free vibrations is tolerably complete, but the explanations hitherto given of maintained vibrations are generally inadequate, and in most cases altogether illusory.

In consequence of its connection with a source of energy, a vibrating body is subject to certain forces, whose nature and effects are to be estimated. These forces are divisible into two groups. The first group operate upon the periodic time of the vibration—*i.e.*, upon the pitch of the resulting note, and their effect may be in either direction. The second group of forces do not alter the pitch, but either encourage or discourage the vibration. In the first case only can the vibration be maintained; so that for the explanation of any maintained vibration it is necessary to examine the character of the second group of forces sufficiently to discover whether their effect is favourable or unfavourable. In illustration of these remarks the simple case of a common pendulum was considered. The effect of a small periodic horizontal impulse is in general both to alter the periodic time and the amplitude of vibration. If the impulse (supposed to be always in the same direction) acts when the pendulum passes through its lowest position the force belongs to the second group. It leaves
the periodic time unaltered, and encourag
courages the vibration according as the d
the pendulum's motion is the same or th
of that of the impulse. If, on the other
impulse acts when the pendulum is at one
of the limits of its swing the effect is so
periodic time, and the vibration is neither e
nor discouraged. In order to encourage—
tically in order to maintain a vibration—i
sary that the forces should not depend s
the position of the vibrating body. Th
case of the pendulum, if a small impulse i
direction acts upon it every time that
through its lowest position, the vibrati
maintained, the advantage gained as the
makes a passage in the same direction
which the impulse acts being exactly neu
the return passage, when the motion is i
site direction.

As an example of the application of
ciples, the maintenance of an electric
was discussed. If the magnetic forces de
upon the position of the fork the vibratio
be maintained. It appears, therefore, t
planations usually given do not touch th
at all. The fact that the vibrations are
is a proof that the forces do not depend
the position of the fork. The causes of d
two—the self-induction of the electric cu
the adhesion of the mercury to the w
motion makes and breaks the contact.
accounts the magnetic forces are more
the latter than in the earlier part of th
although the position of the fork is the s
is on this *difference* that the possibility
nance depends. Of course the arrangeme
such that the retardation of force *enc*
vibration, and the arrangement which
courages the vibration would have had t
effect, if the nature of electric currents ha
that they were more powerful during the e
during the later stages of a contact.

In order to bring the subject within the
lecture, one class of maintained vibra
selected for discussion—that, namely, of w
the motive power. The best understood
this kind of maintenance is that afforded
lyvan's bars, or rockers. A heated brass
bar, so shaped as to rock readily from on
support to another, is laid upon a cold bl
The communication of heat through th
support expands the lead lying immediatel
such a manner that the rocker receives
pulse. During the interruption of the conta
municated heat has time to disperse its
degree into the mass of lead, and it is not
see that the impulse is of a kind to enc
motion. But the most interesting vibrati
class are those in which the vibrating bo
of a mass of air more or less completely

If heat be periodically communicated t
stracted from, a mass of air vibrating (fo
in a cylinder bounded by a piston, the
duced will depend upon the phase of the
at which the transfer of heat takes place.
given to the air at the moment of greatest
tion, or taken from it at the moment of gr
faction, the vibration is encouraged. On
hand, if heat be given at the moment of gr
faction, or abstracted at the moment of gr
densation, the vibration is discouraged.
effect takes place of itself, when the rapidi
nation is neither very great nor very small
quence of radiation; for when air is co
becomes hotter, and communicates heat to
ing bodies. The two extreme cases are e
though for different reasons. In the first,
responds to the suppositions of Laplace's
the propagation of sound, there is not suffi
for a sensible transfer to be effected. In
the temperature remains nearly constant, a
of heat occurs during the *process* of co
and not when the condensation is effected.
corresponds to Newton's theory of the
sound. When the transfer of heat takes p
moments of greatest condensation or of gr
faction, the pitch is not affected.

If the air be at its normal density at t
when the transfer of heat takes place, th
is neither encouraged nor discouraged, but
altered. Thus the pitch is *raised* if heat
nicated a quarter period *before* the phase
condensation, and the pitch is *lowered* if
communicated a quarter period *after* th
greatest condensation.

In general both kinds of effects are pro
periodic transfer of heat. The pitch is a
the vibrations are either encouraged or di
But there is no effect of the second kind
concerned be at a loop—*i.e.*, a place where
does not vary, nor if the communication
the same at any stage of rarefaction, as i
responding stage of condensation.

The first example of aërial vibrations
by heat was found in a phenomenon which
been observed by glass-blowers, and was
subject of a systematic investigation by
hauss. When a bulb about three-quarters

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* *From the Polytechnic Review.*

* A lecture delivered by Lord Rayleigh at the Royal Institution.

in diameter is blown at the end of a somewhat narrow tube, 5 or 6 inches in length, a sound is sometimes heard proceeding from the heated glass. It was proved by Sondhauss that a vibration of the glass itself is no essential part of the phenomenon, and the same observer was very successful in discovering the connection between the *pitch* of the note and the dimensions of the apparatus. But no explanation (worthy of the name) of the production of sound has been given.

For the sake of simplicity, a simple tube, hot at the closed end, and getting gradually cooler towards the open end, was first considered. At a quarter of a period *before* the phase of greatest condensation (which occurs almost simultaneously at all parts of the column) the air is moving inwards—*i.e.*, towards the closed end—and therefore is passing from colder to hotter parts of the tube; but the heat received at this moment (of normal density) has no effect either in encouraging or discouraging the vibration. The same would be true of the entire operation of the heat, if the adjustment of temperature were instantaneous, so that there was never any sensible difference between the temperatures of the air and of the neighbouring parts of the tube. But in fact the adjustment of temperature takes *time*, and thus the temperature of the air deviates from that of the neighbouring parts of the tube, inclining towards the temperature of that part of the tube *from* which the air has just come. From this it follows that at the phase of greatest condensation heat is received by the air, and at the phase of greatest rarefaction is given up from it, and thus there is a tendency to maintain the vibrations. It must not be forgotten, however, that, apart from transfer of heat altogether, the condensed air is hotter than the rarefied air, and that in order that the whole effect of heat may be on the side of encouragement, it is necessary that, previous to condensation, the air should pass not merely towards a hotter part of the tube, but towards a part of the tube which is hotter than the air will be when it arrives there. On this account a great range of temperature is necessary for the maintenance of vibration, and even with a great range the influence of the transfer of heat is necessarily unfavourable at at the closed end, where the motion is very small. This is probably the reason of the advantage of a bulb. It is obvious that if the *open* end of the tube were heated the effect of the transfer of heat would be even more unfavourable than in the case of a temperature uniform throughout.

The sounds emitted by a jet of hydrogen burning in an open tube were noticed soon after the discovery of the gas, and have been the subject of several elaborate inquiries. The fact that the notes are substantially the same as those which may be elicited from the tube in other ways—*e.g.*, by blowing—was announced by Chladni. Faraday proved that other gases were competent to take the place of hydrogen, though not without disadvantage. But it is to Sondhauss that we owe the most detailed examination of the circumstances under which the sound is produced. His experiments proved the importance of the part taken by the column of gas in the tube which supplies the jet. For example, sound cannot be obtained with a supply tube which is plugged with cotton in the neighbourhood of the jet, although no difference can be detected by the eye between the flame thus obtained and others which are competent to excite sound. When the supply tube is unobstructed, the sounds obtainable are limited as to pitch, often dividing themselves into detached groups. In the intervals between the groups no coaxing will induce a maintained sound, and it may be added that, for a part of the interval at any rate, the influence of the flame is inimical, so that a vibration started by a blow is damped more rapidly than if the jet were not ignited.

Partly in consequence of the peculiar behaviour of flames, and partly for other reasons, the thorough explanation of these phenomena is a matter of some difficulty; but there can be no doubt that they fall under the head of vibrations maintained by heat, the heat being communicated periodically to the mass of air confined in the sounding tube at a place where, in the course of a vibration, the pressure varies. Although some authors have shown an inclination to lay stress upon the effects of the current of air passing through the tube, the sounds can readily be produced, not only when there is no through draught, but even when the flame is so situated that there is no sensible periodic motion of the air in its neighbourhood. In the course of the lecture a globe intended for burning phosphorus in oxygen gas was used as a resonator, and, when excited by a hydrogen flame well removed from the neck, gave a pure tone of about ninety-five vibrations per second.

In consequence of the variable pressure within the resonator the issue of gas, and therefore the equivalent of heat, varies during the vibration. The question is under what circumstances the variation is of the kind necessary for the maintenance of the vibration. If we were to suppose, as we might at first be inclined to do, that the issue of gas is greatest when the pressure in the resonator is least, and that the phase of greatest development of heat coincides with that of the greatest issue of gas, we should have the condition of things the most unfavourable of all to the persistence of the vibration. It is not difficult, however, to see that both suppositions are incorrect. In the supply tube (supposed to be unplugged, and of not too small bore), stationary, or approximately stationary, vibrations are excited, whose phase is either the same or the opposite of that of the vibration in the resonator. If the length of the supply tube from the burner to the open end in the gas-generating flask be less than a quarter of the wave-length in hydrogen of the vibration the greatest issue of gas *precedes* by a quarter period the phase of greatest condensation; so that if the development of heat is *retarded* somewhat in comparison with the issue of gas, a state of things exists *favourable* to the maintenance of the sound. Some such retardation is inevitable, because a jet of inflammable gas can burn only at the outside, but in many cases a still more potent cause may be found in the fact that during the retreat of the gas in the supply tube small quantities of air may enter from the interior of the resonator, whose expulsion must be effected before the inflammable gas can again begin to escape.

If the length of the supply tube amounts to exactly one quarter of the wave-length the stationary vibration within it will be of such a character that a node is formed at the burner, the variable part of the pressure just inside the burner being the same as in the interior of the resonator. Under these circumstances there is nothing to make the flow of gas, or the development of heat, variable, and therefore the vibration cannot be maintained. This particular case is free from some of the difficulties which attach themselves to the general problem, and the conclusion is in accordance with Sondhauss' observations.

When the supply tube is somewhat longer than a quarter of the wave the motion of the gas is materially different from that first described. Instead of preceding the greatest outward flow of gas *follows* at a quarter period interval the phase of greatest condensation, and therefore if the development of heat be somewhat retarded, the whole effect is unfavourable. This state of things continues to prevail as the supply tube is lengthened, until the length of half a wave is reached, after which the motion again changes sign, so as to restore the possibility of maintenance. Although the size of the flame and its position in the tube (or neck of the resonator) are not without influence this sketch of the theory is sufficient to explain the fact, formulated by Dr. Sondhauss, that the principal element in the question is the length of the supply tube.

The next example of the production of sound by heat shown in the lecture was a very interesting phenomenon discovered by Rijke. When a piece of fine metallic gauze, stretching across the lower part of a tube, open at both ends and held vertically, is heated by a gas flame placed under it, a sound of considerable power, and lasting for several seconds, is observed almost immediately *after* the removal of the flame. Differing in this respect from the case of sonorous flames, the generation of sound was found by Rijke to be closely connected with the formation of a through draught, which impinges upon the heated gauze. In this form of the experiment the heat is soon abstracted, and then the sound ceases; but by keeping the gauze hot by the current from a powerful galvanic battery, Rijke was able to obtain the prolongation of the sound for an indefinite period. In any case from the point of view of the lecture the sound is to be regarded as a *maintained* sound.

In accordance with the general views already explained, we have to examine the character of the variable communication of heat from the gauze to the air. So far as the communication is affected directly by variations of pressure or density the influence is unfavourable, inasmuch as the air will receive less heat from the gauze when its own temperature is raised by condensation. The maintenance depends upon the variable transfer of heat due to the varying *motions* of the air through the gauze, this motion being compounded of a uniform motion upwards, with a motion, alternately upwards and downwards, due to the vibration. In the lower half of the tube these motions conspire a quarter period *before* the phase of greatest condensation, and oppose one another a quarter period after that phase. The rate of transfer of heat will depend mainly upon the temperature of the air in contact with the gauze being greatest when that temperature is lowest. Perhaps the easiest way to trace the mode of action is to begin with the case of a simple vibration without a steady current. Under these circumstances the whole of the air which comes in contact with the metal, in the course of a complete period, becomes heated; and after this state of things is established there is comparatively little further transfer of heat. The effect of superposing a small, steady upward current is now easily recognised. At the limit of the inward motion—*i.e.*, at the phase of greatest condensation—a small quantity of air comes into contact with the metal, which has not done so before, and is accordingly cool; and the heat communicated to this quantity of air acts in the most favourable manner for the maintenance of the vibration.

A quite different result ensues if the gauze be placed in the *upper* half of the tube. In this case the fresh air will come into the field at the moment of greatest rarefaction, when the communication of heat has an unfavourable instead of a favourable effect. The principal note of the tube, therefore, cannot be sounded.

A complementary phenomenon, discovered by Bosscha and Riess, may be explained upon the same principles. If a current of *hot* air impinge upon *cold* gauze, sound is produced; but in order to obtain the principal note of the tube the gauze must be in the upper, and not as before in the lower, half of the tube. An experiment due to Riess was shown in which the sound is maintained indefinitely. The upper part of a brass tube is kept cool by water contained in a tin vessel, through the bottom of which the tube passes. In this way the gauze remains comparatively cool, although exposed to the heat of a gas flame situated an inch or two below it. The experiment sometimes succeeds better when the draught is checked by a plate of wood placed somewhat closely over the top of the tube.

Both in Rijke's and Riess's experiments the variable transfer of heat depends upon the motion of vibration, while the effect of the transfer depends upon the variation of pressure. The gauze must therefore be placed where both effects are sensible —*i.e.*, neither near a node nor near a loop. About a quarter of the length of the tube, from the lower or upper end, as the case may be, appears to be the most favourable position.

THE APPLICATION OF PHOTOGRAPHY TO THE PRODUCTION OF PRINTING SURFACES AND PICTURES IN PIGMENT.—I.*

By THOMAS BOLAS, ESQ., F.C.S.

Photo-Lithography and Photo-Zincography.

WHEN a photographer wishes to take a picture, he, as a rule, begins by making what is technically known as a negative; this being a transparent picture having the lights and shades reversed. Now, here is a negative; as I hold it before the lime-light you see that the parts corresponding to the dark portions of the original are transparent, and those parts which correspond to the lights of the original are opaque. Here, on the other hand, is a positive, or transparency, of the same subject as the negative which you have just seen; the lights and shades of this being as those of the object represented. A negative taken from nature should show the reverse of all those gradations of light and shade which characterise natural objects, while a negative taken from a line engraving or a page of letter-press should show only two gradations, complete opacity and clear transparentness. Here is such a negative; and notwithstanding the fact that the opaque parts are not quite opaque to the sight, they are chemically opaque—that is to say, they will not allow the photographic rays to pass through. I have nothing to say to you regarding the making of negatives, as this matter belongs to photography proper, and not to our present subject.

Here is a sheet of paper which has been so prepared as to become darkened on exposure to light; let us place this behind our negative, and allow the light of burning magnesium to shine on the face of the negative. You see the result. Those parts of the paper which were covered by the transparent parts of the negative have become dark, while those parts which were protected from the light by the opaque parts of the negative retain their original white colour. Thus a positive print is obtained on paper; but if the paper print be now exposed to daylight the whole will become dark, the picture, consequently, disappearing.

This operation illustrates the first phase in the process of photographic printing as usually practised, the next step being that of unsensitising the paper, so as to prevent the complete darkening which would otherwise ensue on the further exposure of the print to light. Our object now is to study the means of producing printing surfaces (plates or blocks) from which copies can be printed without the direct action of light being concerned in the production of each print.

The piece of paper which I now hold in my hand is sensitive to light, and I will place it under this negative of a line drawing, and expose to the action of an intense light. You observe that a very faint brown image is now produced on the sensitive paper by the action of the light shining through the transparent parts of the negative; and I now hide this from your view by covering the face of the paper and a thin and uniform layer of printer's ink. For this purpose the ink is diluted with a little oil of turpentine, and applied by means of a dabber, made of the glue and treacle composition which typographic printers use for making ink rollers. The oil of turpentine soon evaporates and leaves a compact and thin film of printer's ink on the paper. I next put the inked print into water, and leave it there while I tell you how the sensitive paper was prepared. A sheet of plain paper is first floated on this warm solution of gelatine (containing six per cent of gelatine), and it is then hung up to dry (as I do now). When dry it is insensitive to light, and it may be kept any length of time without injury. To make it sensitive to light it is soaked for a few minutes in this solution of potassium bichromate, which contains about 3½ per cent. of the salt, and it is once more hung up to dry, but this time in a dark room, or in a room illuminated by yellow light. When dry, it is ready for exposure under the negative.

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* Being the Cantor Lectures delivered before the Society of Arts.

Let us now return to the inked print which we left soaking in water, and try the effect of gently brushing the inked surface with a wet camel's-hair brush. You see that the ink is gradually coming off, but in order to save time let us employ a little warm water, and, at the same time, continue to use the brush. Now the end of the matter is, that the printer's ink becomes removed from all those parts of the paper which were not exposed to the action of light, and an image in fatty ink is thus obtained on the gelatinised paper. From this I now remove the excess of water by means of blotting-paper, and lay the print, inked face downward, on a clean and slightly warm lithographic stone. The stone and paper being now passed through the press, you see that the paper adheres firmly to it, but on moistening the paper with a sponge it becomes easily removable. Now I strip it off, and you see that the fatty ink is fixed on the surface of the stone, leaving a perfect but reversed image thereon. Remember that this image consists of fatty printer's ink, and that it penetrates a short distance into the porous stone. Next, I put some thick gum water on the stone, and this also penetrates a short distance into those parts of the stone not already covered with printer's ink. I now rinse off the excess of gum and apply the inking roller; you see that the ink only adheres to those parts already inked, the gummed parts resist the ink, and consequently remain white. A sheet of paper being now laid on the stone, I now pass the stone and paper through the press, and you see that I get an exact counterpart of the original fatty image (technically called a transfer) which was put down on the stone. Numerous copies may be printed from the stone by repeating the damping and inking.

You will recollect that when the light brown image was inked with printer's ink, the ink covered the whole face of the paper, but when this inked image was put into water, the ink became easily removable, from the unexposed parts. Now, gelatine which contains potassium bichromate, undergoes a remarkable change when exposed to the action of light. It not only becomes brown in colour, but it loses its property of swelling in water, and, at the same time, it refuses to be moistened; in fact, water rolls off it just as from a duck's back. Now, when the inked print (transfer) is put into water, the unexposed parts of the bichromated gelatine swell, and loosen their hold on the fatty ink, while the exposed parts neither swell nor absorb water, but hold the ink firmly. In this dish are some uninked transfers, which have been soaked in water, and if you examine them closely you will be able to trace those parts of the gelatine which have swelled, leaving in each case a delicate *intaglio* image, or representation, of the negative employed.

Instead of putting the photo-lithographic transfer down on a lithographic stone, it may be put down on a zinc plate, and the plate can be printed from, if treated exactly as the stone was treated. There are on the table some zinc plates and stones, with images transferred thereon, together with proofs from them, and there are also specimens illustrating the various phases of photolithography and zincography. Messrs. Whiteman and Bass, who have been most successful in the commercial practice of photolithography, have kindly lent me some very fine specimens of their work, which I am sure you will examine with much interest. There are also on the table some admirable specimens of work by Mr. Maurice Adams.

You understand that, in its usual form, photolithography is only adapted for the reproduction of line subjects, or subjects in extreme black and white, and various attempts have been made to render it available for the reproduction of the gradations of a negative taken from nature. By a modification of Asser's starch process I have been enabled to get results which are at least encouraging. Here is a sheet of blotting paper, which I now cover with ordinary flour paste. containing 8 per cent. of flour. The paper having been coated, it is next smoothed with a soft badger brush, and when dry the paper is soaked in a 3½ per cent. solution of potassium bichromate, in order to make it sensitive to light. This piece of the sensitive paper being placed under a negative, and exposed to the light of burning magnesium for a few minutes, soon becomes tinted with a brown colour where acted on by light. The light brown print is next soaked in cold water, in order to remove *the unaltered portion of* the potassium bichromate, after which it is dried and ironed with a warm flat-iron. This last operation is to harden the coating. I now put the iron print into water, take it out, lay it on blotting-paper, and dab on printer's ink with a stiff brush. You see that the ink adheres to those parts where the bichromated paste has been made insoluble by the action of light, and it refuses to adhere to those parts where the paper remained unaltered. In this way a fatty transfer is obtained which, as you see by these examples, shows all gradations of a negative taken from nature, not, however, as a true half-tone, but as a grain or stipple well adapted for transferring to stone or zinc. As a fine image of this kind is liable to get clogged up when printed from stone, it is better to transfer it to a plate of zinc, and to make a typographic block from this by the method which I shall describe in a subsequent lecture. In the interval I will convert this zinc plate into a typographic block, and you will be able to compare these proofs, printed by the lithographic method, with others which I will take from the typographic block.

I hope some of you will experiment on Asser's process, with the view of improving it, as this method affords a promising field for work, it being specially adapted for large pictures.

A NEW CAMERA LUCIDA.*

THE various kinds of camera lucida hitherto used have always possessed many inconveniences, none of them allowing to be seen upon the paper with sufficient precision, and simultaneously, the image of the object and the point of the pencil. For the purpose of remedying this inconvenience, Dr. J. G. Hofmann, of the Rue Bertrand, Paris, has had recourse to an arrangement by which he believes he has obtained the most satisfactory results. The illustration will give some idea of this arrangement.

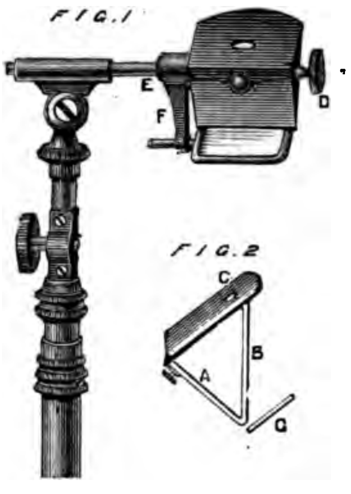
FIG. 1

FIG. 2

Fig. 1 represents the general elevation, in half size, of Hofmann's camera lucida the lower portion of the stem and stand being omitted. Fig. 2 is a transverse section of the optical part, composed, at A, of a metallised mirror, or other metallic surface, polished and rigorously plane; at B, of a small plane mirror of parallel glass, forming, with the metallised mirror, a fixed angle. The function of the latter is to let pass a part of the luminous rays coming from the object to be drawn, and to show at the same time the point of the pencil alongside the image upon the paper. At G may be placed, in a movable frame, either a plate with parallel surfaces, or lenses of neutral glass of various foci, the principal object of which is to enable a satisfactory drawing to be made of the objects placed inside, when using white paper; for the outside, this glass serves to temper the brightness of the sun. At C is the eye-hole or opening before which the eye is placed. The knob, D, serves to place the chamber in a convenient position, which sometimes depends on that of the artist with respect to the object; but generally it is convenient to place the mirror, D, vertically. With the same pieces of the optical part, with the addition of a concentrating lens, Dr. Hofmann has been able to construct a second model applicable to microscopes, for which, as well as for telescopes, all previous forms of camera have given only very mediocre results.

Transverse Vibrations of Liquids.—M. P. Dubois has conducted some experiments upon sand in Jamin's laboratory, substituting a liquid for sand as a means of making nodal divisions. Tinging water with vermilion, he obtains clearly marked equidistant stains, which furnish simple and satisfactory demonstrations of important acoustic laws.—*Comptes Rendus.*

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* From *Nature*.

SCIENTIFIC NEWS.

THE death is announced of M. Barthélemy du Mortier, who died on the 9th inst. at Tournai, in his 82nd year. He was the most famous botanist of Belgium, but latterly had devoted himself to politics. As a Minister of State he was enabled to do much for the study of botany, and the Botanic Garden at Brussels may be regarded as one result of his labours.

Mr. Edison, in a letter dated June 24, writes: —"I stated and proved nearly two years ago that conductors of electricity, when finely divided and moulded in the form of buttons, varied their resistance by pressure, and subsequently that the whole effect was due to surface contact, and not to intermolecular action. The explanation offered by Prof. Hughes is capable of being shown as absurd, and only tends to prove that he did not gain his information by experimental research, but simply by piracy." Nemo mortalium omnibus horis sapit!

The French voyage around the world, unlike the American Woodruff expedition, is an actual fact, the Junon, under the command of Lieut. Biard, being in readiness to leave Marseilles. The British and German proposals for a voyage of study around the world have ended in nothing, and it may be doubted if the French enterprise will be repeated. Only 25 passengers were obtained out of the 70 originally contemplated, and the mean fare is £800. That sum includes instruction at the hands of professors, and board, lodging, and conveyance for a space of 11 months.

The new magnetic observatory at Paulovsk was opened at the commencement of the week. It comprises three buildings, the principal being a stone erection surrounded by terraces for meteorological observations; there is a double arched structure in stone covered with earth for studies in magnetic variation, and a pavilion of wood, without a particle of iron about it, in which absolute magnetic measurements will be made, great care having been taken to prevent the use of any magnetic or magnetised substance whatever in its construction. For the present the work of the observatory will be directed to the observation of meteorological elements and terrestrial magnetism, and as soon as good methods have been devised, measurements of other elements will be undertaken. Dr. Wild, the director of the central Observatory of St. Petersburg, has charge of the arrangements.

Experiments made with the new model Gatling guns last week help to show that the time is approaching when an attacking force must be protected by strong shields proof against a perfect shower of bullets. At a target 1,000 yards distant 650 rounds were fired in less than 70 seconds, the canvas being literally cut to pieces. Subsequently, when the gun was tested for rapidity alone, case after case of cartridges was fired in about a second, or at the rate of 1,760 rounds a minute. The service Gatlings will cost a considerable sum to remodel, but a specimen so treated did not prove a serviceable weapon, so it is not impossible the newer guns will be ordered. They weigh 120lb. each, have ten 18in. barrels, and are fired by a crank handle at the rear, thus dispensing with the worm and wheel of the service pattern.

Mr. Barnaby is going to try the effect of other propellers upon the Iris, with the view of obtaining some trustworthy data. A two-bladed screw, having a very large surface area, is being fitted to each shaft, and it is intended, if possible, to try a four-bladed propeller of similar dimensions to that which gave the excellent results we recently described, but having a coarser pitch. The object is to reduce the number of revolutions, the stress on the engines during the 18½ knot speed trial being very heavy.

Some London warehousemen having returned goods to the manufacturers because the colours had faded, an inquiry was made as to the cause by Dr. Wallace, of Glasgow. London store rooms are usually lit by gas, and in many cases the goods are exposed to the products of gas combustion during the whole working day.

The cause of the fading is found in the action of sulphuric acid, many of the pieces of cotton goods returned containing that substance in notable quantity, while in some the fibre itself was actually destroyed. Dr. Wallace suggests, first of all, thorough ventilation, to remove the fumes of the gas; and, secondly, the use of lime-white on the walls and ceilings, renewed frequently enough to enable the acid vapours to find lime with which to combine.

On Saturday last an under-water man walked across the Thames at Greenwich dressed in diving costume, and accompanied by a barge conveying the pumping apparatus. It was nearly high water at the time, the journey across occupying 15 minutes, and the return 12 minutes. Capt. John T. Guire proposes to walk along the bottom of the Ohio from Cincinnati to Cairo, a distance of 500 miles, and to accomplish the journey in 25 days. He will be accompanied by a float carrying the requisite apparatus, but he claims the privilege of coming up whenever he deems it necessary, although he will walk every foot of the distance.

The two Popoffkas have been recently to the Danube to test their steering powers in a current. Against the stream all went well, but when an attempt was made to return, the vessels turned round and round, and drifted helplessly until, on reaching smoother water, the engines were enabled to regain the mastery over the current. It is perhaps only by an accident that our navy does not contain a few of these costly experiments.

A new fog signal has been erected at Cape Spear, Newfoundland. It consists of a trumpet sounded by means of compressed air, which can be heard at distances varying from 1½ to 10 miles.

The Dundee gas commission are thinking of putting Dr. Siemens' suggestion into practice by utilising the Reeky Linn, a waterfall 20 miles distant, as the motive power for dynamo-electric machines, the current produced being conveyed by a cable to Dundee.

In the year 1872 Count Mocenigo, of Vicenza, observed movements in the galvanometer arising from mechanical vibrations communicated to rheophores and a thermopile apparatus by slight blows. In this (according to M. Rossi in *La Nature*) he discovered the essential phenomena of the microphone. The apparatus was kept constantly acting, and the movements of the needle were produced naturally by unknown causes. Some were clearly due to changes of temperature, others to magnetic perturbation, and others did not appear to be related to any phenomenon. From the movement produced artificially by mechanical vibration, M. Rossi thinks it probable that a minute vibratory motion of the earth's layers may give a similar result. In this way he explains the mysterious perturbations of the galvanometer in telegraphic stations during earthquakes. Considering the microphone to be similarly an apparatus which manifests an alteration in electric currents through mechanical vibrations, he thinks it might be applied to seismological studies; it might reveal minute sounds which precede earthquakes—sounds which may often not be appreciable by the ear.

The *Samara Gazette* (Russia) has recently published statistics of the havoc caused by wolves within the limits of the province. The animals devoured in 1876 amounted to 5,880 horses and horned cattle, 56,000 small cattle, 22,000 domestic fowls, and more than 1,000 dogs. In 1877 their ravages were even greater. Estimating at moderate prices the value of the animals devoured, the loss during these two years is considered to be about 620,000 roubles (the rouble equal to 3s. 2½d.)

M. Cintolesi states in an Italian journal that in looking through the slits of a rotating disc at a white wall illuminated by the sun, one sees this coloured a beautiful violet tint when the velocity of the disc is such that about $\frac{23}{1000}$ of a second elapses between the passage of two successive slits before the eye.

Some interesting particulars regarding an earthquake which occurred at Herzogenrath in June last year, and spread from this centre over a large part of the Rhine province, have been published by M. Lasaulx, who has closely studied the phenomenon. Over the whole surface affected by the earthquake a combination of horizontal and vertical motion was perceptible. The sound accompanying the earthquake preceded it near the middle point, but at a greater distance followed it, thus indicating that there was a greater retardation of the sound than of the motion. The mean velocity of propagation of the earthquake is calculated to have been about 3·85 miles in the minute, or 474·83 metres in the second. The mean velocity of the sound is estimated at 3·93 miles a minute, or 485·96 m. a second—*i.e.*, 1·4 times as fast as the velocity of sound in air. The depth of the starting point of the earthquake is supposed to have been about 3·664 miles.

One of the best fishes of the Celestial Empire appears now to have been successfully acclimatised in France. It has been called variously *Hypophthalmychthys Dabryi* and *H. Molitrix*, and is a cyprinoid, which the Chinese have classed among their domestic fishes, the extensive cultivation of which is one of the most valuable sources of public alimentation in the empire. It is reared in ponds by means of aquatic herbs (such as France happily possesses), and in a short time it acquires considerable dimensions. Its weight sometimes reaches 40lb., the flesh is firm and savoury, recalling at once the taste of turbot and of trout; further, it has few bones. The first attempts which M. De Thiersans made to introduce this species into France were in 1875, when he sent from Canton, for the Société d'Acclimatation, 9,000 fry, of which 9 only arrived at Marseilles. They were confided to a delegate of the society, who constructed a pond for their reception. During these four years the young fish have grown large, and appear to be flourishing. The society has given orders for a number of others to be sent, so that it is hoped the new importation will become a common ornament of ponds, and a delicacy of the table.

The tomatoes in the environs of Nice present this year quite a new form of disease. It consists in the appearance on the fruit of white efflorescences, similar at first sight to the oïdium of the vine. The results of microscopical examination have not yet appeared, but doubtless naturalists will thoroughly study it.

A new direct-vision spectroscope, by M. Thollon, is based on the idea of sending the light rays first through one (say the lower) half of the prisms, then by total reflection twice at the surfaces of a rectangular prism, elevating them and reversing their direction, so that the bundle of rays returns by the upper half of the prisms. M. Thollon arranges two prism systems of this kind symmetrically to the common axis of the collimation and observation tubes, causes the rays by total reflection to be deflected about 90 degrees, and pass to and fro through the first system of prisms, the return being at the higher level. The rays next pass into the upper half of the second prism system beyond the optical axis, return from this to the original level, and are thrown by a further total reflection into the observation tube.

At a recent meeting of the French Physical Society M. Deprez suggested a means of obtaining at a distance diagrams representing the work of steam, in cases where the velocity of the piston was too great for Watts' indicator to be usefully employed, as in locomotives. His plan consists, first, in having a sheet of paper in one of the carriages, moved synchronously with the movement of the piston-rod; second, in registering electrically the pressure of the steam at a given moment. For further details see *La Nature* of July 13.

An apparatus, recently devised by M. Bartoli, offers an elegant realisation of an idea which is not novel, and which consists in proving the existence of a very weak current by employing the invisible bubbles which it produces on an electrode of platinum wire, to cause a violent ebullition in a superheated liquid. The platinum wire, rendered inactive by a suitable process, is placed in the superheated liquid, and terminates in the upper part of a small capsule, which is suddenly emptied of its water through the vapour formed in it, when there is passed by the wire a current of discharge of a Leyden jar, or simply the spark of a good electrical machine.

LETTERS TO THE EDITOR.

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[We do not hold ourselves responsible for the opinions of our correspondents. The Editor respectfully requests that all communications should be drawn up as briefly as possible.]

All communications should be addressed to the Editor of the ENGLISH MECHANIC, 31, *Tavistock-street, Covent-garden,* W.C.

All Cheques and Post-office Orders to be made Payable to J. PASSMORE EDWARDS.

*** *In order to facilitate reference, Correspondents, when speaking of any Letter previously inserted, will oblige by mentioning the number of the Letter, as well as the page on which it appears.*

"I would have everyone write what he knows, and as much as he knows, but no more; and that not in this only, but in all other subjects: For such a person may have some particular knowledge and experience of the nature of such a person or such a fountain, that as to other things, knows no more than what everybody does, and yet, to keep a clutter with this little pittance of his, will undertake to write the whole body of physicks: a vice from whence great inconveniences derive their original."
—*Montaigne's Essays.*

◆

MR. EDISON'S REPLY.

[14625.]—I HOPE you will be able to afford space* for the publication of my reply to the telegram of Messrs. Preece and Hughes, printed in your issue of June 28. The reply is printed in the *New York Tribune* of June 27, 1878. I notice an article in the same number headed "Who Invented the Microphone?" Allow me to state that the writer has evidently obtained the technical information from *Engineering*, to whom, at my request, Mr. Prescott sent proofs and cuts of that portion of his work on telephony descriptive of my carbon telephone. The article as published in that journal has been mutilated, and credit is given Prof. Hughes for exactly what has been suppressed from the proofs sent. Your article, however, contains one short sentence, which did not appear in *Engineering*, which nullifies one of the distinctive claims of Prof. Hughes. I quote:—"The inflexible plate of course merely serves, in consequence of its comparatively large area, to concentrate a considerable portion of the sonorous waves upon the small carbon disc. A much greater degree of pressure for any given effort on the part of the speaker is thus brought to bear on the disc than could be obtained *if only its small surface alone were used.*"

Beneath this sentence the writer says:—"Let it be remembered that in the microphone there is really no diaphragm at all, and it is clear that Mr. Edison has written under a misapprehension, for his inflexible plate is, to all intents and purposes, a diaphragm."

The words that I have italicised surely mean, if they mean anything, that I did just what Mr. Hughes claims as a distinctive feature—*i.e.*, talk directly against the carbon. But, finding the results improved by adding the plate to concentrate the waves upon the disc, I adopted it as a practical improvement, especially as it prevents the spittle from being absorbed in the carbon.

The following paragraph was suppressed by the writer in *Engineering*. "* * * I discovered that my principle, unlike all other acoustical devices for the transmission of speech, did not require any vibration of the diaphragm—that, in fact, *the sound waves could be transformed into electrical pulsations without the movement of any intervening mechanism.*"

Again, the writer in your paper says that Mr. Hughes "went very much farther and beyond (Edison) by discovering that all conducting substances may be employed with 'equal success.'"

I quote another paragraph suppressed from *Engineering*:—"Mr. Edison has found, however, that plumbago, hyperoxide of lead, iodide of copper, powdered gas retort carbon, black oxide of manganese, amorphous phosphorus, finely divided metals, and many sulphides may be used. Indeed, tufts of fibre, coated with various metals by chemical means, and pressed into buttons, have also been employed, but they are all less sensitive than lamp-black, and have consequently been abandoned."

Now, if Prof. Hughes has found any other substance not included in this list that may be used with "equal success," I should like the name of it; but, above all, I should be happy to learn for what purpose the paragraphs quoted here were suppressed by the compiler of the article in *Engineering* on my carbon telephone. **Thomas A. Edison.**

Menlo Park, N.J., U.S.A., July 11.

MICROPHONES AND ELECTRICITY.

[14626.]—THE inventions of the last few months have interested me immensely, and, finding your correspondents' experiments very interesting to me, I send you some of my experiences and ideas. I have made telephones, microphones, and a phonograph, all of which work satisfactorily, but find the microphone the most interesting. I have made them in several different ways, and am sorely puzzled to know why they vary in their force. For instance I have a watch laid on my microphone box, and the telephone (a powerful horse-shoe box telephone), in another room, sends forth a loud sound, which is distinctly heard 20ft. off, but what I have failed to account for yet is a variation in power. It is generally instantaneous, but has sometimes grown weaker gradually; sometimes the watch will cease to be heard, except by placing the ear close to the telephone mouthpiece, and then only very inwardly, and perhaps remain so for ten minutes, then all at once commence loud operations. This occurs without my being able to notice any apparent cause. Thinking at first it was from a fly settling on the balanced carbon I have covered it from all outward interruption. The shake of the room from vehicles passing, opening and closing doors or windows, does not cause it, as I have tried to cause it and have not succeeded. The sounds vary sometimes like sounds carried away by the wind, at others there is a singing and jarring noise; when that is heard the electric spark is generally visible between the carbons in the microphone. Your correspondent, "L. B. B." (14548), speaks of this, I see, but I don't think his idea is a correct one, for I find the cause of that to be lightness of contact. The microphone I have heard it oftenest with is the balanced carbon (No. 14505, p. 393), and it generally occurs when I am getting the tension right. For instance I lay a watch on the microphone, and then adjust the balance of my carbon to get the best result, but find I get the singing when the carbon is overbalanced, so that it would fall off if there was no electricity passing (for electricity attracts with very light contact), so I think the singing is caused by the rush of electricity—in fact you hear the current passing.

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* We have already referred to Mr. Edison's reply on p. 433, and again mention it this week.

I cannot help thinking the microphone will be a great assistance to finding out something more than we know about electricity at present. For instance, with its assistance we can hear sound—in fact, I say *hear* it; by placing the two wires on the tongue, not quite close together, you can *taste* it. With a watch beating on the microphone you can *feel* it in the telephone, and between the carbons, with careful adjustment, *see* it, and see also that it has the power of attraction.

I find it possible to hear musical sounds from the microphone to telephone without *any connecting wire*, but they are so weak that they are useless at present. Thinking perhaps others may be able to improve upon it I mention the experiment. Attach one wire of your telephone to the gas-pipe, and put the other wire in the earth; now go to some other part of the house and attach one wire of the microphone and battery to the gas-pipe and the other to the earth, and you can hear a tuning-fork, either its tone or the chatter occasioned by it, when the ends are allowed to touch the diaphragm, but cannot hear the voice. The experiment shows that the gas-pipe is a conductor, and may yet be utilised.

I have forgotten to mention that I have the "phonograph transmitting funnel" on my large telephone, for the microphonical results. I also have two hand telephones attached, as I like to let those who listen use both at the same time, so that they may experience that peculiar sensation of not being able to hear in either ear, but hear and feel the sounds at the back of the head. I have made an articulating microphone like one suggested by R. Blakeborough, F.G.S., F.M.S., &c., but do not find it answer better with the magnet than without. I suppose the fault is mine, but cannot trace it yet.

Rye. **J. N. Masters.**

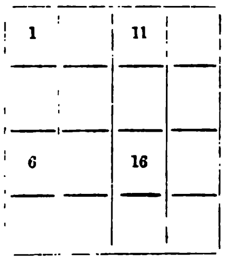
THE MICROPHONE AND THE TELEPHONE.

[14627.]—I READ Mr. Edmund P. Toy's letter (p. 443) with much interest, as his experiments and opinion seem to confirm mine. When I speak of more or less contact I mean practically. Theoretically the molecules are not actually touching even if the substance be rigid. The fly in walking causes more or less contact in the microphone. If he (the fly) buzzes, make or break contact may be the result. This is the loudest noise heard in the telephone as receiver, but this, in my opinion, does not represent the true sound—the fly simply shakes the microphone and the telephone registers the time. It does not seem to occur to most experimenters that if the fly were placed direct in the ear the result of true sound would be better than with the microphone. The same may be said with respect to using the microphone for surgical purposes; the beating of the heart varies the contact. The sound is heard more perfectly by placing the ear direct to the source of sound. I look upon the microphone as a means of conveying sound to a distance, not at all as magnifying true sound. I should like to know whether the telephone is as sensitive to induction, using the microphone as a transmitter.

R. G. Bennett.

MAGIC SQUARES.

[14628.]—UNLESS I have mistaken his meaning, I think "Amara" (14604) is incorrect in stating that *all magic squares have complementary figures* opposed; see my cases of square of 4 in 14500, page 373, where they are opposed on the diagonals of squares of 3.



&c.

The 3 forms given in my letter are equivalent to 16 forms each.

1	14	11	8*
12	7	2	13
6	9	16	3
15	4	5	10
1	14	11	8*

*				*
1	14	11	8	1
12	7	2	13	12
6	9	16	3	6
15	4	5	10	15

by performing the transpositions there referred to.

Can any correspondent say how many forms the square of 4 admits of? And how can it be proved that no other are possible?

The analytic method is not a safe guide, because (1) it gives dummy square in which some numbers are omitted, and others put in more than once; (2) it does not give every possible form. The analysis I refer to is to look on the numbers as multiples of the root plus the remainder—thus, 15 = 4 × 3 + 3. Two subordinate squares are formed in one, and the contents of each cell added to the corresponding cell of the other to fill the cells of the perfect square.

$$\begin{matrix} 0 & 3 & 2 & 1 \\ 2 & 1 & 0 & 3 \\ 1 & 2 & 3 & 0 \\ 3 & 0 & 1 & 2 \end{matrix} + \begin{matrix} 1 & 2 & 3 & 4 \\ 4 & 3 & 2 & 1 \\ 2 & 1 & 4 & 3 \\ 3 & 4 & 1 & 2 \end{matrix} = \begin{matrix} 1 & 14 & 11 & 8 \\ 12 & 7 & 2 & 13 \\ 6 & 9 & 16 & 3 \\ 15 & 4 & 5 & 10 \end{matrix}$$

Here is one instance which violates the analysis, and yet is perfect:—

1	2	16	15	0	0	3	3	1	2	4	3
13	14	4	3	3	3	0	0	1	2	4	3
12	7	9	6	2	1	2	1	4	3	1	2
8	11	5	10	1	2	1	2	4	3	1	2

The diagonals in the analysis violate the rule.

It is worth notice that if any even square be cut in quarters, and these transposed, the upper two to the bottom and the right hand to the left, a new perfect square is formed. Thus from the above we obtain—

9	6	12	7
5	10	8	11
16	15	1	2
4	3	13	14

It is evident the diagonals are preserved as well as the rows and columns.

I have gone to a good deal of trouble to try and discover an exhaustive law, and I have succeeded in discovering proofs that the number must lie within certain high numbers; but I have not yet got a definite result. I should be glad to have the formulæ of Messrs. S. and J. Jewsbury.

Leeds. J. G. F.

ON THE AGE OF THE EARTH.

[14629.]—IN your article in last week's issue bearing the above title, a very able review is given of the Rev. Prof. S. Haughton's paper, more especially bearing upon his theory of the glacial periods, &c., and the said article concludes with a query as to what are the general opinions of geologists and physicists with reference to the conclusions arrived at by the professor. It may be interesting to your readers to compare the views held by Dr. Croll and Mr. Sydney Skertchley, on the same subject, as laid down in that excellent work "The Physical System of the Universe" (an excellent manual for the careful student), by Sydney Skertchley. London: Daldy, Isbister, and Co., 1878. After disposing, in a most masterly manner, of the arguments brought forward by Messrs. Drayson and Belt, with reference to the variation of the obliquity of the ecliptic, and consequent shifting of the position of the poles, and proving by close reasoning, that any such variation, far from being followed by an increase in cold, would actually cause the polar regions to become excessively hot, or, in our author's own words, "Not only would every particle of ice be dissipated in polar regions, but the very seas around the pole would be, for several months in the year, at the boiling point," Dr. Croll's theory is then subjected to careful examination, with results that tend to show that his theory accounts in a most satisfactory manner for the glacial and interglacial periods, without necessitating the belief in any extraordinary variation in the obliquity of the ecliptic, or any alteration in the equatorial bulge. Mr. Skertchley says:—"Dr. Croll's theory is, that the
changes of climate are the indirect results
tions in the eccentricity of the earth's orbi
precession of the equinoxes, &c. These astr
phenomena we have already described (p. 1
it may be as well to recall the fact, that, i
quence thereof, the orbit is being continua
gated and being brought back almost to ci
again, and that summer and winter, in th
of a long series of years, occur in all par
orbit. At present the eccentricity is small,
northern winter occurs in perihelion, or w
earth is nearest the sun. The theory we a
to elucidate affirms that when the northern
in aphelion at a time when eccentricity is
northern hemisphere will be glaciated,
southern hemisphere be enjoying an int
climate; but this result is brought ab
secondary causes. We will proceed to sho
that a glacial period would not result direct
these causes; and, secondly, how a glacial p
produced indirectly. The first point can b
in a few words. The total quantity of heat
from the sun during one revolution is inver
portional to the minor axis of the orbit; an
difference of the minor axis at the periods
mum and minimum eccentricity is only a
1,000, the quantity remains practically th
and can have little or no influence upon
It is quite otherwise when we consider the
effects of variations of eccentricity. Tak
mean distance of the sun as 91,400,000 m
we have done throughout the volume, we
when the eccentricity is at its superio
(0 07775) the aphelion distance is 98,506,35
the perihelion distance 84,293,650 miles,
difference, consequently, 14,212,700. The
of heat received by the earth in these two
is as 19 to 26. Let winter in the norther
sphere (and for the future, when winter
mentioned the northen winter will be und
happen in aphelion, when the eccentricity
superior limit, as it must have done owing
cession. The earth will then be 8,641,87
farther from the sun in winter than at pres
the direct heat received will be one-fif
and during summer one-fifth more tha
Next let winter occur in perihelion wh
eccentricity is at its greatest. The earth w
be 14,212,700 miles nearer the sun in winter
summer. The winter will then be comp
warm, and in our latitude the difference of
ture between summer and winter will be
annihilated. Now, as winter in one hen
corresponds with summer in the other, it
that while one hemisphere would be endu
extreme of summer heat and winter cold (a
first illustration), the other would enjoy a p
summer. From this we gather (1) that t
of high eccentricity with winter in aphelion
duce extremes of heat and cold in that hem
and to minimise the difference of summer a
ter temperature in the other; and (2) tha
the one hemisphere is being glaciated, the
passing through an interglacial epoch."

After some further elucidation of this theo
Skertchley sums up in these words:—

"Here we have a complete explanatio
cause of interglacial periods. The eccentric
and, indeed, actually does, remain high for
which may be measured by hundreds of th
of years, during which time the solstitial po
many times complete their revolution, a
give rise to alternate glacial and interglacial
in each hemisphere. But the theory does
us even than this. It gives us the date of the
period, which began about 200,000 years a
terminated about 80,000 years since. Dur
long era, glacial and interglacial periods, of
or less intensity, alternated at intervals
10,000 to 15,000 years." (See p. 323 et. seq
above-mentioned work.)

I believe that the above explanation is i
way satisfactory, and in accordance with the
facts; but it shows that the earth's age ca
deduced from the glacial periods, as these ha
many, and alternating with periods of tropic

S. Bot

CLUBBING IN THE BRASSIC

[14630.]—A FEW years ago (p. 642, Vol.
and p. 171, Vol. XVIII.), I ventured to sug
reply to a query, that the cause of club
Brassicæ was not rightly understood, and
of your correspondents were kind enough t
my remarks and give the results of practic
rience in connection with club-root and amb
that time "clubs" were supposed to be ca
either the cabbage-fly (Anthomyia brassicæ
species of Cynips, though some writers h
gested that a weevil had a hand in their prod
I pointed out certain facts which prevented
accepting the usually received dictum (ga
duced by a Cynips), and ventured an opini
"clubs" were not due to insect agency at
the simple reason that I had found many
the ghost of an insect visible. I also sugges
the subject was worth more inquiry than it h

ɔd. That was in 1873. I find, from an in *Nature*, of July 11, by Mr. E. Percival ɩt, that in the *Botanische Zeitung* for May 75, there appeared a short abstract of a paper y M. Woronin, before the Botanical Section Natural History Society of St. Petersburg, on ı of March of the previous year, on the cause disease, and within the last few weeks he has ɔd the full memoir, illustrated with upwards r figures. The memoir, says Mr. Wright, is ısian, but, thanks to a colleague (Prof. R. ɔon), he has been able to glean a notion of its interesting contents, in which he has been assisted by the beautiful figures. The disease ıown in Russia as "Kapustnaja Kila" sta = Cabbage, Kila = Hernia). About years since it was so extremely prevalent that ɡetable crops about St. Petersburg failed, ɪe Government ordered an investigation, from much information was obtained as to the adopted in different countries for its cure; ɑ sowing the ground, before planting the vith common salt, wood ashes, or, before all, Every one knows, too, that in transplanting ıng crucifers into their permanent beds that ıstomary to pinch off the swollen portions, n, if favourable weather followed, the newly- roots could well keep ahead of any fresh ınce of the disease. But M. Woronin went ically to work, and he was not long in dis- g that the cause of the disease was a parasitic ɪe which seemed to have some affinities with yxomycetes on the one hand, and the ıiaceæ on the other, and the results of con- ɪsearches carried on through 1875, 1876, and ar, have resulted in nearly the whole life- of this new plant being discovered. It is *ʾlasmidiophora brassicæ*, and is decidedly ɑrly allied to the Chytridia, but the new f this group daily coming to light, appear rent in their development that much more ɜ known about them ere any satisfactory ation can be attempted. One most striking in the new plant is indicated by its generic this will be best understood by a short his- the plant's life. Take an old well-developed f a club-root, and examine the tissue; most arenchymatous cells will be found enlarged, arcby contents gone, and they themselves with a mass of spore-like bodies; by the r disintegration of the cellular tissue these will get released, and after a lapse of six ɪt of each spore will proceed the whole of ents, which, colourless, but nucleated, will out like so many minute amœbæ; these ıa will then attach themselves to the deli- ɪt-hairs of the nearest young cruciferous

One end of the plasmodium is attenuated lium. The spores soon penetrate into the ıere they will look just like Myxamœbæ. ɪe cells up with delicate plasmodic projec- ɪey will next soon develop lots of spores, ll further contaminate the cellular tissue of , and in process of time the formation of ɔing will be seen.

ımes the ripe spores are spherical, some- ɪy are twin-like, or lenticular. If cabbage seeds be sown in a watch-glass and sup- h distilled water, and shortly after the earance of germination, a number of spores *ɪdiophora brassicæ* be added to the water, ll be found to at first float freely in the ut sooner or later will sink and attach ɑ to the delicate root-hairs of the little , and in this way their whole history, so v known, may with facility be traced. It ɪeworthy that the whole mass breaks into at once, as in Chytridium proper. There ɪm to be as yet no conjugation detected, ɔlasmodia would appear as if they abso- ɪulfed the starch granules on which they

ıo apology for requesting the insertion of ʾ, as I think now, as I thought before, that similar subjects will well repay those of ers who have the leisure and means to ɦ the microscope. A knowledge of the disease is the surest means to devising a ɑd certainly the study of such subjects as ıb-roots in cabbages" is of more value resolution of difficult diatoms, which be after all veritable chameleons.

Saul Rymea.

. AND N. W. R. ENGINES.

]—In answer to "L. L." (letter 14493, p. ɪeason the engines now working the news- ress from Rugby to Manchester do not fore 2.0 p.m., is, that there is another ɡine at Crewe to take up the 3.0 p.m. ex- ɪe, which engine has come from Rugby at ., arriving at Crewe 1.12 p.m., leaving arriving at Euston 7.10 p.m., leaving , arriving at Rugby 11.20. No. 868 to w in the sheds at Rugby; 887, Knowsley; ɦam; and 847, Odin, are running in their fancy "W. J. S." must be wrong about Penrith Beacon, 2,187, being the up Scotch express (4.25 p.m. express Crewe) on 19th or 20th of last July, as she was at that date at Crewe running to London in the No. 1 link, which she has done ever since she was built, and London engines, 2,191, 2,184, 2,194, 1,002, 1,003, 871, 872, 1,008, were running that train in July last year.

Some weeks back I saw a query, No. 32608, which has not been answered, I believe. L. and N. W. R. Bloomer engines have inside cylinders single framing, and are not coupled. Miranda, 1,897, No. 2 Rocket, 1,810, are the same class: they have outside cylinders 7ft. wheels, and are similar to Edith, 1,427; Alfred Paget, 1,429; or Lady of the Lake, 531, only smaller. There are not many of the class. The following I know:—Centaur, Raven, Pegasus, Etna, Marathon, Euston, and one or two more. This also answers query 33428, p. 457. "R. N. H." must not confuse the new coupled engines now running the 2 p.m. London train from London-road. Most of the Bloomers have cabs over the footplate, but not all. 887 has not, nor 898, 1,198, 1,200, 991, 849, 850, 854, 891. Next week I will give a list with numbers of the Bloomers, and they will be useful for reference; and, if any reader cares for them, I will, by classes, give all the N. W. R. engines in a few weeks—one class at a time. The tractive force of Precedent class (query 33414) is 98·222, of Umpire, &c., class 82·6571, and of Lady of Lake 77·066. I believe the engines numbered from 1,427 to 1,436 are the newest of this class. I will see 1,436, and get date. The Precedent class runs Scotch mail from Rugby to Crewe, and then Crewe man, with same class of engine, takes it to Carlisle. The engines mentioned on page 316 are as follows:—561, Prince Oscar; 622, Prince Alfred; 991, Japan; 891, Trentham; 887, Knowsley; 895, Torch; 565, Napoleon; 723, Clive; 804, Soult; 531, Lady of the Lake. All others are Webb's coupled, and will be found in the list I give in this week.

Egeria.

LOCOMOTIVE ENGINE SHEDS.

[14632.]—As there have been several inquiries in the English Mechanic as to where certain locomotives are stationed, the following table, though incomplete, may be of service to parties who would like to know where engines on the L. and N. W. belong. On the tender side of the weatherboard, or on the back of the cab, is an oval-shaped white enamel tab, with black figures on; the number on this tab denotes the shed the engine belongs to. I do not know them all, but I give what I can:—

No.	No.
1, London.	22, Holyhead.
8, Rugby.	23, Warrington.
14, Stafford.	24, St. Helen's.
15, Crewe.	25, Wigan.
16, Manchester.	26, Liverpool.
17, Leeds.	27, Preston.
18, Birkenhead.	28, Carnforth.
19, Chester.	29, Carlisle.
21, Bangor.	30, Shrewsbury.

Perhaps our L. and N. W. correspondents can supply the missing numbers.

On the Midland line the name of the driver and the shed he was at was painted on the engine headlamp, but I cannot speak for the present time, though I have no doubt the plan is still in use. Drivers on some of the M. S. and L. engines have the same painted on the small tool-box.

July 20. **R. N. H.**

SINGLE v. COUPLED ENGINES.

[14633.]—I am somewhat amused at the varying criticisms my letter (14535) has called forth. I read some of your correspondents' contributions with interest, but cannot see why one or two should fall foul of me. I travel about once every week on either of the lines in question, and have every opportunity for observing what I wrote about. It is evident "L. L." has not noted carefully my letter which he corrects. The 39 miles an hour I adverted to referred to the past L. and N.W. running, when they took 50 minutes for the 31 miles, which I beg again to say is not much above 39 miles an hour, and I am perfectly aware that the present speed is as mentioned by "L. L.," which still bears out my remark that even the present running is not as good as the Cheshire L. Com. doing the 36 miles in the same time, and that the Cheshire Lines Committee coming forward to do it in 45 minutes compelled the L. and N.W. to do it also in the same time by their route.

I beg also to say that "Finem Respice" need not consider me "unfortunate," as I was simply speaking of the fast running on the rival lines without deciding the point that a company owning "one-third" jointly, yet may not be spoken of as among the company's running trains therefrom. I may leave other critics alone, as their own letters do not coincide.

In conclusion, I beg to point out that the 10 a.m. from Euston runs at 45·5 miles an hour average, which "slightly exceeds" 41, as my friendly critic, "L. L.," mentions.

I observed an inquiry, I forget by whom, what engines had the company's arms painted over the driving wheel. In my journeys about here I have noticed it on the following engines:—Perseverance, Sir Hardman Earle, Albion, Gladiator, and Dunrobin.

W. J. S.

CONTINUOUS BRAKES.

[14634.]—As this subject is again under discussion in your columns, perhaps the following incident may prove of interest. On 5th January las I left Paddington by the 10.15 a.m. South Wales express. When between Woollaston and the Wye Valley junction, our driver saw a heap of stones on the rails ahead and applied the brake (I presume Sanders'). We were going at a very humdrum pace at the time, but the stop didn't strike me as anything out of the way, but seemed very much the same as the ordinary stops we had made at the stations. To my mind it was vastly inferior to stops that I have experienced at times on the Midland when signals have been against us. Of course, this was only my impression at the time, but for other reasons (with which it is not worth while troubling you), I believe that we ran a considerable distance before we stopped. The train was a light one.

W. E. H.

[14635.]—Permit me to suggest that in giving the result of experiments tried with the above, the level of the permanent way and the state of the atmosphere should be given, as a difference in either would materially affect the trial. **J. W. Terry.**

Eastern Bengal Railway, Calcutta.

[14636.]—Mr. R. D. Sanders (letter 14608) leaves readers to "draw their own conclusions," and he will consequently not be surprised if they do; but I suspect their conclusions will not be favourable to his claims. He devotes nearly a column to demolish "C. E. S.," but omits to notice my modest hint that he should supply the "manner" in which his wonderful stops were recorded, and my pointed question—"Will Mr. Sanders challenge" the Westinghouse brake to a trial? Now, before I avow my "conclusion," will Mr. Sanders answer one question?—Is not the "extract" which he quotes from Mr. Westinghouse's circular (p. 473) a *réchauffé* of the description of the Sanders brake, published previously by some one else. If it is so, why does Mr. R. D. Sanders occupy a column in the endeavour to prove that "C. E. S." has taken his description from Westinghouse's circular, when he could obviously have taken it from the Sanders "circular"? I do not know, of course, that he did do so, but he says, p. 443, "my drawing was made by myself from an official diagram," and "the description I gave" was supplemented by "information sent to me not long ago from the Sanders Brake Company." It is reasonable to conclude that the Sanders Company issued a description of their brake, and that "C. E. S." took some of his facts from it. Mr. Westinghouse has it appears also given a description, and in the fairest manner has taken that furnished by the Sanders Brake Company. But what has all this mixing up of "extracts" to do with the question? I do not find that Mr. Sanders has proved any of the statements of Mr. Westinghouse or "C. E. S." to be incorrect, and the whole subject will have to be rebeiled if Mr. S. expects to "extract" any wrong conclusions from it. Once more, will he show his faith in the superiority of his brake by challenging the Westinghouse brake to a practical trial?

Nun. Dor.

[14637.]—I have been watching with great interest the discussion which has for some weeks been going on respecting the subject of continuous brakes, more especially the Sanders' brake. The letter of "C. E. S.," page 315, gives a description of this brake as used on the Great Western Railway, and from my own knowledge I am enabled to say that the drawing and description are perfectly correct.

Upon page 397, R. D. Sanders gives a drawing of his brake as used upon the Midland Railway. The reason that these two drawings are not alike has not been pointed out. It is that Mr. Sanders has altered his brake. A great deal has been said about a circular issued by Mr. Westinghouse. I have read this circular and all the statements therein made are well known to be correct and can easily be proved.

Mr. Sanders upon page 473 makes a quotation from the Westinghouse circular and "C. E. S.'s" letter, with a view to show that one is a copy of the other. There is no proof of this, as before either of them was published the same information was given in an official description. Part of it also was given before the Mechanical Engineers in January last.

"C. E. S." has several times denied that he belongs to any brake company, and as he is an old and valued correspondent of our paper, I think his word should not be doubted unless positive proof can be given. I for one should be very glad to know once for all if "C. E. S." has or has not any private interest in any brake company. Could our Editor ascertain this,[*] or can Mr. Sanders prove his insinuations? I cannot understand Mr. Sanders declining further correspondence with "C. E. S." A party of engineers remarked in my presence to-day that it looks as if he does not know what to say.

The point in question is, has "C. E. S." made any incorrect statement about the Sanders brake? If so, by all means Mr. Sanders should at once point out the error. If he cannot do this "C. E. S.'s" statement must be correct. The only interest I myself have in the brake subject is that I desire to see a fair discussion in the English Mechanic, and to see the best brake adopted as soon as possible.

July 19th. **Locomotive Engineer.**

MONOPOLY OF LAND AND SCARCITY OF HOUSES.

[14638.]—"Pioneer" (14596) invites us to consider the question of what he calls "the monopoly of land," which, he says, "ought to be for ever abolished in order to stimulate industry, advance science, and extend commerce." Will he be kind enough to take the first step in the consideration by explaining what he means? He has either fallen into the common mistake of writing a quantity of fine-looking phrases without knowing what he means by them, or else he means something which he does not say plainly.

Monopoly means the right of prohibiting other people from selling what they have to sell. A patentee has the exclusive right of selling what other people could make and sell as well and cheap as he can. In countries where protection prevails native manufacturers exclude foreign goods which could be sold cheaper than their own. If the English masons could have excluded foreign ones last winter they would have had a monopoly of masonic labour here, and raised the price of houses still higher.

Of course nobody can sell a given piece of land except the owner of it, any more than anybody can sell a particular picture, or horse, or house, except the man who owns them. And the price of all these things depends on the amount of competition for them, and in some measure on what they cost to produce. I should like to know how "Pioneer" seeks to alter all that. At any rate he must begin in some more rational way than by calling it monopoly, and by talking of a "well-established union of landlords," which every newspaper full of advertisements of land to be sold by auction proves to be untrue and absurd. Perhaps he fancies it would do him some good if the owners of land near towns were compelled to sell it for building either by arbitration or by auction. If he does he had better consult somebody with a little experience of what are called compulsory sales as to the cost of land bought by that process. All building land is sold by auction in effect, for the builders or "feuars" (as he is talking of Scotland) are always bidding against each other as much as at a formal auction. Whatever vision he may have of some cheaper mode of getting land, that will do practically nothing for him unless he has another law ready to make the builder let the house he builds at a rent satisfactory to him who wants to live in it. And then there must be another to compel the men who work for the builder to do more work for the same wages, or else the builder will decline to build. Everybody knows that the chief reason why houses cost twice as much as they did 30 years ago is that the workmen do less work for the same wages than they did then.

Let me, however, recommend to him what an eminent countryman of his did to a seller of brooms who complained of being undersold by another, which, he said, he could not understand, as he stole all his materials from the neighbouring woods. Lord Erskine answered that his rival probably stole his brooms ready made. Why does "Pioneer" stop at coveting his neighbour's land? Land is only the means to an end. It will bear either houses, or corn and potatoes, or sheep and oxen. Why should the owners of them have the "monopoly" in the sense of selling them for as much as anybody will give, which is his notion of monopoly? The only remedy for this "injustice to the working class" is to go in for stealing their brooms ready made—*i.e.*, for taking any house they fancy at a price to be fixed by themselves, while, on the other hand, their union is to fix the price they are to receive for their labour. I have had to buy land and build houses myself, and it would have been much nicer if I could have got them ready-made at my own price. The only difficulty is that in a short time there would be neither houses built nor labour hired, and we should relapse into the condition of savages, who literally live from hand to mouth.

The publication of this kind of communistic nonsense now proves that the "worthy sons of labour" and "the intelligent of the working class" (if "Pioneer" claims to be one) have learnt nothing yet in the school of adversity, which they have been preparing for themselves for years, and still maintain at a rate ten times more burdensome than the highest School Board rate in the kingdom. Until they do learn better neither the good harvest we are expecting, nor the Berlin peace, nor anything else, will do them any good, but rather harm, by giving temporary encouragement to suicidal delusions. Such doctrines as "Pioneer's" can only lead his followers to **Ruin.**

A TRANSLATING MACHINE.

[14639.]—It is with some reluctance that I venture to introduce to the notice of your readers a subject which has long occupied my mind, but which, from the many difficulties which beset it, I have never before dared publicly to discuss. It is *a machine for translating foreign languages.*

This may sound oddly, and be suggestive of the works of Jules Verne; but who, a twelvemonth ago, would have thought it possible to reproduce the speech of the dead!—and yet the phonograph or talking machine has accomplished this seemingly preternatural result. The *Vernian* era, indeed, seems to have set in. I will endeavour to prove the possibility of constructing a machine that will translate any language that may be required, and, perchance, when the matter has received a little ventilation in your columns the idea may not seem so improbable after all.

I must, however, premise that, for the purposes of this machine, it will be necessary to reduce language to its simplest elements, and to employ only the most ordinary words and phrases. All superfluous words must be got rid of, and in lieu thereof synonyms or paraphrases must be employed. Thus, instead of "a mansion" we must say "a large house," and instead of "schooner," "frigate," "barque," "yacht," &c., the simple word "ship" must be used.

I must, however, leave the literary portion of the subject for a moment in order to describe a simple form of the apparatus proposed to be employed.

It will be necessary to construct a large cylinder or drum of tin or other light material—say 3ft. in diameter and 1½ft. wide. Upon the outside of this drum is placed a cylinder of paper or card fitting closely to, and of the same width as, the drum. Upon this sheet of paper or card are printed all the more ordinary words of one language, these words being arranged in columns of 100 words each. The columns of words are numbered from 0 to 99, and the words in each column are also numbered from 0 to 99. It will thus be seen that the sheet contains a vocabulary of 10,000 words, a number amply sufficient for the purpose. It would, perhaps, be as well to have a few columns of phrases instead of words, each phrase to have a distinct number as in the case of the words. For every language that the machine would have to translate there would be a separate sheet of paper, such as I have described, and every word or phrase in the sheet would have to be translated into the language in question.

The following are specimens of the commencement of some of the columns in English, French, and Spanish:—

2500		2600		2700
0 bird	...	0 father	...	0 hand
1 book	...	1 fire	...	1 heart
2 bread	...	2 flower	...	2 horse
3 brother	...	3 frog	...	3 hour
2500		2600		2700
0 oiseau	...	0 père	...	0 main
1 livre	...	1 feu	...	1 cœur
2 pain	...	2 fleur	...	2 cheval
3 frère	...	3 grenouille	...	3 maison
2500		2600		2700
0 pajaro	...	0 padre	...	0 mano
1 libro	...	1 fuego	...	1 corazon
2 pan	...	2 flor	...	2 caballo
3 hermano	...	3 rana	...	3 casa

The drum or cylinder is mounted on a spindle and placed in a suitable case having an opening at the top large enough to admit of one column of words being seen at a time. Near this opening there is a handle in connection with the spindle of the drum, which, when turned round once, causes the drum to make one complete revolution. This handle, to which a pointer is attached, works over a dial divided into 100 parts, and on being turned round causes the columns of words to pass in succession beneath the opening at the top of the case. The object of this arrangement is to enable the operator to refer to any column he desires by turning the handle round until the pointer is opposite the figure in the dial corresponding with the number of the required column. Suppose, for example, the operator wishes to find the word which is against No. 2,702. He first turns the pointer to figure 27 in the dial, which brings column 27 under the opening. He then looks down column 27 until he reaches No. 2, against which will be found the word that is equivalent to No. 2,702 in the language into which he is translating. This, then, is the simplest form or principle of the machine, but before proceeding to describe a more complicated arrangement it will be necessary to show how numbers may be employed in the translation of foreign languages, and for this purpose I will quote an extract from the preface to a pamphlet published on the subject a short time ago, entitled "International Correspondence by Means of Numbers; an Easy Method whereby People of Different Nations may Readily Communicate with Each Other. London: E. Marlborough and Co." "It is evident," says the author, "that as numbers are common to all nations, if a distinct number were given to a word that number would convey the same or a similar impression to people of many nations, and if every word in common use had a distinct number attached to it, and some universal system of grammar were adopted whereby these numerical expressions could be formed into sentences, a new language would be produced which would be intelligible to the people of many different nations."

The author has selected a few words in common use, to which he has attached certain numbers and has translated these words into several languages. He has also laid down certain rules whereby the numbers representing the words may be formed into sentences intelligible to foreigners acquainted with those languages; but it is impossible in this letter to give these rules, for which the reader is referred to the work in question. It will be sufficient for the purpose to say that, according to the author's system, the expression

1=111 36–140 190 33 05=163 : 4 02=‡154 : 79

would mean, to an Englishman acquainted with the system, nothing more nor less than "John's brother bought five sheep and two cows yesterday." To a Frenchman it would mean, "Le frère de Jean acheta cinq moutons et deux vaches hier." To an Italian, "Il fratello di Giovanni comprò cinque pecoras e due vacche ieri," and so on.

In the above sentence 1 = the, 111 = brother, 36 = of, 140 = John, 190 = to buy, 163 = sheep, 4 = and, 154 = ox, 79 = yesterday. All the other figures and marks employed are to indicate grammatical inflections.

It will thus be seen that, if the sentences to be translated are expressed numerically, and the operator has a machine the words of which are in his own language, he will be able to comprehend what has been written by a person of any other nationality.

The machine may be made self-recording by having a stereotype cylinder, similar to that used for printing newspapers, instead of a cylinder covered with paper, and by having an arrangement for printing the words upon a continuous strip of paper. As, however, a detailed description of such a machine will involve several diagrams I must reserve it for a future occasion. In the mean time I shall be glad to receive the suggestions of any of "ours" on the subject.

Westminster, July 20. **Mercurius.**

THE LONDON INSTITUTION.

[14640.]—Allow me, as a proprietor in the above institution, to make a few remarks on your paragraph in "Scientific News" (p. 440), concerning the rejection of the recent scheme for enlargement. The London Institution, which has for many years been famous for its scientific lectures, is a proprietary body of shareholders in whom are vested certain privileges for themselves and their nominees. The shares bear no interest: "au contraire," the proprietors pay an annual subscription towards working expenses. There have been no alterations in the arrangement of the rooms for some time past, and the term "refreshment room" is not recognised in the institute. We are not, at least in that sense, a club; the only approach to it is, tea and coffee are served in the conversation room in the winter. Ladies were always admitted. The lady nominee of a proprietor could never be legally refused admission. Our library, a very fine and large one, is open to the public by ticket, to be obtained either of the librarian or of any proprietor. The case stands thus:—Our theatre will only seat about 600—there are 900 proprietors, each one of whom has the privilege of admitting one or two friends to the lectures. Added to this we have 300 (not 600) subscribers, to whom the board of management have granted yearly tickets. These subscribers overflow our theatre on any special occasion, and although many of the proprietors live away and do not attend all the lectures, still there is rarely standing room at a popular lecture. It was proposed, besides other alterations, to enlarge the theatre by about 300 seats and let in 700 more annual subscribers, thus making it more difficult than ever for proprietors and their friends to find seats. The other proposed alterations would have made the building very much larger, have made it a gigantic circulating library, and would in many senses have been *pro bono publico*, but it is the way of the world for people to consider themselves first. We proprietors did not require them for our own

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[*] We have every reason to believe that "C. E. S." writes disinterestedly and free from bias, and we object to this discussion taking a personal turn, and shall not allow it.—Ed.

ıce, although more room in the theatre
very acceptable. The benefits to be derived
alterations were so very visionary, so far as
the proprietors, who were to pay the
(for it was proposed to get an Act of Par-
o enable us to sell £13,000 of our funded
e property of the institution), that one
ly wonder that we refused to allow our
and self-interest to be utterly set aside in
accommodate the public, who, if the ven-
not a success, would not be a penny the
. One of the board of management stated
eeting that the resolution was only passed
ority of one on the board. I may add our
ow stand higher than they have done for
rs, and that the board of management have
ed to reduce the number of annual sub-
and to raise the subscription of the rest.
ask, do other scientific institutions (similar
evince such great anxiety to open their
the public utterly regardless of the con-
of the members themselves? I am no Tory
d keep at a standstill, but I think it was
for us to look to ourselves first and to
t the scheme by the great majority which

C. J. Tabor.

Institution, E.C., July 19.

OF INCREASE OF POPULATION.

]—It seems to me that the two correspon-
J. A." and J. Steel (letters 14566 and
ave made the mistake of reckoning the in-
population from Adam instead of from
ich makes a difference of 1,600 years.

Dandie Dinmont.

'ERATIONS OF FOOD DETECTED, AERATED WATERS.

ado, Soda Water, and Ginger Beer.

]—These pleasant and refreshing beverages
contaminated with lead and copper through
n contact with the metal piping of the
in which they are manufactured. But
machines now made in which glass tubing
uted for the lead and copper piping, thus
g the water becoming contaminated with
tals. Care should be taken to see that the
ed is pure and the bottles quite clean, as
where impure water and dirty bottles have
d particles of wood fibre, fungoid growth,
, &c., can be plainly seen under the micro-
enuine soda water should contain about
s of bicarbonate of soda to the bottle,
some of the low-priced so-called soda
not contain any carbonate of soda what-
l consists only of water into which atmo-
ir has been forced in lieu of carbonic acid
they are, however, deficient in that agree-
rpness peculiar to the genuine article.
ct the metals, proceed as follows:—
e the water to dryness, add a few drops
hloric acid, and evaporate nearly to dry-
n add some distilled water, and pass a
f sulphuretted hydrogen through it, when,
copper is present, a dark precipitate will
e; but, if we want to know which metal is
the precipitate should be got upon a small
washed with sulphuretted hydrogen water,
dried, burned in a porcelain crucible (not
num one), then moistened with a little sul-
id, and after standing some time distilled
ould be added and a few drops of ammonia,
ill give the characteristic blue colour if
present, and by evaporating off the
and adding a little potassic ferrocyanide,
precipitate of ferrocyanide of copper will
e.

t for lead, the ash should be mixed with
id, and some distilled water added. Sul-
id produces a white precipitate; chromic
ellow precipitate, as does also iodide of
n. The soda is best estimated with a stan-
tion of oxalic acid or sulphuric acid made
trength that each division of the burette
tralise one grain of carbonate of soda.

antimoniate of potash is added to a solution
precipitate is formed (but when carbonate
n is in solution it prevents its precipitation)
oniate of soda, or the water may be evapo-
dryness, and the residue weighed if sensibly
which will give results near enough for
purposes.

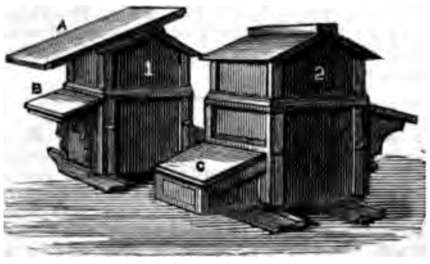
ade: The adulteration consists of sulphuric
tartaric acid. Sulphuric acid forms, with
of barium, a white precipitate of sulphate
a. Tartaric acid is best detected by adding
f acetate of potash and a few drops of
and stir with a glass rod. Lime-water
excess produces a white precipitate of
of lime soluble in chloride of ammonia.
ter added in excess to citric acid does not
a precipitate until the mixture is boiled,
rate of lime is deposited. The precipitate,
ng, will be partly re-dissolved, citrate of
ng more soluble in cold than in hot water.

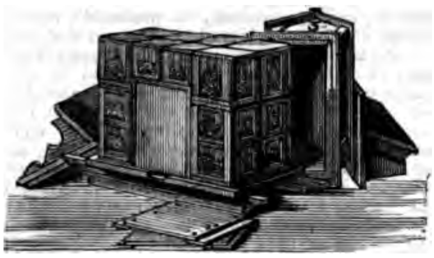
Ginger Beer:—This is sometimes made by forcing atmospheric air or carbonic acid gas into the water, and adding tincture of capsicum. The adulteration can be detected by evaporating to dryness, adding alcohol, and applying the tongue. The hot blistering taste of capsicum is very different from the milder taste of ginger, and if a little of the dried residue be diffused upon a glass slide with water, and examined under the microscope, particles of cayenne will sometimes be seen.

Albert Smith.

A NEW BEEHIVE.

[14643.]—May I call the attention of your excellent bee master, Mr. Travis, to the following description of a bee hive which has been patented this year in the United States by Mr. Macy, of Lamington, Somerset Co., New Jersey? Will Mr. Travis give his opinion of the new hive? It will be readily seen from the engraving that, among other improvements, the honey-boxes are easily accessible for examination or removal. Among other new features are removable shades for excluding rain and sun, and a feeding trough so constructed that it may be supplied by an attendant without risk of his being stung. Three forms of the hive are illustrated. In that marked 3, there is a central box, on each side of and above which are grouped the honey-boxes. The bees have access to the latter through openings having swinging covers. The hive may be a box, or it may consist of frames composed of slats suitably arranged and held together by clamping bars. The exterior walls of the hive are connected at the angles by hooks. This allows either end, or the front, back, or all sides, to be removed without disturbing the other parts of the hive or honey boxes, so as to inspect, remove, adjust, or replace the latter. Hive 3, in the engraving, has honey-boxes on top and on both sides; hive 2 has them on top and on one side; and hive 1 on top only. Surmounting the hive is a peaked roof, which is lifted off before removing the detachable sides. At A is a screen, consisting at a light frame covered with muslin or paper, which serves to protect the hive from the heat of the sun. The shield, B, protects the entrance from rain or moisture. At C is the feeding trough.





Ligurian.

SEPARATION OF THE PLANETS FROM THE SUN.

[14644.]—In the article which appeared in p. 439 of this volume, Prof. D. Kirkwood speaks of the planets having been "separated from the solar mass." That they once formed parts of it, and were afterwards detached from it with an initial velocity equal to that of a particle in the sun's equator at the time, and arising from his rotation, has certainly been a favourite hypothesis; but no sort of proof has ever been given of it. On the other hand, if we treat it in the same way that we do the theory of gravity, we shall find that it is quite impossible to reconcile it with facts. For, knowing the time of the sun's rotation at present, we shall easily be able to find what it would have been at the supposed time of detachment, when its radiance was equal to that of the earth's orbit, and this will give us the initial velocity; and hence we shall have all the data necessary for calculating the elements of the orbit. And if these are found to agree with observation, it will be as strong a confirmation of the hypothesis as the observed motion of the planets are of the theory of gravity. But if, on the other hand, they totally disagree, it may be fairly said that the hypothesis breaks down.

Let v be the velocity with which the earth commenced its independent motion at a distance, a, from the sun's centre, which distance is also equal to what the sun's radius was at the time. Also let A be the major axis of the orbit which the earth would describe under the circumstances, and which we wish to compare with that of its actual orbit. Then, by the theory of central forces, we have

$$A = \frac{2\mu}{2\mu - v^2 a} = \frac{a}{1 - \frac{1}{2}\frac{v^2 a}{\mu}}.$$

Now the velocity of a particle in the equator will be equal to the circumference divided by the time of rotation, t—that is, $v = \frac{2\pi a}{t}$.

Also, if T be one year, we shall have $\mu = \frac{4\pi^2 a^3}{T^2}$. Substituting these values in the equation for A, we shall find, after a little simplification,

$$A = \frac{a}{1 - \frac{1}{2}\frac{T^2}{t^2}}.$$

Also, if t_1 and a_1 be what t and a have become now that the sun has shrunk to his present dimensions, it is easy to show that $t = \frac{a}{a_1} t_1$; the last equation then becomes

$$A = \frac{a}{1 - \frac{1}{2}\frac{a_1^2\, T^2}{a^2\, t_1^2}}$$

But the value of $\frac{a_1}{a}$ is about $\frac{1}{207}$, and that of $\frac{T}{t_1}$ about 14·4; and this will finally give $A = 1{\cdot}00245\, a$. We shall also find that the eccentricity is ·9975.

Let us compare these results with facts. We find, then, in the first place, that the orbit, instead of being nearly circular, is considerably more eccentric than even that of Halley's comet. One would suppose that this was a sufficient condemnation of the hypothesis; but if any further disproof is wanted, we may say that, in the second place, the earth at its perihelion distance would be less than the sun's radius, so that it would fall into the sun again. This is easily seen thus: since a is the aphelion distance, and A the major axis, the perihelion distance is $A - a$, or $\cdot 00245\, a$, whereas the sun's radius is $\cdot 0048\, a$.

Again, the time of the earth's rotation about its axis at the time of detachment would be the same as that of the sun at that time—*i.e.*, about 25 × 207 days,—and its radius must have been at least as large as that of the orbit of the moon; for the same hypothesis which says that the earth was detached from the sun says also that the moon was afterwards detached from the earth; and, therefore, now that it is supposed to have shrunk to less than a sixtieth part of its original dimensions, its present time of rotation ought to be about $\frac{25 \times 207}{60}$, or about 87 days. The above results are only approximations, inasmuch as we have supposed that the masses of the earth—Venus and Mercury—may be neglected in comparison to that of the sun, and that of the moon compared with that of the earth. Still they are exact enough to show that the actual motions of the earth are so utterly unlike what they ought to be according to the detachment hypothesis as to make that idea wholly untenable.

In conclusion, we may compare—or, rather, contrast—the proceedings of those who put forward the view, either new or second-hand, with that of Newton, who forthwith set himself to work to see whether the observed motions agreed with what they ought to be according to his new theory of gravity; whereas the former will not take the trouble to attempt anything of the sort—but, nevertheless, expect us to take their word that it is so.

W. G. P.

RAINBOWS, &c.

[14645.]—It appears that Mr. Webb (letter 14591, p. 470) finds a difficulty in accounting for the non-coincidence of the real arc and its image in the water. It would be indeed unintelligible if they did coincide. Let me tell him that it requires no very high knowledge of mathematics and optics to account in the most satisfactory way for the grand spectacle he saw.

His remarks about the direction of the electric flash being perceptible are to me most interesting. Again and again has the flash appeared to me to rise distinctly from the ground to the cloud. Only lately did I witness, with a friend, three simultaneous forks strike upwards from the ground, apparently a mile or so apart. Did it not seem to present so many theoretical difficulties, I should never dream that my eyes were deceived.

Accinctus.

[14646.]—Mr. Webb's testimony (p. 469) is conclusive. May I add my observation? Early last month I distinctly saw the reflection of a rainbow in the river Derwent (Derbyshire) before seeing the rainbow itself. The reflection drew my attention to the original.

Arcanum.

A METHOD OF SOLVING PROBLEMS IN MAXIMA AND MINIMA.

[14647.]—On p. 296 (letter 14413) of the English Mechanic for 31st May, I notice an article from S. Stokes on "Maxima and Minima." It is only an algebraic way of treating geometrically certain problems involving one variable. Substituting y and z for x and equating is simply supposing the function to have two maxima or minima values, which must be equal. After equating and reducing, I remark there is no necessity, except to complicate the process, to substitute $x + d$ for y, and $x - d$ for z, and afterwards assume $d = 0$; but, after the reduction, at once replace y and z by x, when the solution is effected.

To illustrate the foregoing, let it be required to inscribe in the triangle, A B C, the greatest rectangle. Suppose A D the altitude, and E F G H the rectangle sought, and let J K M L be another rectangle, such that J be very near E. Join O K, O J, then the triangles, E J O and E J K, are evidently equivalent, proving that K O is parallel to A B. In the limit, when J coincides with E, and K with F, the figures, A E K O, E B K O, are parallelograms, and A B is bisected in E. Hence the parallelogram or rectangle at half the altitude is the greatest. Mr. Stokes's method now follows. Let α = A D, a = B C, and x = required altitude of the rectangle; the area $= \frac{a}{\alpha}(\alpha x - x^2)$, then $a y - \frac{a}{\alpha} y^2 = a z - \frac{a}{\alpha} z^2$. Hence $\alpha = y + z$. Replace y and z by x, then $\alpha = 2x$, and $x = \frac{1}{2}\alpha$. Note: J K and E F in the diagram are y and z. The algebraical solution of such maxima and minima is very simple. Thus, let

$$\frac{a}{\alpha}(\alpha x - x^2) = u,$$

$$\text{then } (x - \tfrac{1}{2}\alpha)^2 = \frac{\alpha^2}{4} - \frac{\alpha u}{a} = \frac{\alpha}{a}\left(\frac{a\alpha}{4}\right) - u$$

$$\therefore x = \tfrac{1}{2}\alpha \pm \sqrt{\frac{\alpha}{a}\left(\frac{a\alpha}{4} - u\right)}.$$

Here, evidently, the greatest value of u is $\frac{a\alpha}{4}$ = half the area of the triangle, and $x = \frac{1}{2}\alpha$ as before.

J. F. W.

MINOR 9th AND DIMINISHED 7th.

[14648.]—I think Mr. Ballard is quite right in regarding the chord GEC♯B♭ as a diminished seventh. I think it can be no other than that chord in second inversion. I don't see how it can be made out a ninth. I think there can be little doubt that C♯ is the root, giving us the chord C♯EGB♭, or in sol-fa nomenclature, de, m, s, ta. This chord is no stranger—it is frequently met with. Although, as Mr. Ballard says, it belongs to the minor mode, it is frequently met with in the major; sometimes the second and fourth are sharpened D♯F♯AC (re, fe, l, d); sometimes it appears as F♯ACE♭ (fe, l, d, ma). It consists of three minor thirds, and thus differs from a minor or dominant seventh, which is made up of one major and two minor thirds. It is a very flexible chord, and "exceedingly rich in its resources for modulation." For instance, take the one now before us. By merely lowering B♭ to A, we get a dominant seventh in first inversion — C♯EGA (de, m, s, l), giving us a smooth and agreeable modulation into D major, DDF♯A (r, r, fe, l), not to speak of the inharmonic changes of which the diminished seventh is capable, which may be an interesting study to the theorist, but one of little practical use.

C.

MUSICAL TONES.

[14649.]—I would beg Mr. Jackson to take for granted that I am acquainted with all the elementary, and something more than elementary, literature on this subject; were it not so, I should hesitate to handle the subject at all. On the construction of the diatonic scale, such as Mr. Jackson believes in, I can only say I have a very decided opinion that he is on the wrong track, and following a blind—or shall I say a deaf?—guide, for this, among other reasons, that it is a question simply and entirely for the ear, and not of figures. When he says, "I have yet to learn the simple, well-ascertained, indisputable fact that the ratios of the scale are the same in every key," I presume he is talking of the tempered scale of the keyboard. If he refers to the absolute truth of the scale of the fine singer and violin player, then he does not see that he is begging the question I am disputing, and he forces me to ask: Can Mr. Jackson say from his own knowledge that the exact ratios of the notes of the major diatonic scale have ever yet been experimentally ascertained, or even attempted to be ascertained, in any other than the key of C major, from the time of Huyghens down to the present day.

If Mr. Jackson cannot give name and time, and refer me to volume and page, then all I can say is he is arguing upon mere assumptions. He suggests that it is for me to ascertain by the siren whether the laws laid down by the musical theorists are right or wrong; on the other hand I humbly suggest that it is unpardonable in the theorists to have attempted to lay down laws, professors of physics as they are and having facility of access to expensive instruments, if they have not already been at the trouble of measuring the relative vibrations of the notes of the scale in other keys than that of C major. If they have already done so, then Mr. Jackson can refer me to records of the experiments, and I will at once confess myself silenced. Can he do so? We shall see.

H. C. K.

AUTOGRAPHY AND COLLOGRAPHY.

[14650.]—Your correspondent "Selim" (p. 475) has jumped at conclusions I think. He has found a specification, with the name Pumphrey attached, also my name in connection with some remarks on the above subjects. He concludes that the abstract of the specification he gives has reference to what I referred to. In the abstract given there is nothing about collography or writing from glue, but a process with aniline ink, in which a writing is made with a special ink, and it is printed from by the diffusion of the ink on the opposite side of the paper, so that there is always, as it were, the thickness of the paper between the original and the copy, and an absolute fac-simile is not possible. In the collographic process an ordinary writing is brought in contact with a moistened glue or gelatine surface, which takes a perfect impression of the paper and is instantly ready to be printed from, and it is often quite difficult to tell which is the original.

In due time the specification of this process shall be sent you, and your correspondent will then see that the specification of J. Pumphrey for autographic printing (called the fifty-fold writer), and my process of autographic printing, which I call collography, are quite distinct.

Alfred Pumphrey.

[We did not understand our correspondent to refer to the process invented by Mr. A. Pumphrey, but rather to give an abstract of the specification quoted and to ask a question as the kind of paper to be used.—Ed.]

A New Method of Determining the Heat Value of Fuel.—With regard to the important question of the heat value of fuel, it has been proved that conclusions from the results of elementary analysis are very uncertain, and, also, that little reliance can be placed on direct evaporisation experiments. In a recent paper in *Die Chemische Industrie*, Dr. Weyl points out the faults of these methods, and recommends, as preferable, decomposition of the fuel by dry distillation and analytical determination of the solid, liquid, and gaseous products of decomposition. In this method the accident of too small a sample being used is avoided, as also too great pulverisation and drying at high temperature and the decomposing action of atmospheric oxygen, which is therewith connected, and the whole of the coke is weighed, and its carbon, hydrogen, and mineral constituents determined. The water, tar, and gas that are formed are measured, and their heat of combustion ascertained with the aid of data that have been supplied by Favre and Silbermann and Deville. The final result will, of course, exceed the true combustion value of the coal by the amount of heat equivalent to the work of decomposition into coke, tar, and gas. The decomposition of the coal should be done as quickly as possible, and at a high temperature.

New Fire Engines.—The Metropolitan Fire Brigade have just added to the plant of the new chief station, in the Southwark Bridge-road, two of the most improved form of light steam fire-engines, specially suited for rapid transmission to a fire. These engines were tested on the premises of the makers (Messrs. Shand, Mason, and Co.), in the presence of Captain Shaw and his officers. Various improvements have been introduced; by means of those in the boiler steam was raised from cold water to 100lb. on the square inch in 6½ minutes, this being an acceleration of time by about three or four minutes as compared with the engines previously in use—a most essential point, considering the necessity of bringing a jet of water to bear upon the fire in the shortest possible time. The increasing height to which warehouses and public buildings are now carried in London rendering it necessary for increased pressure in the water jet, has been met in these engines by an increased area of steam cylinder as compared with the water cylinder, while the difficulty of the man in charge of the jet being able to shut it off entirely to avoid unnecessary damage by water, or from other causes, without the roundabout way of sending a messenger to the engine, which may be in another street, has been met by the adoption of a patent self-acting apparatus by which the jet may be entirely closed at the building on fire without interfering with or stopping the working of the engine. This is accomplished by a special hydraulic safety-valve regulated by a spring balance, which allows all excess of pressure to be relieved by passing the water to the suction-pipe. The first of this improved form of engine has been sent by the makers to the Paris Exhibition.

REPLIES TO QUERIES.

⁂ In their answers, Correspondents are respectfully requested to mention, in each instance, the title and number of the query asked.

[33029.] — **Electrotyping in 15 or 18 Carat Gold.**—I think "Os" makes a mistake when he says dissolve the gold (alloyed with silver) in nitro-hydrochloric acid. Does he not know that the hydrochloric will throw down the silver as chloride? Perhaps if the bath were made up by the following process he might succeed: — Take a solution of cyanide of potassium in distilled water—say, 1oz. to a pint of water—attach an anode of 15-carat gold, and cathode of same, and immerse in bath till, on removing the cathode and replacing with a silver one, it received a deposit. Of course the solution must be kept hot. Battery power must be low.—R. H. Thomas, Fermoy.

[33034.]—**Staining Wood Sections.**—The utility of staining wood sections is very doubtful, as it is only with some varieties that the "diversity of the structure" is brought out by its means. But if your correspondent wishes to try the effect he cannot have anything better, cheaper, or more ready to his hand than the aniline dyes.—Nemo.

[33054.]—**Sulphuretted Hydrogen.**—I can only infer from Mr. Grey's reply (p. 476), that my system is a more delicate "gas-poison-meter" than his; the cause being probably that he has a robust constitution, while mine is anything but that. My contention is that the books do not sufficiently warn students of the harm that may be done by such bodies as H_2S, H_3N, HNO_3, HCl, CO, HF, H_3P, H_3As, and, in fact, most chemical substances, especially those that easily volatilise.—Daghbert.

[33106.]—**Coal Waggons.**—I have never seen any 6-ton waggons made to carry coal, except to use up old iron, old wheels, &c. These are let out on hire, at about 3s. 6d. per day, till paid for. It would soon ruin a man to buy or hire 6-ton waggons if he wanted to convey any great quantity of coal. For instance, let us suppose twenty 10-ton waggons to hold 200 tons of coal, twenty-five 8-ton waggons to hold 200 tons also; here we want five more 8-ton waggons to carry the same amount of coal, and the difference in the price is so light that it is in favour of the 10-ton. Again, it would take thirty-three 6-ton waggons to hold 200 tons; so it will be readily seen that these will not answer for carrying coal. If the work is to be good, the draw-bars, hooks, shackles, spring buffers, guards, bolts, &c., should be quite as strong in the 6-ton as in the 10-ton waggon, and if the woodwork is any lighter they will get dreadfully ill-used if they get mixed with the large waggons by shunting. I should advise 10-ton waggons for coal—that is, if the tips, &c., will permit—with side doors, dead buffers on one end, and spring buffers on the other, swing bar and end door springs, shackles and scroll irons to carry body of waggon, and rubber springs to draw-bar. If made in this way they will repay the extra expense by requiring very little repairs.—Chelt.

[33159.]—**Locomotive.**—In reply to A. Broadbent, whose answer appeared on page 451, the word "diaphragm" was a mistake—it should have been "diagram." The engine A. Broadbent mentions is not the one I saw. I am unable to give full dimensions of it because I only saw it pass me twice, and I saw no name on it. The Monmouthshire Railway and Canal Company had it for heavy trains, and from what I could learn it was not suitable for its work. As nearly as I could guess it would be about 40 tons; cylinders, about 14in. diam.; wheels, 8 in number, 4ft. diameter; one fire-box, one door, side bunkers, and side tanks, the driver standing one side and stoker on the other side. Each end is four-coupled, and two sets of motions, two regulators, and two wheels for reversing. Driver can work either end, independent of each other. I think it is built by Dubs and Co. I should like to obtain some particulars and results of working. It was in 1870 that I saw it. The engine referred to in the second paragraph is one with the driving axle over the boiler. I should be glad to obtain some information about either of them.—W. H., Salford.

[33160.]—**Sheave.**—"Underground" must say of what the sheave is made, and in what part the hole is, before he can obtain a useful answer.—Nemo.

[33161.]—**Electric Bells.**—What would be the necessity for making a special form of Léclanché for use on board ship? However, "W. R. S." could easily obtain the best answer by writing to the manufacturers.—J. M.

[33167.]—**Steel Watch Chains.**—They must be japanned—that is, the varnish burnt on in a proper stove.—Oberhof.

[33168.]—**Foundry Coke.**—There is a fairly long article, with illustrations, in Ure's "Dictionary." See also Percy's "Metallurgy of Iron and Steel."—Nemo.

[33170.]—**Outrigger.**—About 30ft. long, 20in. beam; but "Torpedogo" should try several boats, and, finding one that suits, take its measure.—C. J. L.

[33178.]—**Restoring Gilded Organ Pipes.**—The batters must be rounded out by hammering on a mandrel with a mallet; then either strip the gilding off or re-gild.—H. G.

8.]—**Brakes.**—The brake which is put on by ir rushing up the chimney" is the Smith .—ESSAR.

8.]—**Brakes.**—A "Passenger," on p. 352, out "a brake which is most disagreeable." "the air rushes up the chimney, and makes ful noise, and as soon as the train stops it about 2 yards." From the first part of the tion there is no doubt that the brake to which ssenger" refers is Smith's vacuum brake. adful noise is caused by the steam rushing the ejector into the chimney. This creates m in the brake pipes, and in the collapsing rs or sacks; the atmospheric pressure then the cylinders to collapse, and apply the The recoil spoken of is not any fault in the system, and does not occur when a train throughout with a continuous brake. It is by the brake being fitted to the engine, or the front part of the train. As soon as the portion of the train is retarded, the unbraked causes the buffers to be greatly compressed. he train comes to rest, the buffer springs, of expand or recoil, causing the rear carriages ack. This, it will be seen, is not only disle but dangerous to the passengers, and I self seen people thrown down on the platform is cause. I have also known the recoil to iolent that even couplings and draw-bars n broken. This is always cited as another hy the whole of a train should be fitted with uous brake. The Sanders' vacuum brake jector upon the engine, and makes the same Smith's, the only difference being that in ers the disagreeable noise is made before starts, and in Smith's when it is stopping. S.

.]—**Automatic School Bell.**—I doubt very hether a large school bell could be rung by rical arrangement. It would be better to arge gong.—H. M.

.]—**Capital Investment.**—At the recomon of "Penance Point," I have procured f life annuities from the National Debt ut fail to understand them. Ex. £100 stock, g the next dividend in the 3 per cent. Bank es, is stated to yield on a single life annuity 4d. to a male person of 45 years of age the average price (query, how averaged?) of ent. stock yields a rate of interest of £3 16s. ," or £6 7s. 5d. when yielding a rate of of 3 per cent.—*i.e.*, I suppose, when standing What is understood under £100 stock? Can ought for less than £100 sterling? Will rling (money may be paid in lieu of stock), less, purchase the same annuity? What is £3 16s., £3 15s., &c., per cent.? Is the pound sterling supposed as divided into 16 What is about the price of £100 3 per cent. onsols?) at present, including the next ? Why is the annuity for same amount of s to females than to males? "Penance will oblige by explaining and working out ple for practical use. As to building sociend that some of them offer interest of 5 per d others (including bonus) of even 8 per nd a discount company as much as 7 per 3 months' notice. Allowing for the cost lishments and of management, &c., these must, one would think, be employed at very es of interest, and must necessarily, theresomewhat speculative. On the other hand, one's capital in an annuity for a rate of only a little in excess of what can be obpon good foreign Government stock (Prus instance, yielding 4·17 per cent. at present ad nothing in excess of American stock and posit banks, seems rather short-sighted, and ing due use of one's means. Doubtless the wed in the case of annuities is based upon mortality tables; but, still, the uncertainty proverbial, and the work of years might be in as many days. I should have thought e home City loans would have been safe nerative, or that, at any rate, colonial City ld have been recommended. Can any furce be given in this matter? Brokers and I find, never actually advise investments r that, but confine themselves to laying on their list, leaving the selection to youro life annuities vary, when once taken, to fluctuations in price of stock, or is the for ever afterwards a fixture, as at first ?—AN ENGINEER.

]—**Brass.**—Has "A Sheffield Blade" tried of varying the quantities of zinc added to r? If he has brass, let him try adding a c, and, if that does not produce what he y copper.—E. M.

]—**Leather Composition.**—If the compo o the description, it would be useful.—T.

]—**High-Pressure Horizontal Engine.** gram shows that your engine was intended fairly with its former load. You find you he full amount of power required with half pressure on the piston, the engine remainfore. Putting "lap" on the valve so as to ¾ the stroke (or when piston has travelled,) would effect a considerable saving, but, on, you would require to have all your d cylinder well protected to prevent any at by radiation. The most economical plan in the end would be to take out the 20in. cylinder and replace it with a 12in. (as advised in my former reply). You will save the cost of the alteration in 6 months. Your feed-heater is a very good one, almost acting as a condenser.—LANCASHIRE FITTER.

[33304.]—**Old Tin Goods.**—The presence of tin and lead would be most objectionable in melting down the metal, and at any rate malleable scrap is almost useless for melting purposes. Repeated attempts have been made to recover the tin, dissolving it off by means of hydrochloric acid or caustic soda, but in most cases with but doubtful success. At present a company near Swansea, South Wales, has commenced recovering the tin by a new method recently patented. The residual scrap iron, after removal of the tin, may be used for precipitation of copper, but is not so valuable for this purpose as clean new scrap; the metal is so honeycombed by the treatment, that a much larger surface is exposed to oxidation.—H. B. F.

[33317.]—**Carbonate of Lead Manufacture.**—I suppose by this is meant white lead, and commercial white lead is not carbonate of lead alone, but a mixture of carbonate and hydrate. It is owing to the presence of the carbonate that white lead possesses such opacity, while it is due to the hydrate that its covering qualities are so good. It is the absence of the hydrate quite as much as any crystalline structure of the carbonate, that renders a white lead prepared by precipitation with a soluble carbonate almost useless. Instead of extracting the carbonate of lead, proceed by estimating the total lead, then estimate the carbonic anhydride, satisfy this with lead, and the lead in excess calculate to hydrate. "J. M." will only be misled by the answer of A. E. Menke to a similar question. Barytes is almost the only adulterant which can be used with white lead, as it alone combines cheapness, weight, and purity of colour. When chalk is mixed with oil the whiteness is at once lost—*e.g.*, putty—and for this reason whiting can never be used as an adulterant.—H. B. F.

[33321 and 33443.]—**L. and N.W.R. Engines.**—Isabella, 403; Hardwicke, 790; Princess Helena, 1,517; Abercrombie, 1,525. The above are all Ramsbottom's coupled 4-wheel, cylinders 17 × 24. The first 3 are stationed at Birmingham; the 4th was, when I saw her last time, at Crewe on No. 3 link, working to Rugby, Liverpool, &c. Trent, 830, is the same build, but has no cab, and its cylinders are, I believe, 16 × 24, wheels 6ft. 6in. She is at Stafford, running to Birmingham, Rugby, Manchester, &c. Sphinx, No. 2,156, is at Oxford, running daily to London. She is Webb's build—6ft. wheels, same as Baltic, 2,151; Atlas, 2,150; Sybil, Unicorn, &c. Engine in Abergele accident (No. 291), Prince of Wales, now being repaired, and will again commence on Irish mails when fresh from shop. Harrow accident, engine Shelvey had was 850 Columbine (pilot); train engine, 833 Clyde, the driver of which now runs Princess Beatrice. I append a list of the new coupled engines built by Webb as they may prove useful to some:—

857 Prince Leopold (15)
858 Sir Salar Jung (15)
859 Yakoob-Khan (15)
860 Merrie Carlisle (15)
861 Amazon (8)
862 Balmoral (8)
863 Meteor (8)
864 Pilot (8)
865 Envoy (8)
866 Courier (8)
867 Disraeli (8)
868 Condor (8)
869 Llewellyn (8)
870 Fairbairn (8)
871 Poserpine (6)
872 Wizard (1)
883 Phantom (6)
890 Sir Hardman Earle (26)
1,105 Hercules (6)
1,177 Pincess Louise (15)
2,175 Precedent (15)
2,176 Robert Benson (26)
2,177 Edward Tootal (26)
2,178 Pluck (26)
2,179 Patience (26)
2,180 Perseverance (26)
2,181 Buffalo (15)
2,182 Giraffe (15)
2,183 Antelope (1)
2,184 Reynard (1)
2,185 Alma (15)
2,186 Lowther (15)
2,187 Penrith Beacon (15)
2,188 Chillington (15)
2,189 Avon (15)
2,190 Princess Beatrice (15)
2,191 Snowdon (1)
2,192 Caradoc (1)
2,193 Salopian (15)
2,194 Cambrian (1)

Those marked (1) are stationed at Euston; (15) at Crewe; (6) at Northampton; (26) at Liverpool; (8) at Rugby. I am not quite certain of Nos. 858 and 860; the others I have seen, and know they are correct. The engines which have gone to Crewe for repairs have the arms of the company painted upon them:—890, Sir Hardman Earle; 2,180, Perseverance; 861, Amazon; 862, Balmoral; 863, Meteor; and 868, Condor, will, I expect, when she comes out. I have not seen Sir Salar Jung for some time, and I do not know an engine named "American Isle."—EGERIA.

[33342.]—**Magnetic Meridian.**—I am obliged to Mr. Lancaster for information hereon, so far as given, and hope he or some other correspondent will deal with the question in relation to the mining map referred to. I can understand that if the declination as in 1740 (16° 10′ W.) should have again come round—*i.e.*, if it had been the same to-day as then—the operation of recovering the position of the old underground workings would present no difficulty, as the same lines would obtain; but, according to Mr. Lancaster, the present variation is just 17° W. (for London), or 0° 50′ more westerly than in 1740. Although less than I had imagined, it still applies to my inquiry, "how to correct and adapt to the map in question, and its explanation would be practically serviceable for any other greater or lesser variation. I assume that the true meridian remains the same at all times, and that, supposing this to have been laid down on any map or survey, the same line would be found at any time by the angle of variation which the needle makes with it (as might be known for such time and place) being read off and applied. Although, then, the angles at which the undeground works have been carried out would not be the same with respect to the needle, they would, I presume, be the same now as then in respect to the true or sun meridian, and thus they might be re-plotted out from this latter line, and the present magnetic meridian laid down and worked from. Is this correct? There remains, however, still the difficulty of determining the true meridian for any given place or spot. This is known with sufficient exactness for certain principal places; but, as Mr. Lancaster shows, there is a difference of 2° 30′ between London and Dublin, and doubtless, therefore, to be correct, it requires determining in each case, especially if distant from places for which it is known. Is there any simple way of doing this, with or without the assistance of the miner's compass or dial? Incorrectness in a work of this nature would be productive of great pecuniary loss.—E. W. A.

[33351.]—**Rifle Shooting.**—There could be little if any practical difference in range between a shot fired over the land or over the sea; but surely, theoretically, it should go farthest over the land. The nearer a weight is to the centre of the earth the greater is the power of gravity. As the surface of the land is as a rule above the surface level of the sea the weight to be projected would be less over the land than over the sea, and so the ball would go farther.—R. P. G.

[33360.]—**Willows.**—In the autumn of 1860, wishing to screen one side of a piece of ground quickly, I procured some freshly-cut willow poles. They were about 6ft. long, and looked like broom-handles with bark on. These I roughly pointed at one end with an axe, and then hammered into the clay soil with a mallet, placing a piece of wood over the top of the poles to receive the blows, and driving them in about 2ft. They every one "took," and when I left the place in 1872 were regular trees from 20ft. to 30ft. high, and of corresponding width.—B. H., Solicitor.

[33369.]—**Stamping Foreign Goods.**—Some three years back it was possible for an English firm to import into England articles made abroad and stamped with their name. The Custom-house authorities required that a member of the firm should make the necessary declaration before a magistrate. I do not know of any alteration in the law respecting such importations, but "Puzzled" can obtain all the information he requires from any Custom-house agent, as such cases were far from uncommon.—G. W. B.

[33374.]—**Steam Heat.**—The pressure of steam over that of the atmosphere will be at 212° Fah., 0lb.; at 300° Fah., 53lb.; at 400° Fah., 232lb.—H. B. F.

[33379.]—**The Zodiacal Light.**—This beautiful phenomenon is by no means difficult to observe during the evenings of March, and can also be observed in February and April. I even observed it on Jan. 23rd, 1878, but not satisfactorily. I give a list of all the occasions on which I have observed it this year:—

Jan. 23, 1878.	It must be zodiacal light.
Feb. 18,	Seen rather well at 7h. 10m.
28,	Visible plainly at 9h. 20m.
March 2,	Fairly seen at 8h. 30m. quite plain.
4,	Not particularly good.
5,	Very bright a few degs. Sp. π Piscium
23,	Fine; light exceptionally intense.
25,	Fine.
27,	Not so fine as on 23rd and 25th.

I believe that I observed it also on December 29th and 31st, 1877, and perhaps on December 24th and 27th. If "X." wishes for a fuller account, I shall be happy to write to him, if he will advertise his address or write to me. Mr. Dennett considers that the zodiacal light is more intense than usual this year (ENGLISH MECHANIC, March 15th, 1878).—VAUGHAN CORNISH, Debenham Vicarage, Suffolk.

[33389.]—**School Board Education.**—"The Education Craze and its Results" is an anonymous work, and is supposed by some critics to be a satire on the utterances of certain people—an attempt to make their views ridiculous by stating them in a grossly exaggerated form. E. H. Gray (whose reply (p. 480) reads remarkably like an advertisement of the book,) seems to take the matter seriously, and actually recommends the work as sure to have a "most beneficial effect." Well, perhaps, it may "benefit" those persons who consider the Education Act of 1870 to be a "stupendous national folly." It is difficult to see, however, how "the small volume in question" can contain "innumerable" replies to examiners; and if Mr. Gray could be a boy again and would get a little knowledge of what a Board School really is and does, by attending one, he might learn in a striking way that such composition is there considered carelessly done. Here is an extract from the book:—"It is a great mistake to imagine that the ability to read is any such inestimable boon as is pretended. In by far the majority of cases, practical experience shows that the only real result is manifested in the rapidly-increasing circulation of vast quantities of unwholesome, pernicious, and immoral productions—of works of the vilest tendencies—their prevalent characteristic being open defiance of all religion, subordination, law, and order."

What have authors, publishers, compositors, and the whole fraternity of bookmakers and sellers to say to that? If the book is not ironical, somebody has a "craze," undoubtedly, and his friends should carefully keep pens and paper out of his way.—DAGHBERT.

[33393.]—**Leclanche Cell, &c.**—By half filling the cells you get a good action, and, as I have found, a very continuous one, and the screws, &c., do not get choked up so soon as when the cells are nearly full. As I suppose you really want to make a telephone with your 5in. magnet, you would require a bobbin with about ½ an ounce of 36 wire, and I would advise you to use silk-covered wire for two reasons. First, and most important, because of its more perfect insulation; and, secondly, its smaller bulk. Ferrotype-plate about 2½in. diameter will work best.—W. J. LANCASTER.

[33396.]—**Organ.**—"E. W." may get over the difficulty by cutting all the holes in the soundboard the same length in the direction that the slider moves, with the same amount of space between each hole. For the large pipes they should be extended, and for the small ones rather short. The soundboard "E. W." has illustrated cannot possibly work properly.—J. LEWIS.

[33402.]—**Rough Powerful Battery.**—About the simplest battery you can make is the bichromate. You should have plates about 5in. × 3in., and use couples only. There is no necessity to have two carbons to one zinc; one and one in a large battery will do all the work you want.—W. J. LANCASTER.

[33404.]—**Lens Grinding.**—To grind and polish a lens out of rock crystal will be too much for an amateur to commence with. If you like to grind such a lens out of either flint or crown-glass, I will give you all the necessary instructions on your sending another query.—W. J. LANCASTER.

[33409.]—**Oxygen Gas Bag.**—Fold the bag as neatly as you can and wrap it in strong paper, and put in a warm place. On no account let it be put in a damp cupboard. When about to be used again blow it full of air with a pair of bellows: then let it hang in a warm room for a few days.—W. J. LANCASTER.

[33412.]—**Coca Leaves.**—Boil (or infuse) the leaves, strain, and evaporate until of a pasty or stiffer consistence. When required for use add water quant. suf. A liquid preparation to keep might be made by adding sanitas, borax, or alcohol, but either would, I imagine, be objectionable.—NEMO.

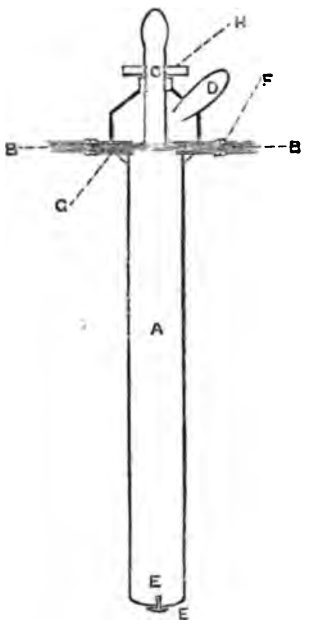
[33413.]—**Hysteria.**—I have known many cases cured by simply taking a cold sponge bath each morning. But if the case is of long standing the best way is to place yourself under a doctor in whom you have confidence, and follow his instructions persistently, not trying first one treatment and then another.—R. P. G.

[33413.]—**Hysteria.**—No drug can in particular be recommended, but you might give iron, in combination with a vegetable tonic, a trial. You had much better however, consult a physician.—E. J. MARSHALL.

[33414.]—**L. and N.W.R. Engines.**—There are three engines of Caithness class—viz., Delamere, 1,198; Caithness, 1,199; Maberley, 1,200. The last lot of "Lady of the Lake" class were built in 1866. I believe no single engines have been built since 1870—more's the pity, in my opinion. The Scotch mail between Rugby and Carlisle is run partly by Precedent class and partly by Procursor class, also by 1,513 class. "Willesden" should have specified which Scotch mail he means, as the different ones are run differently. I cannot answer the rest of the question.—ITZAEX.

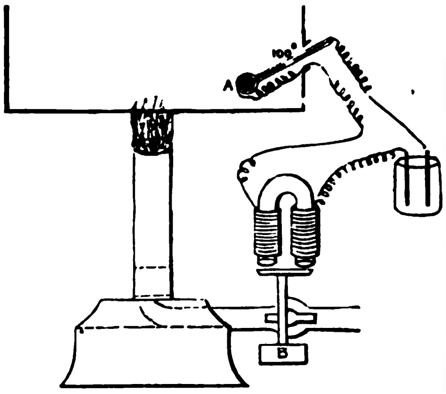
[33415.]—**Pith Balls.**—Get the pith out of elder sticks. You will be able to make good balls out of sticks an inch or so in diameter.—W. J. LANCASTER.

[33416.]—**Regulating Heat of Gas, &c.**—Some seven years ago a friend and myself devised a heat-regulator of the greatest simplicity, and although it was designed to regulate the heat of water for the purpose of artificial incubation there is no reason why it should not do for anything else. I have known this regulator to keep water at the same temperature within a degree for months. The regulator acts by the expansion and contraction of a fluid (methylated spirits is the best) confined in a rigid metal chamber, a small portion of which is cut away and closed by a small diaphragm of vulcanised indiarubber, which acts as a valve rising or falling as the liquid alters in temperature, so increasing or decreasing the supply of gas. The chamber must be quite full of fluid, and quite tight, so that the whole of the variation may tell on the valve. The chambers must be placed where the heat is required to be regulated. The best way to regulate the heat of a gas would be to immerse the chamber containing it in a vessel of water, the heat of which could be regulated by inserting the spirit chamber in it. A is the spirit chamber: a piece of brass pipe does well. B B, indiarubber diaphragm. C, movable gas pipe going to heating lamp. The pipe should be screwed down, so as partly to cut off the supply, when you have got the temperature you require, after which it will be self-acting. D, gas from supply pipe. E E, aperture to fill chamber, closed with screw and washer. Fill with cold spirit, then place the chamber in water at *about the heat you* will require; when the spirit gets to the same heat screw up tight. F and G, metal diaphragms to fix indiarubber. H, set screw to keep pipe in place when set. The same apparatus



may be made to regulate the heating power of a small furnace by regulating the supply of air. Shall be happy to give any further information if required.—R. P. G.

[33416.]—**Regulating the Heat of Gas.**—Make a rough thermometer (A), with one wire perforating its bulb, and another passing through its tube from the top, and ending at the point to which the mercury would rise in registering a temperature of 100°. Let this be placed in the air chamber, and its wires put in circuit with a battery and a small electro-magnet. If the magnet be arranged as in figure, so that its armature is connected as shown with the stopcocks of gas lamp, the supply of gas will be regulated automatically. The current of gas from main pipe should be sufficient to heat the chamber to a temperature somewhat higher than 100°, so long as the lamp stopcock is fully open. As soon,



however, as the temperature in chamber exceeds 100°, the mercury, rising in thermometer, comes in contact with the wire in its tube, completing the electric circuit, and causing the magnet to attract its armature, and thus to partially close the stopcock, and lessen gas supply to lamp. When the temperature now falls below 100°, the mercury descends, the circuit is broken, the magnet ceases to act, and the stopcock is again fully opened by the action of the small weight, B. In this way a temperature varying but a few degrees from 100° can be maintained as required.—C. P. C.

[33419.]—**Steam Yacht.**—The cause of complaint is, I infer, the formation of deposit in your boiler. To obviate this, use the salinometer when going into sea-water, and on no account allow the water to exceed $\frac{3}{32}$ in density; if it gets above this point blow out the brine from the surface. The density of the water ought to be taken every hour. By adopting surface condensation, and at the same time compounding your engines, you ought to effect a saving of 25 per cent. You would get the same power out of a smaller quantity of steam, whilst the boiler would be fed with distilled water, and would make steam as fast as wanted. Should there be any difficulty in raising sufficient steam, a ½in. pipe put into the funnel would easily overcome it. Against these advantages are, heavy cost of alterations and increased complication and weight of machinery, which latter would, to some extent, interfere with speed of yacht. If any further informatio required I shall be most happy to give it practical experience.—LANCASHIRE FITTER.

[33420.]—**Nitric Acid Stains.**—The acid cannot be removed if old, but if quite recent t ing the cloth with strong liquid ammonia mig of service.—C. J. LEAPER.

[33421.]—**Lantern Spectroscope.**—To Mr. CASTER.—The best light you can have for sp scopic purposes is the electric, but as this is troublesome the next best is the limelight. pyrohydrogen light is useless for the purpos lantern with 4½in. condensers will answer ever pose, and the most essential additions are given below. About 4in. in front of condense at the end of the ordinary cone, a lens sho placed of about 6in. focus; the light should t so adjusted as to give a parallel emergent then the greater part of such light should be by an adjustable slit frame, the two shutters adjustable from closing over each other to apart. A good form to make such an arrang in is that of a parallel rule, so that the apert always of the same diameter top and bottom, prism will be required. This may be either a flint prism or a bottle prism to hold bisulph carbon. Having this it will be an easy ma arrange object lenses to give a sharp image u screen. To show bright lines it will be neces scoop a cavity in lime ball, and place the m the cavity; then, when all is in adjustmen using opposite side of lime ball, gradually rot lime ball until the metal is fused and its lin ble. Bands, of course, will be seen when th trum passes through the vapour of any meta J. LANCASTER.

[33422.]—**Zincography.**—Gum arabic is rally used, but any clean firm gum, such as lian (which only costs about 6d. a pound answer equally well. This is an old recipe am in the habit of using, but the exact prop are not very material:—Soak ¼oz. of good 3 gills of water for about 24 hours, then bo strain the liquid through muslin; next put gum or thereabouts into a quart jar, and fill water. When all dissolved it should be so thicker than the so-called "office gum" bottles. These two liquids should then be together, and 3oz. of a strong solution of pho acid added, when your gum will be ready f After gumming up your transfer, the gum washed off again in about half a minute, plate kept damp by a sponge during the pr inking. I have mislaid my notes on the a process, but will hunt them up, and send par soon.—ERNEST A. NUTH.

[33423.]—**Bicycle Tire.**—In reply to " Amateur," I have mended some very bad the tires of my bicycle with a solution of indi purchased at the Surrey Machinists' Co., opposite St. George's Church, in the Boroug cut must have all dust and dirt removed then the solution is rubbed in with the fin the cut bound with twine till the solution which it does in about 24 hours. If carefull the tire will be almost as good as new.—A.

[33424.]—**Water Raising.**—You cannot water other than by ladling it out of lower higher one. Of course, you may have a sma attached to upper tank, but the labour of will be greater than that of lifting.—W. CASTER.

[33424.]—**Water Raising.**—I would ad not to attempt it, unless you are seeking a of that absurd mechanical problem, motion, in which case you will assuredly fai MARSHALL.

[33426.]—**Chemical.**—Miller says:—"Iro is not acted upon by cold sulphur or by hyd acid, but is rapidly oxidised and dissolved acid and aqua regia; boiling oil of vitriol di gradually with evolution of sulphurous anh —W. J. LANCASTER.

[33426.]—**Chemical.**—FeS_2 is soluble in s nitric, and hydrochloric acids, but is, at t time, decomposed by them, the Fe uniting of the acid to form a salt of iron, and the h of the acid combining with the sulphur of th form sulphuretted hydrogen.—C. J. LEAPE

[33428.]—**Bloomer Engines.**—Odin is a and has had a new boiler. I gave a descri them in No. 619, or thereabouts.—ITZAEX.

[33433.]—**Battery Carbon Blocks.**— cutting use plenty of sand and water. A wheel cutter in lathe and good sand will much. The only method I have found wor joining broken carbons is to warm them w them as close together as possible, and c outside of the crack with sealing-wax. T that the carbons are well in contact befo sealing-wax. Let the wax cover ½in. on eac crack.—W. J. LANCASTER.

[33435.]—**Gas Engines.**—The following ciency results obtained by M. Tresca in exp on various gas engines:—Lenoir's double-ac engine, net efficiency at brake, 4 per cent.; gas engine, 4·1 per cent.; Otto and Lange spheric gas engine, 8·4 per cent.—JAN.

[33436.]—**Gelatine.**—Perhaps the butt "B." refers to are made of tungstic glue, prepared by mixing a thick solution of tungstate of soda and hydrochloric acid, by means of which a compound of tungstic acid and glue is precipitated, which at a temperature of 86° to 104° F. is sufficiently elastic to admit of being drawn out into very thin sheets. On cooling this mass becomes solid and brittle, and on being heated is again soft and plastic This new compound, it is said, can be used for all purposes for which hard rubber is adapted.—AMERICUS.

[33438.]—**House Electric Alarm.**—A good dog will be the best alarm you can have, for, although it is possible to connect up all the doors and windows in a house, it is more than probable that in less than a week some part will be wrong. If, however, you desire an alarm, you had better leave electricity out of the question, and work in the following manner:—Have bell wires payed out to front and back doors, all the windows, and connected to a main wire going up into bedroom, terminating in a detent connected with a clockwork alarm. Thus the wire could be attached to the detent at night, and be liberated in the morning. The ends on the doors would be like the pulls in a room, so that the opening of the door would liberate the detent, and you would be aware of the entrance of a "friend." The window attachment should be so arranged that the lifting of the lower sash would move a lever similar, in fact, to the bell pull I have mentioned above. The stud in the lower sash should at once lift the lever, or, say, when not more than 6 inches open. Such an arrangement would be permanent, and would not interfere in the least with opening and closing the doors and windows in the daytime. Of course, if you cared to go to the trouble, you could have a bell in the bedroom to each window or door; but I take it that, if one awakes, it would be only a work of a few moments to find our "guest."—W. J. LANCASTER.

[33439.]—**Painting Bath.**—Mix wholly with varnish, white lead for inside of bath; flake white for birdcages. I mixed ¼oz. of vermilion with a tablespoonful of oak varnish I painted a sample tin box forwarded to the Editor with two coats, allowing the first to dry before the second was put on. The colours want well mixing before the brush is put in the japan. Clear varnish would be best for bright colours. But I only tried it for an experiment, having the oak varnish by me.—BARK TAN.

[The sample box sent looks very well; but we are not sure that the japan would stand hot water, as it would be required to in a bath.—ED.]

[33440.]—**Swelled Fingers.**—Iodine is sometimes used for the purpose you name, though it is difficult to say whether it would prove beneficial in your case. However, it is worth a trial.—E. J. MARSHALL.

[33441.]—**Reflector.**—Better line the waterproof with some non-conducting material, such as thin felt; otherwise you will have a deposition of moisture on the tubes, &c.—W. J. LANCASTER.

[33443.]—**L. and N.W. Engines.**—2,177, Edward Tortal; 2,178, Pluck; 2,179, Patience; 2,180, Perseverance; 859, Merrie Carlisle. This last is the name which I fancy "Tamerlane" has mistaken for American Isle. 857 is the first of the class. There are no re-built, at least, passenger ones, between 872 and 883. None of the 11 hundreds except Hercules have been re-built like her, for 1,177, I believe, is of Precursor class.—ITZAEX.

[33448.]—**American Organ.**—The items of "necessary" expenditure can be reduced to very small dimensions. They are, for the board and reeds, a guinea; for the rubber cloth about 5s.; and keys, which may be had from a guinea, say, up to £3. If it is desired to reduce the price to about the level of a £5 harmonium I dare say it might be done by getting similar quality keys at 15s., which would make the "necessary" items £2 1s., leaving £2 19s. for the case, wood, wire, glue, labour, &c. It would be advisable to buy pallets, springs, &c., which would absorb another 9s. The wood, leather, &c., would probably cost £1, and another £1 for case, would leave 10s. to pay for the labour. But a one row is scarcely a profitable instrument to make, though it would be much superior to a £5 harmonium. I would not recommend anything less than a one and a half row, with the complete row voiced, when the half row can easily be imitated, or left almost as they are. It is well to remember that, with the exception of the stop action, practically as much work has to be done on a one row as on a 2½, which is the size I chose for giving directions, and with that you need only buy the 4ft. set voiced, copying them for the 8ft., and leaving the half row unvoiced with a stop labelled clarionet. A one and a half row, with an oct. coupler and a tremolo makes a very passable instrument at a moderate cost.—ORGANON.

[33451.]—**Water Power.**—If "R. E." will state the greatest fall he can get by damming up the stream, or taking the water at a point higher up than his shop by means of a "goyt," I will give him the best advice I can on the subject.—LANCASHIRE FITTER.

[33452.]—**Management of Trains.**—In working a train there are three things to consider—the speed, the weight of train, and state of rails. With a very light train it may be pulled up in 200 yards. By reversing the train receives a very powerful check, but it is impossible to estimate the distance as required by "P."—J. LEWIS.

[33460.]—**Walking Sticks.**—These may be made pliable by boiling, but the usual method is to bury them in hot sand over a stove. The end of the stick is then placed in a notch of a board for the purpose, and the stick is straightened by straining and bending. Vide Vol. XXIV., No. 621, p. 557.—W. E. H.

[33461.]—**Turner's Cement.**—I think Singer's cement would answer "J. R.'s" purpose. It consists of 5lb. of resin, 1lb. of beeswax, 1lb. red ochre, and 2 tablespoonfuls of plaster of Paris, all melted together.—C. J. LEAPER.

[33462.]—**Harmony.**—The study of harmony is no exception to the general rule—that, if the student exercises patience and perseverance, no master is necessary further than his textbook. Hile's "Catechism of Harmony, Thorough Bass, and Modulation" (price 1s.) is a very cheap and popular work. There are many other works of the same kind, all ranging about 1s. in price, which may be had of any music-seller.—J. B. OLIVER.

[33462.]—**Harmony.**—"A Poor Musician" will, I think, find in "How to Observe Harmony" what he wants. The illustrations are in the sol-fa and staff notations. It is published at the Sol-Fa Agency, Warwick-lane, London.—W. W. H.

[33464.]—**Dirty Filter (Lipscombe's).**—Take the sponge out, and thoroughly wash it. That is all the cleaning you can give the filter, unless you can manage with hammer and chisel to break away the cement all round the inner cover without breaking the said cover. (I have tried to do so with 3 such filters and failed.) Then turn out the gravel (?), charcoal, &c.; throw them away, put in a fresh charge, and, while about it, you had better renew with animal charcoal instead of the comparatively worthless wood ditto commonly used, and re-cement cover with hydraulic cement. I hope you will enjoy the task. If the filter has been long in use and has really done any work on the water, you will probably observe (with eyes and nose) some interesting facts in connection with the spent charge. These filters are (or were) advertised as "self-cleaning;" which is either inaccurate or else the title of your query is a misnomer. You had better get a carbon block filter, which you can really clean; or, still better, one of Mr. Rawlings' "Excel" filters, which is the latest kind I have tried, and so far with much satisfaction.—DAGHBERT.

[33465.]—**Acoustics.**—1. The musical pitch of a sound does not perceptibly influence the speed of its transit. 2. It is generally understood that the higher the pitch the farther the sound travels—witness the siren and railway whistle. 3. The length of a monochord is influenced by the conditions of breadth and tension, and may vary from 30ft. to as many inches. For lecture illustrations the greater length is selected, because the nodes or points of rest are then more palpable; but for sonorous effects alone a length of about 4ft. is as good as any. It may be taken that when a string is just within its breaking tension the tone is at its best. 4. The elasticity of a fluid is calculated according to its compressibility: thus, the more resistance it offers, the greater is its elasticity; consequently water is infinitely more elastic than air; and, were its density equal, sound would travel through it at an enormously increased speed.—W. H. DAVIES.

[33465.]—**Acoustics.**—1. The pitch of a sound does not affect the velocity with which it will travel. Sounds of high and low pitch will be conveyed with the same speed through the same media. 2. If a brass band is playing in the distance you may hear the bass notes only, if they were produced with greater intensity than notes of a higher pitch; but you would never hear first the one and then the other. 3. The best length for a monochord is 3ft. 4. It is not either the density alone or the elasticity alone of the medium through which sound travels that would determine its velocity, but the ratio of the two, the relation the one bears to the other. The velocity of propagation is inversely proportional to the square root of the density, and directly proportional to the square root of the elasticity.—WIESENDANGER.

[33473.]—**Microphone and Phonoscope.**—The sounds transmitted by means of a microphone can easily be made audible to a large audience by simply using as a receiver an ordinary Bell's telephone firmly fixed on a stand or box, and fitted with a resonance tube of brass or thin sheet metal. If made of the latter it should have a tight fit to the lid of the telephone, and be of a conical shape, the wider orifice being at the further end, and about 10in. diameter. The length of the resonance cavity would then be about 18in. You would better buy a cheap phonoscope. They can be had at 2s. 6d., and show you the principle better than any description would do.—WIESENDANGER.

[33474.]—**Rheumatism.**—"T. M.'s" heart has apparently been affected by his rheumatic attack, and he must avoid all exertion or excitement, mental or physical, for years to come.—GIMCRACK.

[33479.]—**Poppy Oil.**—The following information on the subject of poppy oil, its uses, and properties, as well as the cultivation of the poppy, may be of service to "A. G. E." It is extracted from M. Malpeyre's "Treatise on Oils," in the "Encyclopédie Boret," p. 127, et seq.:—"In commerce the name of poppy oil is given to an oil extracted from the seeds of the opium poppy—*Papaver Somniferum*. When good these seeds should be dark, small, quite clean, unctuous when crushed, and should have a decided taste of hazel-nuts. In Flanders they are sown between the 15th and 30th of April, and harvested towards the end of August. Poppies are also cultivated for the sake of their oil in the French departments—Du Nord, Pas de Calais, in the neighbourhood of Arras, of Douai, of Lille, in Alsatia, &c. The Count of Ourches has introduced the culture of this poppy in the Department du Loiret, where they sow the seeds between the 1st of September and the 1st of October, or, if the season be unfavourable at this time, in February, March, and April, in rotation with potatoes, after which they succeed very well. Each acre of ground requires about 5½ pounds of seed to sow it. The white poppy grows to a height of about 5ft., and produces fine large flowers, which are followed by the capsules, in which are contained the seeds. Every 5lb. of these seeds will yield 1lb. of oil on an average; but Count d'Ourches has succeeded in extracting 1lb. of oil from 3lb. of seed, which is greatly in excess of that usually obtained in Flanders. Pure poppy oil is less viscid than most other oils; its colour is nearly white, with a very slight tinge of yellow. It is inodorous, has a slight taste of almonds, and does not freeze until the temperature falls to 0°; but when once frozen retains the solid form until the temperature rises to 28° F. Poppy oil is one of the drying oils, and this property is enhanced by litharge. Its specific gravity is 0·9249 at 60° F. The pure oil is extremely bland, and is largely used in place of olive oil for alimentary purposes, being, perhaps, the best substitute, as it does not easily turn rancid. In lamps this oil burns badly. Two varieties of this oil are found in the market—one almost colourless, which is the purest, and fittest for the table; and the other of a ruddy tint, which is used in the arts. A similar oil may be extracted from the following poppies also: *Papaver Argemone*, *P. nudicaule*, *P. Alpinum*, *P. hybridum*, *P. dubium*, *P. Cambricum*, *P. orientale*, *&c.*" To this I need only add that the opium poppy may be grown with great success in England, and is occasionally seen in the grounds of those who grow medicinal herbs, as at Mitcham and elsewhere. Poppy oil is used in the preparation of delicate colours and fine varnishes, being far before linseed oil in its transparency and innocuousness as a vehicle. A very bland grey soap may be prepared with this oil. The following gives the behaviour of this oil with various re-agents:—With strong solution of caustic soda, dirty yellowish white colouration; with sulphuric acid, of the specific gravity 1·635, no colouration; with nitric acid, specific gravity 1·33, red colouration; with phosphoric acid (trihydric), no colouration; with calcium bisulphide, golden yellow; with chloride of zinc, white; with mercuric nitrate, white; with stannic chloride, instantaneous colouration to golden yellow.—AUDACES FORTUNA JUVAT.

[33480.]—**Sea-sickness.**—The best cure for sea-sickness is to endure it until it goes off, which it will do when the sufferer becomes accustomed to the motion of the vessel. It is said that a belt worn tightly round the body above the waist prevents it; but that involves a total sacrifice of personal comfort. There are other cures which send their victims off into a deep sleep, but if "A Would-be Sailor" cares to spend his holidays in a state of somnolency I venture to suggest that he would be better at home. However, unless a considerable time is going to be spent upon the sea, I think there is little chance of encountering any tempests at this season of the year, and therefore he need not give up his intended pleasure for fear of sea-sickness.—J. B. OLIVER.

[33482.]—**Daniell's Battery.**—Daniell's battery is the most constant and reliable of all if it is properly and carefully made. You can easily make one at a trifling expense if you will carefully follow the instructions I gave in a former number of the MECHANIC. The copper is always worth two-thirds of what you gave for that article alone. Daniell's battery is not equal in strength to half the number of Grove's cells. See also reply No. 33526.—WIESENDANGER.

[33493.]—**Writer's Cramp (or Scrivener's Palsy).**—No mechanical contrivance is of any use, in the end it would make bad worse. Treatment should be rest, the continuous galvanic current, cod-liver oil, good food, and strychnine. But there is only one remedy: you must give over penwork. Whether you be young or whether you be old you must, hard as it may be, find some other vocation, and that at once. Most likely the hand can be used for any other kind of work.—R. P. G., Harcourt-house, Anerley.

[33495.]—**Harmonium Reeds.**—Broad or broad bent reeds will do on the same sized channels, but do you not mean will they do on the same channels as the narrow reeds? Yes, if the apertures are large enough; but for what would you change? Unless the reed is proportioned to the channel and the pallet aperture there cannot be so much advantage as will make it worth the labour of changing.—HENRI ETIENNE.

[33496.]—**Sick Dog.**—It is probably a slight paralysis of the hinder extremities. Treat with the following:—Strychnia, 1 grain; confection of roses, 2drs. Mix and divide into 36 pills. One night and morning. If you make these pills yourself you will require to triturate the strychnia with sugar of milk before making into pills.—D. STRATHEARN, Medical Student.

[33501.]—**Street Tramways.**—"Lyons" will find all his questions fully answered in "Tramways," by D. K. Clark (Crosby Lockwood and Co., Stationers' Hall-court).—GIMCRACK.

[33502.]—**The Ladies' Tricycle.**—The velocipede about which "Llewon" inquires is probably the "Coventry tricycle," manufactured by Messrs. Haynes and Jefferis, of Coventry, in whose price-list will be found an ample description of it.—C. A. K.

[33504.]—**Honey-Dew**—Is produced by most species of aphis, and is exuded from a pair of tubercles situated near the extremity of the insect. It is said that some ants keep these insects in durance vile for the sake of their honey, squeezing them when they require a supply, much in the same way as we keep cows for their milk. This I cannot vouch for, but certainly, like our friends at the North, bees, wasps, and ants are very fond of the "Dew." These last go to the fountain head and lick up the honey as it oozes from the tubercles. Any one might see this for themselves. The "feathery specks of white" are also, I think, caused by a species of aphis, the American blight (*Lachus lanigerus*). If so, the feathery specks when crushed will stain like cochineal. Have often seen it on apple trees, to which it is very injurious, but did not know that it infested the larch; if so, it would be worth recording.—R. P. G., Harcourt-house, Anerley.

[33511.]—**Ink Stains in Leather.**—Make a saturated solution of oxalic acid in the cold, and apply solution with a sponge.—D. STRATHEARN, Medical Student.

[33513.]—**Purgative for Dog.**—Give a couple of podophyllin pills, or dissolve 4 grains of podophyllin resin in rectified spirits of wine, 2drs. Dose, ten drops on piece of bread.—D. STRATHEARN, Medical Student.

[33514.]—**Firearms.**—There are two books published by Messrs. Cassell and Co., Ludgate-hill, on firearms, viz.:—"Choke-Bore Guns, and How to Load for All Kinds of Game," by W. W. Greener, with illustrations, cloth, 7s. 6d.; and "Modern Breechloaders, Sporting and Military," by W. W. Greener, with 123 illustrations, crown 8vo. 250 pp., cloth, 7s. 6d.—MARKSMAN.

[33517.]—**Pianoforte Tuning.**—There is, I believe, a small book on the above subject, published at the *Musical Bouquet* office, which will suit "Pimpernel."—W. W. H.

[33519.]—**Civil Service Examination.**—Messrs. Cassell, Petter, and Galpin publish a book, entitled "A Guide to Employment in the Civil Service" (price 2s. 6d.), which I think would answer "Xit's" requirements. There is another book on the Civil Service (price 1s.), published by Warne and Co., I think. The examination papers set at previous examinations are contained in the appendices to the "Report" of the Civil Service Commissioners, the price of which is from 3s. to 5s., according to size.—J. B. OLIVER.

[33521.]—**Photographic.**—The following is an outline of what I believe to be the cheapest, most rapid, simplest, and most convenient (and least injurious to health) process known at the present time, while it certainly gives as delicate and detailed a film as can be got in any other way, being, at the same time, more sensitive to weak light than any other process. It is, as will be seen, a combination of the suggestions on various details of many workers in the art, and I am especially indebted to Messrs. King, Maddox, Kennett, Wratten, and Wainwright, and M. C. Bardy, for the hints they have given during the past four years, in the course of which I have tried almost every process published, and exposed many thousands of plates—working in all cases, not for pictures, as most amateurs do, but to find, by comparison, the finest, most rapid, and most detailed dry-plate process, with a view to taking very small negatives that would bear enlargement about fifteen diameters. I have not yet arrived at the goal, but hope to do so eventually, and the information I possess will, probably, be very acceptable to many who would dabble in the art were it not for the fear of stained hands and such like inconveniences. The dark room requires our first consideration in the gelatine process (the ordinary yellow glass being utterly useless), and the best of all dark room windows or lamp glasses are made as follows:—Saturate methylated spirit with a coal-tar dye called chrysoidine—to be got at Judson's—filter it, and again saturate it with good unbleached shellac, and with this varnish, and a stiff hog's-hair varnish brush, cover the window of your dark room or lamp—using common window glass—and be very particular to avoid any air-holes or bubbles. Do it on a warm bright day, and it will soon dry, then give it another coat, and you will have a dark room that will defy the sun himself. Next as to plate-cleaning; if the glass is new and clear take a clean diaper napkin, shake over it from a dredger some clean dry Tripoli powder, and give each plate a smart rub on each side and edge. If old glass is used, that has been used for collodion, clean with a strong solution of carbonate of soda crystals (warm), dry on a drying rack, and polish in a polishing plate-holder as for wet plate work. If old glass that has been used for the gelatine process is to be used, then place a few dozen in a deep pan, cover with hot water, leave till cool enough to handle, and then clean with a common nail-brush, dry on the rack, and use the diaper napkin and tripoli. Next make your emulsion thus: Get two small white Bohemian glass flasks with flat bottoms (I use 8oz. size), and for two ounces—which, *with ordinary care*, will cover forty 4¼ × 3¼ plates—place in one flask 28 grains of bromide of potassium and one ounce of distilled water, and when dissolved add sixty grains of Nelson's No. 1 photographic gelatine (sold in ¼lb. packets only, at 3s. each), and place it aside for five minutes. Now take the other flask, and in it place 36 grains of nitrate of silver and 1oz. of distilled water. Now take into your dark room a large basin of warm water (not over 100° F.), and, being very careful from this point to exclude all actinic light (which is the only enemy to be feared), immerse both flasks in the warm water, and as soon as the gelatine is thoroughly dissolved, and the contents of each flask is thoroughly warmed, mix, by pouring a small quantity, say one-fifth, of the gelatine solution into the nitrate of silver, and shake thoroughly; repeat again and again till all is mixed, then pour all the contents back into the gelatine flask, and, after shaking thoroughly (say two minutes at least) re-immerse in the basin of water, cover up, and leave half an hour; then take it out, and pour into the emulsion 4 or 5oz. of strong methylated spirit (4s. 6d. per gallon), set aside for half an hour, when the emulsion will be found to be in a leathery mass at the bottom of the flask, the water and waste salts having combined with the alcohol, which carefully pour away. Fill the flask up with water, let stand ten minutes, pour off, and repeat again, then put as much water in the flask as will fill it as high as the emulsion originally did, and having again filled your basin with water at 100° F., immerse the flask of emulsion, and leave till thoroughly dissolved, when it is ready for coating your plates, which do in the same way as with collodion. If the plates are small you will find it easy—if large pour a pool on plate, spread with a glass rod, pour more on, and after flowing evenly pour surplus off, and place on a level place (a sheet of plate-glass levelled is best), or in a drying box till dry. Large plates should be slightly warmed before coating. In the winter time, when the nights are long, I have occasionally prepared batches of plates in my sitting-room after bedtime, leaving them to dry—say at 11 p.m.—on a levelled sheet of plate-glass on the table in the warm room (60° to 65° F.), and, getting up at 5 or 6 a.m., found them thoroughly dry and hard. But beware of dust—it sticks "like a creditor." Now for the extraordinary properties of these plates. You can either expose them the same time as wet plates, and develop as follows:—(For soaking, and solutions for developing, fixing, and washing, be careful always to use hard water, and if not obtainable harden it with ¼oz. Epsom salts to the gallon.) Soak the plate five minutes in water. Mix a four grain solution per ounce of pyrogallic acid, also water, 1oz.; bromide of potassium, 40 grains; strong solution of ammonia, ¼oz.; and for a quarter plate take 1dr. of the pyro solution, and 1 to 10 or more drops of the bromide and ammonia solution according to light and exposure; mix; flow the plate, and wash off before the darkest shadows discolour. Fix with hyposulphite of soda, or cyanide of potassium in weak solution. Let dry, and then flow with a weak solution (about 3 grains per ounce) of citric acid, and "intensify" as required with acid pyro and silver; or you can vary the exposure and strength of developer by reducing the bromide and increasing the ammonia, until, by exposing in a good light with a rapid portrait lens and spring shutter instantaneously, you can develop with a mixture (for a quarter plate) of water 2dr. pyro, as much dry as will cover a sixpence or more, and one to six drops (according to lighting) of the strongest liquor ammoniæ without bromide. But keep your eyes skinned. Dash on developer after soaking plate; wash off quickly when picture is out, and proceed as before—in fact, you may take any liberty in exposure when once you have acquired the power of proportioning the developer to it. But the more rapidly you work the greater mastery you must have over it. When working plates with longer exposures you can add the ammonia by degrees, but not so with the short exposures—fog comes in such cases at once. When you have mastered working these plates as quickly as described above, and would like to increase the speed, increase the proportion of nitrate of silver by one grain when making the plates; and, if not then satisfied, make still more rapid by leaving the emulsion a longer time in the warm water basin before adding the methylated spirit, but make sure of each step before taking another, because there is a point beyond which you cannot go. I have gradually decreased my size till I have come to plates 2½ × 2, using a small very rapid portrait lens (ratio of aperture to focus $\frac{F}{3}$) to which I have made a small brass camera with a spring shutter, which opens and closes by one motion of the wrist as quickly as you would fire a pistol, and this is not quick enough in some cases. Should you wish to use any other bromide instead of bromide of potassium you can substitute 10½ grains of bromide of ammonium, 11 grains bromide of sodium, or 13 grains bromide of zinc, the proportions of which I have ascertained by experiment (as the combining proportions as given in the chemical works have not answered with me); but I find the bromide of potassium gives a denser film, with less inclination to fog than any of them. I shall be obliged if "Gelatine," or any one else experimenting in this process, will give the results in this paper; and if any further help is needed I shall be glad to do what I can in reply to any query.—FINEM RESPICE.

[33525.]—**Lathe Tools and Boring.**—The steel requires "upsetting"—that is, hammering on the end when heated till it is thick enough to bear shaping as required. I always put it into an old vice when at a red heat, and after upsetting it enough, and then, forging the sides square, shape the face and heel by filing with a "half-round" file. To bore a true hole through the side of ⅜in. round bar you will require what I call a "semi-circular seat chuck" fitted into the spindle of the loose head-stock for the bar to rest in, and then if the front and back centres of your lathe are in line, and you use a short stiff drill and start fair, you will go through straight. I have drilled many "tommy holes" in my drill chucks that way. To make the chuck take a piece of 1¼in. round bar iron, turn it to fit spindle, cut off square and file a half-round groove across the face.—FINEM RESPICE.

[33526.]—**Minotti's Battery.**—To construct a good Minotti's constant battery buy as many jam-pots as you want cells. The pots should be of not less than 4in. diameter. Cut for each cell a disc of copper 3½in. diameter, and with a bradawl or punch make three small holes in the copper, take a piece of guttapercha-covered copper wire, No. 18, 9in. long, and take off the guttapercha cover at one end for about 2in. Pass this end through the three holes in the copper, as if you would sew with a needle, and then hammer the wire into the copper. Place the copper plate at the bottom of the cell, with the covered wire at right angles, so that it projects over the top of the cell, and over the copper plate put ½lb. or ¾lb. of crystals of copper sulphate. Over this place twenty discs of white blotting-paper 4in. diameter, and over that put a layer of sawdust or river sand, then put a disc of blotting-paper, and on that a disc of stout zinc, 3½in. diameter, with a binding-screw fixed in the centre. *Do this in such* a manner that you have about 1½in. free from the top. Then fill the cell with clean water to about ½in. from the top. If you have many cells connect always the copper of one to the next zinc by means of the covered wire. This and all gravity batteries should be placed on a shelf where they are never shaken or displaced—then they will be very constant and reliable. The sand or sawdust will not suffer through not being used for some time.—WIESENDANGER.

[33530.]—**Telephone and Æolian Harp.**—Fix an ordinary upright microphone on your Æolian harp by means of screws or glue, and have a line, including a battery, running to a telephone.—WIESENDANGER.

[33533.]—**London University Matriculation Examination.**—The two languages you mention are sufficient. Does not the "Calendar" give information on the subject?—J. B. OLIVER.

UNANSWERED QUERIES.

The numbers and titles of queries which remain unanswered for five weeks are inserted in this list, and if still unanswered are repeated four weeks afterwards. We trust our readers will look over the list, and send what information they can for the benefit of their fellow-contributors.

32914. Hair Dye, p. 251.
32916. Wing or Throttle Valve, 251.
32917. Romping Twist, 251.
32925. Hjorth's Magnet, 251.
32938. Fireworks (Japanese), 251.
32939. Glass Staining, 251.
32940. Great Northern Engines, 251.
32954. Old Music, 251.
32959. Incorporation of Building Societies, 252.

33165. Painting Imitation Granite, p. 352.
33174. Olive Oil, 352.
33176. Midland Lights, 352.
33186. Organ, 352.
33188. Pressure Gauge, 352.
33191. Fumigating Wood, 352.
33194. Mining, 352.
33201. Sulphuric Acid, 353.
33203. Civil Service, 353.
33209. Brewing, 353.
33210. Mining, 353.
33213. Aniline Black, 353.
33220. Muriate of Tin, 353.

QUERIES.

[33539.]—**Breeches Paste.**—Will any of your readers give me a receipt for breeches paste?—A CONSTANT READER.

[33540.]—**Vegetable Tar.**—Can any of "ours" tell me what is meant by "vegetable tar?" Is it the same as Trinidad pitch or asphalte?—L. GILBERT.

[33541.]—**Worm Eaten Harmonium Case.**—We have a harmonium in our chapel—it is about a year old, and the case is made of rosewood, and it is getting full of little worm holes. I should be greatly obliged if some one would let me know what would prevent this.—A SINGER.

[33542.]—**Antique Watch.**—A very curious antique watch having recently come under my notice, made by "Fitzschau, London," I should feel greatly obliged to any amateur or practical horologist who could inform me whether the maker was celebrated in his day, as evidently his watch was made for some person of distinction. The watch, which is in the finest state of preservation, is very singular in form, being an oblate spheroid, having a frosted wrought silver dial, the minutes engraved in large Arabic figures in an outer, and the hours in smaller Roman numerals in an inner circle, and bearing the maker's name—Fitzschau, London, No. 1,062, and enclosed in a very massively embossed, engraved, and pierced silver case. It is a verge clock watch, strikes the hours loudly on a very fine-toned bell, and winds up in two places—viz., for the striking and going gear. On the back of the case is a cleverly and beautifully executed monogram, "M. M. W."—East Anglian.

[33543.]—**Nocturnes and Harmonies.**—What are nocturnes and harmonies in blue, &c.? I understand that they are paintings, but what are they like?—K. S.

[33544.]—**Spring Brass.**—How can brass (pieces cut from sheet) be made springy, for flute keys, for instance?—S. K.

[33545.]—**Wood and Metal Pipes.**—Is there any difference in the tone of organ pipes of metal and wood, supposing both to be voiced alike? That is the wood to imitate the metal, the latter to imitate the wood. Can the difference be made apparent to a listener?—R. M.

[33546.]—**Watercresses.**—How can these be grown at home in pots or boxes?—Oberhof.

[33547.]—**Boring Wood Tubes.**—How can I bore wood tubes perfectly true?—B. E. P. L.

[33548.]—**Multiplication.**—Is it correct to say that ½in. multiplied by ½in. equals ¼in.? If so, would it not be better to use some other word than multiply?—Erasmus.

[33549.]—**Musical Tones.**—If, as I understand the letter 14618, the A and the B of the pianoforte are, in the experiment named, respectively too flat and too sharp, what value can be attributed to the opinion "only play as well in tune as the pianoforte and you will do well enough?" On most pianos both A and B are sharp of the true number of vibrations, and if the voice is to take the note B flat or A sharp from a chord struck on a piano, I submit the result can be no test at all for any but that voice and that piano. Will Mr. Bosanquet or Mr. Colin Brown try the experiment and let us know the result?—Mathematicus.

[33550.]—**Books on Food Analysis.**—As I wish to proceed to the analysis of foods I should be much obliged to any contributor who would recommend to me the best works on the chemical and microscopical analysis of foods and the detection of adulteration therein. Kindly mention publishers and prices if possible.—A. E. S.

[33551.]—**Wheel Gearing.**—I have a wheel containing 60 teeth, and it is 1½in. diameter outside of teeth. What size must wheel be to carry 40 teeth and gear correctly with that of 60? And also what size must pinion be to carry 20 teeth and gear correctly with both?—W. W.

[33552.]—**Steam in Small Boats.**—With reference to the observation of "Black Witch" (reply 33110) on the relative merits of screw and paddles in small boat, while thanking him for his proffered information, I wish to impress upon him that the point I chiefly aim at is facility of adjustment and removal, both of machinery and either method of propulsion to which it may be applied. I should prefer whichever best attained this object.—Aquarius.

[33553.]—**Astronomical Books.**—Will Mr. Wm. Oldfield or "F.R.A.S." kindly tell me where the following books can be obtained—viz.: "Herschel on the Telescope" and "Coddington's Optics?" I have tried both here and in England, and have failed to get either of them or any clue to their existence. I see them frequently mentioned and quoted in "ours," and thought I should have no difficulty in procuring them. My English bookseller says he tried Black, of Edinburgh, for the first named work without success.—Charles P. Truro, Nova Scotia.

[33554.]—**Battery Power.**—To Mr. W. J. Lancaster.—Many thanks for your answer to mine (No. 33363), but I should like a little more of it. I know that one covered wire would attract one other wire by themselves, but when the covered wires are placed together, in fact making a solid block of them, can I send a current through any one of them without affecting the others, thus making the electric current collect as it were any one of the opposite wires I pleased, leaving all the others unaffected? I do not like giving this idea up as not practical without a struggle, so would you kindly recommend me a few books that would be useful. I should like to have your opinion on some of those cheap batteries that have appeared in "ours" just lately; would they be of any use to me?—Would-be Inventor.

[33555.]—**Astronomical.**—I am greatly obliged to "A Fellow of the Astronomical Society" and others who have so kindly answered me on the subject of the zodiacal light, &c. Respecting the "dipping needle" I did (as suggested by your correspondent) visit the shops of two eminent opticians, to make inquiries as to the instrument used for observations of the Aurora Borealis, but there was an uncertainty about the answers which I received that left me greatly in doubt (as I know nothing of the matter myself) as to whether I had asked for the proper article or not. Can you kindly tell me where Highfield House Observatory is?—X.

[33556.]—**Chemistry.**—Would any reader kindly inform me which of the many textbooks would be most suitable to a beginner to get a thorough knowledge of the science by self-instruction—one that would also give instructions for making experiments? Would Wilson's or Thorpe's be suitable?—Amateur.

[33557.]—**Geological.**—Would some reader kindly give two or three general rules for identifying fossil shells, adding the names of a few of the principal kinds which resemble each other in appearance or otherwise, and stating in what these differ?—Hibernicus.

[33558.]—**Unfermented Wines.**—Will some of our chemical readers be kind enough to inform me how the presence of alcohol can be detected in the so-called unfermented wines, as they are pronounced by some to be as strong as other wines?—P. W.

[33559.]—**Speed of L.C. and D. Engines.**—I shall be greatly obliged if some one will give me some of the best performances of any of the L. C. and D. express engines.—Europa.

[33560.]—**Lieblich Gedact Pedal Pipes.**—Our friend "Diapason" in this has given the scale of a set of lieblich gedact pedal pipes. Would he kindly give a description and diagram showing how to make them? Also would the same scale and pipe do to continue for a set from tenor C to F³?—A Young Beginner.

[33561.]—**Colouring Gold.**—Can any of "ours" inform me how to colour gold so that the gold shall have the different tints as seen on gold leaves in the West-end shops? The tints are green, brown, and red. By answering the above query a great favour will be conferred, as it is for the purpose of earning a livelihood.—Economical.

[33562.]—**Chemical.**—I should be much obliged if some contributor would explain the cause of the following for me:—I wished to prepare some hydriodic acid; so I consulted "Miller's Inorganic Chemistry," in which it is stated that into a small retort ·1 gram of phosphorus was to be placed with 1 cub. cm. of water, and then 2 grams of iodine were to be added; the mixture was to be heated gently, and the gas collected by downward displacement. I followed these directions, except that I used a Florence flask instead of a retort; I used red phosphorus, and powdered the iodine finely. All the connections were firm. I heated the mixture very cautiously at first, but gradually increased the heat when I found that nothing happened; the only result of this was that the mixture boiled and the iodine sublimed. Phosphorus and iodine have been used from the same bottles, some time ago, with perfect success. Both the bottles have glass stoppers.—W. W.

[33563.]—**Rash.**—A friend of mine has been troubled for several years with a rash on his arms and legs; it comes first as a very small white watery pimple, and after being rubbed appears as if it had been stung with nettles, and feels the same. It is usually worse when the weather changes from cold to hot or hot to cold. Has taken medicine from several doctors for it, but without gaining much benefit. Any information thankfully received.—Semaphore.

[33564.]—**Microphone.**—Would not the spoon and wire in "R. M.'s" bandbox microphone (14487) form a small battery capable of affecting the receiving telephone? I find a pair I made give a decided click on completing the circuit by touching a bit of damp zinc with end of No. 36 copper wire, without other battery.—Semaphore.

[33565.]—**Induction Coil.**—I have made a large coil, partly from the description given in "Sigma's" book, the particulars of which are the core, composed of soft iron wires, 1¼in. diameter, 13in. long. The primary, No. 15 cotton covered, in two layers, covering about 12 inches in the length of the core; the secondary, 3½lb. silk covered, is wound on a parallel tube of ebonite, 7-16ths thick, having three diaphragms, also of ebonite; the middle one is thickened towards the centre, and the end ones towards the outside edge, the space between each diaphragm being about 2¼in. I attempted to make the outline elliptical, but only partly succeeded, the two middle spaces being parallel, containing 23 layers each. I can get a spark ½in. long with one Bunsen cell, holding one pint in the outer cell, without condenser. I experience the greatest difficulty with the condenser; it increases the length of spark at the secondary terminals very slightly, and takes very little spark from the contact-breaker. The dimensions of the condenser are 50 sheets of tinfoil, 20in. × 8in.; 60 sheets of thin paper, 20in. × 10in., well soaked in paraffin wax. 18in. × 8in., I suppose, will be the effective area of the tinfoil. Will you please point out the probable cause of failure (there is a peculiar snapping sound proceeds from the interior of the condenser), and say if any sound should be heard from it at all? And what size of cell is generally used and meant when a specified number is mentioned as working a coil?—Yorkshireman.

[33566.]—**Telegraph Engineering.**—(1) Which is the best school of telegraphy in London? (2) What reputation has the Submarine and Military Technical Institution Co., Conduit-street? (3) Having principally devoted my attention to classics, I know very little of mathematics, chemistry, magnetism, &c. I conclude the former would be of little use, but would it be necessary to have a knowledge of the latter before entering? (4) Is it advisable for one who knows nothing of engineering to go in for the six months' course? (5) Are the prospects good? What salaries and pensions are given? What can one rise to be? I don't mean if one has great genius, but with moderate ability. (6) Is there any limit to age? Does the time spent at the schools ever exceed six months, or is it only the very clever ones who get through in that period? What is the probable expense (including extras)? Supposing one has passed, should one have to pass a further examination before being appointed to a post, or is the school certificate accepted as a test of proficiency? (7) Are the appointments in the Submarine Departments worth more than those in the Home? (8) How is it the Government only succeeds in teaching their employés in three months, whilst the schools profess to "turn out" their pupils complete engineers in six months? (9) Are the appointments Government or company that successful candidates receive? Are the posts abroad worth more than at home? (10) Are the appointments permanencies? (11) I suppose, that, being a well-paid profession, the telegraph engineers or manipulators hold a good position? I understand that the Government employés in the Home Department are merely badly paid clerks.—Engineer.

[33567.]—**Ancient Literature.**—About two years since a long review appeared in the *Daily Telegraph* of a translation just published of the two Hindoo poems known as the Râmâyana and Mahâbhârata; I believe it was headed "The Iliad and Odyssey of the East." If any of your correspondents are in a position to refer me to the date of the paper they would greatly oblige. Also if they could refer me to those numbers which gave translations of the Chaldean tablets, as deciphered by the late Mr. Smith, or any sources from which I might gain some knowledge of this kind of ancient literature at a minimum of expense, they would increase the obligation. How can I procure Prof. Max Müller's recent lectures on religion?—E. Sprague.

[33568.]—**The Lord Mayor's Special Express.**—Can any correspondent give the particulars of the running of this train from Blackpool to London on Monday last—the load, time of departure, and number and description of engine?—Locomotive Engineer.

[33569.]—**Bath Bricks.**—How are Bath bricks (brick dust) manufactured? Is it clay or dust? If the latter, by what method is it congealed? Can any one describe the processes they undergo? Any part or the whole of above information will greatly oblige—Busy Bee.

[33570.]—**The Leamington Kitchen Range.**—Will any of your readers who have made practical trial of this kitchen range kindly say if it is a good and serviceable range, and one that can be recommended as simple and easy to be kept in order?—Engineer.

[33571.]—**Communication between two Shops**—I have two shops, but unfortunately a shop not belonging to me intervenes. What would be the best means of communicating, by speaking tube or by telephone, and which would be cheapest and least likely to get out of order?—J. R.

[33572.]—**Oval-Top Trunks.**—Can any fellow-reader tell me the best mode of making one of the above? They are sometimes called French trunks. My difficulty is with the top.—Amateur Carpenter.

[33573.]—**Gasholder.**—I am about erecting a small gasholder and tank, 3,000 c. f. Could any kind reader inform me of the best material to join the holders with so as to make it air or gas-tight.—Gas-tight.

[33574.]—**Resistance of Glass Tube.**—I should be glad to know of some one versed in such matters whether a thin glass tube filled with hydrogen gas (not carburetted hyd.) would offer more or less resistance to salt water than a piece of cork of the same volume as the tube? The glass must be thick enough to sustain some considerable amount of pressure.—D. A.

[33575.]—**Measuring Casks.**—Having had occasion recently to purchase a certain liquid in casks, and which is sold by the gallon, I have been led to notice a peculiarity in the casks which I should like to bring before your readers. I find it is usual to gauge the contents of the cask by a rod, which is inserted in the bung-hole, and is supposed to give the contents in gallons, &c. By comparing this process with an old rule for finding the contents of a cask I found a difference of about 40 gallons, and on examining the cask I found that instead of being round it was oval at the end, the difference in the diameters being about two inches, and the longest diameter being that through the bung. I have since examined another cask and found a similar difference. Now I do not know whether the casks are made in that shape purposely to deceive, but it is evident that the common method of gauging them will not answer. Perhaps some of your correspondents may know of a simple rule which will meet the difficulty.—Un Teinturier.

[33576.]—**Electric Clock.**—To Jostephanus.—I have commenced to make an electric clock according to the instructions given by you in No. 576, Vol. XXIII.; in fact the mechanism is almost complete, with exception of the magnet. Will you kindly tell me the number of wire to wind the magnet with, and the quantity I should require? Will it not do as well to wind the wire on very thin wooden bobbins, in the lathe, instead of directly on the magnet? I could do it easier in the lathe. The circuit wire will be No. 24, about 50 yards long, ditto return. What number of Léclanché cells should I require? I have followed your instructions so far, and should like to complete the same. Any further hints would oblige—Electric C.

[33577.]—**Looms.**—Could any one inform me if there is any information published in regard to the construction and working of the following makers' looms, by Schofield and Kirk, Huddersfield, and Platt and Co., Oldham?—A Tuner.

[33578.]—**Hammock.**—I wish to net one. Will any reader kindly tell me what sort of string, and of what strength to use, my weight being about 10 stone? Is it the same as is used for fishing nets? What sized mesh, and what is the most convenient size for hammock?—A. B.

[33579.]—**"Flying Dutchman."**—Can any one tell me if the G.W.R. Co. are going to put automatic brakes on this train? It seems folly to run the fastest train in the world without means of pulling her up within three quarters of a mile or more. I should also like to know whether the G.N.R. Co. have automatic brakes on their 10 a.m. "Flying Scotchman." Also, as a rule, on the large lines, are single driving-wheel engines being given up? Of course I do not mean the M.R.—Orion.

[33580.]—**The Comet Discovered at Washington.**—It is announced that at Washington, U.S., a large comet has been discovered. Perhaps one of the gentlemen whose practical knowledge of astronomy enriches the columns of the English Mechanic may be able to say whether it is likely to become a conspicuous object in these latitudes; and, if so, when.—Tyro.

[33581.]—**Midland Bogie Engines.**—On p. 419 of No. 693 "L. L." kindly gives us an engraving and description of No. 1,320. But is he correct in saying that the driving and trailing wheels are 6ft. 6in., and the cylinders 17½ × 26? I was under the impression that these dimensions applied to the Kitson bogie engines, Nos. 1,310-1,319, and that those by Dubs—viz., Nos. 1,320-1,339—had 7ft. wheels, and cylinders 18 × 26. Perhaps "C. E. S." will set us straight on this point. Will he also kindly tell me how many and what class of engines have been built since No. 1,339?—W. E. H.

[33582.]—**Mechanical Motion.**—I shall be much obliged by any of your readers assisting me in an investigation I am engaged in. In carrying out certain researches I require a machine to move two or more glass rods across the surface of a cylinder, 8in. diameter, one on each side, with an up and down stroke of at least 6in. (more, if possible). The rods would be crossed like two swords in fencing, or two fiddle bows, one on each side of the cylinder. I have partly formed the machine in plan, but think it very probable some of your readers could suggest a better plan than I have thought of. The motive power could be either a weight and line round a drum, or, perhaps, a spring. The motion would require to be kept up as long as possible—an hour or so at a time. If any of your clever correspondents will assist me by showing how it can best be done, they would much oblige, as I wish to obviate loss of time and money by avoiding failure. A drawing of the proposed plan would be a great advantage.—Amalgam.

[33583.]—**Shirt-making.**—Could any of your readers inform whether there is a machine for cutting, or a book treating on the above?—J. T.

[33584.]—**Tartans.**—Could any of the readers of the English Mechanic inform me of a book containing specimens of the tartans of clans and families of Scotland?—J. H. Turriff.

[33585.]—**Bath for Electro-plating Solution about 25 Gallons.**—I want a large bath. What is the best and cheapest material to make one with, or where are they to be had ready made? I at present use 8gall. bell glasses.—Roy.

[33586.]—**North Pole of Magnets.**—Which should *properly* and *correctly* be called the north pole of a bar magnet? Is it that which itself points to the north; or is it that end to which the compass needle points, as it does to the north pole of the earth? This question arises from the necessity of using a battery with the microphone, the electric current from which must pass through the coil of the telephone receiver. Now it is clear that unless the current is passed through the coil of the telephone in the proper direction, the magnet thereof will be weakened, or, perhaps, destroyed; but if the right direction be given to it the tendency of the current will be to strengthen the magnet. The first point, therefore, to be decided was, which is the north pole of the telephone magnet? The next point is, which way to send the current?—F. G. Ll.

[33587.]—**Steel.**—Would any mechanic inform me who are considered to be the best makers of cast steel, and what is the best method of welding cast steel?—J. H. Turriff.

[33588.]—**Annealed Cast Iron.**—Are these castings made of any particular sort of iron, or are they annealed after casting? If so, please explain process.—R. H. Thomas, Fermoy.

[33589.]—**Bismuth for Plumbers.**—Will some reader kindly say what kind of bismuth is used for plumber's solder?—H. Allingham.

[33590.]—**Lathe Castings.**—What is the most economical mode of obtaining castings for a carpenter's lathe, the frame of which would be made at home? Information as to probable cost, and where obtainable, will oblige. —H. Allingham.

[33591.]—**Swiss Crayons.**—Will some artistic reader kindly say what Swiss crayons are made of? Any particulars as to manner of using, and the best selection of colours for landscape drawing, will be thankfully received by—Water Colour.

[33592.]—**Esquire.**—Will some reader kindly state what constitutes an esquire (the title of dignity below a knight)? Must he be a freeholder?—Roy.

Arctic Exploration.—Mr. J. G. Bennett proposes to send his yacht Dauntless on a voyage of discovery to the Polar seas viâ Spitzbergen, in addition to the Pandora (Jeanette), which will attempt to reach the Pole by another route.

The Adulteration of Coffee.—According to M. Wittstein, a simple method of testing coffee for an admixture of chicory is to shake it well in water. If pure the coffee will float for an hour or more, but chicory sinks. This method is well known, but is not thoroughly satisfactory. It is difficult to make a trustworthy analysis without the help of the microscope, though it is comparatively easy to prove the purity of the article if it is either all chicory or all coffee. An infusion diluted with a large quantity of water and treated with bichromate of potash (a common salt), undergoes no visible change if of chicory, but if of coffee it assumes a deep brown tint. With standard test solutions the latter should prove a ready way of estimating the amount of adulteration by a comparison of the depth of tint between the suspected infusion and that of pure coffee, especially if proof of admixture is furnished by the microscope.

Catalpa Wood.—Mr. E. E. Barney, of Dayton, Ohio, gives in a recent pamphlet some interesting information in regard to the catalpa tree, and the use of its timber for railway sleepers and telegraph poles. The wood is said to possess a power of resistance to decay, especially when buried or in contact with the earth, that should make it very valuable. Fence posts made of it, that have stood in the ground forty-six years, have been taken up and show no signs of decay; and we have a specimen of the wood taken from a post that has been standing two feet in the ground for seventy-five years. The specimen is perfectly hard and sound, and is beautifully polished. The part of the post that was in the ground was decayed about a quarter of its diameter, the remainder being as sound as ever. The wood is light in weight, of compact fibre, has a handsome grain, takes a brilliant polish, and is well suited for ornamental cabinet work. Trees of four years' growth have no sap, and the older ones but a mere film, hardly thicker than paper. They are indigenous in Indiana and other parts of the West. It is very prolific and has a rapid growth, and these peculiarities would doubtless be more fully developed under favourable conditions of cultivation. A tree large enough for four railroad sleepers can be grown from the seed in 20 years. They should be planted thickly, so as to confine the growth to the trunk, and after a certain period thinned out by transplanting or otherwise. A general manager of one of the western roads will plant 640 acres this year with catalpa for future railway sleepers, and from experience thus far Mr. Barney is of opinion that with proper effort a road may in twenty or thirty years grow ties enough for its own use, and at the same time thin out and sell enough of the smaller growths for telegraph poles, fencing, and other purposes, to cover all expenses of growing and manufacturing the sleepers.—*Engineer.*

SPHINX.

*** *All communications for the "Sphinx" should be addressed to* T. Mitchesson, B.A., *City of London School, Cheapside, E.C.*

Owing to the influx of mathematical correspondence a little time will be required for a satisfactory perusal and election for insertion, the space allotted for the "Sphinx" being necessarily restricted.

Questions.

774.—Three plane angles X O Y = $\frac{\pi}{2}$, X O A = α, Y O A = β, form a solid angle. Keeping O A and O X fixed, whilst O Y is rotated through an angle θ round O A to O Z, show that

$$\cos. XOZ = 2\sin.\frac{\theta}{2}\left\{\cos.\alpha,\ \cos.\beta\ \sin.\frac{\theta}{2} \pm (1 - \cos.^2\alpha - \cos.^2\beta)^{\frac{1}{2}}\cos.\frac{\theta}{2}\right\}.$$

—Leidhold.

775.—Given $f(m)$ to be a function of m, such that $f(o) = 1$, and that the relation $f(m) - f(m-1) = (m-1)\,f(m-2)$ holds for all positive integral values of m; show that $f(m) = \underline{|m}$ times the co-efficient of x^m in the expansion of $e^{\frac{1}{2}x^2 + x}$.—Leidhold.

776.—Solve $397\frac{1}{2}\,x^{260} = 400\,x^{259} - 2{\cdot}75$.—J. T.

777. — Integral $\left(\frac{4x^2+3}{x^2+1}\right)^{\frac{1}{2}} dx$.—B. G. N.

778.—The first of a line of 10 sentries, standing at equal distances from each other, wishes to send a message of 20 words to the last. The men begin to walk at the same instant and walk even distances right and left of their posts alternately, and each time they must pass on 5 words. The transmission of the message occupies 48 minutes, and the men walk at the rate of 3 miles an hour. How far is the first man from the last?—J. A.

779.—The difference between the squares of any two prime numbers is 24.—A Student.

780.—Prove that

$$\log. x = {}^{r}_{n}\ {}_{m}\left(\frac{(x^{mn}-1)}{m(x^{n}+1)}\,m\right);$$

where $S^{r}_{m}\,.\,f(m)$ denotes the sum of (r) terms of the series whose nth term is $f(m)$.—A Student.

Solutions.

733.—With a set of weights 1lb., 3lb., 3^2lb., how could 820lb. be weighed?—[Amara.]—Reduce 820 to the scale of 3. Thus:—

$$\begin{array}{r l}
3)220 & \\
3)273 & \ldots\ 1 \\
3)91 & \ldots\ 0 \\
3)30 & \ldots\ 1 \\
3)10 & \ldots\ 0 \\
3 & \ldots\ 1
\end{array}$$

$$\therefore 820 = 3\,.\,3^5 + 1\,.\,3^4 + 0\,.\,3^3 + 1\,.\,3^2 + 0\,.\,3 + 1.$$

$$\text{But } 3\,.\,3^5 = 3^6;$$

$$\therefore 820 = 3^6 + 3^4 + 3^2 + 1:$$

—*i.e.*, One 3^6lb. weight must be used
" 3^4 " " "
" 3^2 " " "
" 1 " " "
820

—A. B. C.

754.—Is it accidental that the following simple formula gives the same result, or is it the proper way of solving the question?—

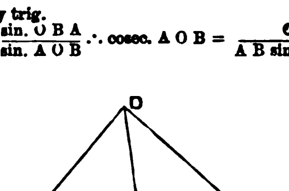
55½ miles = motion of train per 60′;
ψ miles = man's rate per 60′.
Then ψ + 55½ = 60′ work of train and man;
∴ ψ = 60 − 55½ = 4½.—S. G.

[Of course the total distance is 1-10th mile in 6 seconds —*i.e.*, 60 miles per hour, and thus 60 − 55½ = 4½ miles, the man's rate, in opposite direction.—Ed.]

764.—$x = y - y^3$. Assume $y = a\,x + b\,x^2 + c\,x^3 + d\,x^4 + f\,x^5 + \&c.$ Then $x = a\,x + b\,x^2 + c\,x^3 + d\,x^4 + f\,x^5 + \&c. - (a^3x^3 + 3\,a^2\,b\,x^4 + 3\,a\,b^2x^5 + 3\,a^2c\,x^5 +$ higher powers of x); ∴ comparing co-efficients of powers of x. $a = 1$, $b = 0$, $c = a^3 = 1$, $d = 3\,a^2$, $b = 0$, $f = 3\,(a\,b^2 + a^2\,c) = 3$. ∴ $y = x + x^3 + 3\,x^5 + \&c.$—James Seaford.

765.—By trig.

$$\frac{OA}{AB} = \frac{\sin. OBA}{\sin. AOB}\ \therefore \text{cosec. } AOB = \frac{OA}{AB\sin. OBA}$$



$$\frac{OC}{BC} = \frac{\sin. OBC}{\sin. BOC}\ \therefore \text{cosec. } BOC = \frac{OC}{BC\sin. OBC}$$

$$\therefore OC\ \text{cosec. } AOB : OA\ \text{cosec. } BOC$$

$$:: \frac{OA\,.\,OC}{AB\sin. OBA} : \frac{OC\,.\,OA}{BC\sin. OBC};$$

but sin. O B A = sin. O B C $:: \frac{1}{AB} : \frac{1}{BC}$—*i.e.*,

$$\frac{OC}{AC} = \frac{\sin. OAC}{\sin. AOC}\ \therefore \text{cosec. } AOC = \frac{O}{AC\sin.}$$

$$\frac{OB}{AB} = \frac{\sin. OAB}{\sin. AOB}\ \therefore \text{cosec. } AOB = \frac{O}{AB\sin.}$$

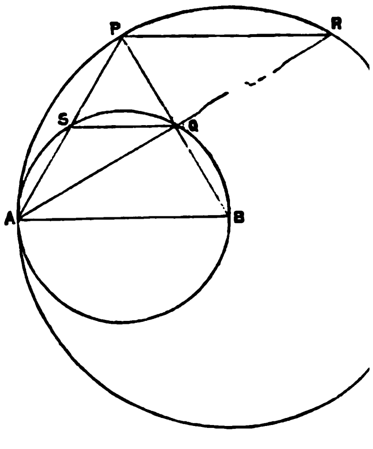
$$\therefore OB\ \text{cosec. } AOC : OC\ \text{cosec. } BO$$

$$:: \frac{OC\,.\,OB}{AC\sin. OAC} : \frac{OB\,.\,OC}{AB\sin. OAB}$$

$$:: \frac{1}{AC} : \frac{1}{AB}\ \text{—i.e., } AB\,.\,AC$$

By which it is seen the given relationship is proportion to the division of the line A C.—Pea

761.—Produce A Q to meet the circle A P Draw A P, meeting the circle A Q B in S, and S Q. Then, because the circle A P Q bisects ev from A, in the circle A P R, the chords A R, bisected in Q and S; therefore R P is parallel to



the angle R P A equal the angle Q S A; the segments A P R, A S Q, are similar; and, si double of A Q, the segment A S Q is a fourth p segment A P R, and therefore half of the figure L. S.

766.—

$$(y+3)_2\,y^4 + 6\,y^4 + \frac{115}{6}\,y^3 + \frac{25}{2}\,y^2 + \frac{7}{2}\,y$$

$$\text{Add } \frac{49}{144},$$

$$(y^3 + 3\,y^2)^2 + 2\,(3\,y^4 + \frac{115}{12}\,y^3 + \frac{7}{4}\,y^2) + 9$$

$$+ \frac{49}{144} = \frac{169}{144}.$$

Extracting square root—

$$y^3 + 3\,y^2 + 3\,y + \frac{7}{12} = \pm\,\frac{13}{12},$$

$$\text{Add } \frac{5}{12},$$

$$y^3 + 3\,y^2 + 3\,y + 1 = \frac{3}{2}\ \text{or}\ -\ \frac{2}{3}.$$

Extracting cube root—

$$y + 1 = 3\sqrt{\frac{3}{2}}\ \text{or}\ -3\sqrt{\frac{2}{3}}$$

$$y = -1 + 3\sqrt{\frac{3}{2}}\ \text{or}\ -1 - 3\sqrt{\frac{2}{3}}$$

—W. Morshead.

Answers.

L. S., 762, 764, 748, 761, 741; James Seaford 765, 761, 762, 763; Peake, 761, 764, 765; W. 761, 766; Anon, 766, 767; T. G., 754; J. F. W. 763, 772, 768, 773.

Industrial Science Exhibition.—Arr are being made in Paris for an interesting 1879 to the present exhibition, which entitled "Exposition des Sciences App l'Industrie." It will occupy the o de l'Industrie. Assurances of co-oper the part of leading scientific and industri ages have been so numerou, that the the undertaking is considered already we teed. The programme defining the aims of the exhibition will appear at any early

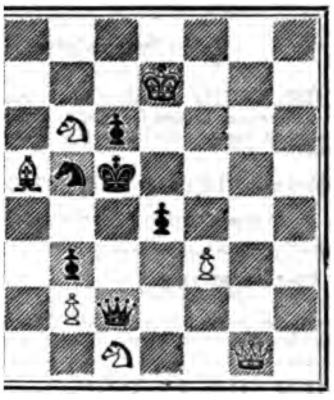
A Hand Torpedo.—A new warlike ap it is said, about to be introduced into t and will probably be known as the "hand Like the grenades of half a century ago tended to be thrown by hand into the enem or over parapets or stockades; but instea a shell exploded by a fuse, as a grenade, it sist entirely of gun-cotton compressed into ball of 3lb. or 4lb. weight. A long cord i to each charge, by means of which the c be fired. One such charge skilfully app annihilate a boat's crew, and in the hand men might work great destruction by bei into large ships.

CHESS.

ımunications intended for this department lressed to J. Pierce, Copthill House, Bedford.

ɪLEM CCCCXXXV.—By W. T. Pierce.

Black.



White.

Vhite to play and mate in two moves.

Solution to 433.

White.	*Black.*
Q Kt 2.	1. P to K 5.
K R 6.	2. Anything.
ıtes.	

Notices to Correspondents.

received with thanks from H. M. Prideaux and ch.

ɔlutions to 429 and 430 by J. G. F.

r **Treatment of Tape-worm.**—Maleousso, and the bark of the pomegranate ıe anthelmintics usually employed to expel .t their action is violent, and often un- A careful inspection will always enable l attendant to discover the ova and frag- he parasite in the stools, and when this done we have a simple and effectual insuring a cure. From the results of experiments M. Bouchut has ascertained ınly ascarides, but fragments of tæniæ, d in a weak alcoholic solution, containing amylaceous pepsine, are digested by the course of twelve hours. We thus obtain l digestion of the animal matter exactly that which ensues when meat is treated ıe process. On submitting the conclusion n his experiments to the test of practice ıns Malades, M. Bouchut found that the f pepsine was eminently successful. If nce be confirmed a valuable addition will adult as well as to infantile therapeutics. ion we may observe that animal food is, tainly, the channel through which the conveyed; and hence that official inspec- ıspected dealers in meat would form a ınct to the practice of the physician.

ɔon **Living without a Brain.**—Dr. described before the American Philoso- .ety (Feb. 1, 1878), a case of the extirpa- rly the whole of the cerebrum of a pigeon, pon by himself. He desired to place on fact that the animal not only survived the 4 days, but that it gradually regained its rs and habits of flight, and its ability to and drink. Only one other such case is

ɔlcano in Peru.—A Peruvian newspaper, says that extraordinary phenomena have red in connection with the "Corpuna" ı the province of Castilla, which have ıt alarm among the population. The im- ıs of snow which have crowned its summit immemorial have suddenly melted away rapidity as to cause torrents to rush down f the mountain, washing out immense of stones and earth. The river below, le to contain the great body of water so lded to it, overflowed its banks, causing ge and distress. A great chasm or lateral opened on one side, throwing out volumes and steam as well as tongues of flame, distinctly visible at night, accompanied ubterranean rumblings. It had never been ıat the Corpuna was or could be a volcano, no tradition that it was ever in a state . Nor within the memory of man has its ıow ever been absent.

ANSWERS TO CORRESPONDENTS.

*** *All communications should be addressed to the* Editor *of the* English Mechanic, 31, *Tavistock-street, Covent Garden, W.C.*

HINTS TO CORRESPONDENTS.

1. Write on one side of the paper only, and put drawings for illustrations on separate pieces of paper. 2. Put titles to queries, and when answering queries put the numbers as well as the titles of the queries to which the replies refer. 3. No charge is made for inserting letters, queries, or replies. 4. Commercial letters, or queries, or replies are not inserted. 5. No question asking for education or scientific information is answered through the post. 6. Letters sent to correspondents, under cover to the Editor, are not forwarded; and the names of correspondents are not given to inquirers.

The following are the initials, &c., of letters to hand up to Tuesday evening, July 23, and unacknowledged elsewhere:—

H. Allingham.—W. A. Carver.—Hugh Jones.—Henry Crouch.—Rev. J. B. Annesley.—J. Baxendale.—S. Middleton.—F. W. Streatfield.—Walter.—G. H. A.—W. Clark.—B. W. Lane.—Ne Sutor.—Enquirer.—Americus.—E. E. L.—Dip of Horizon.—150,000 Miles by Sea.—Walter A. Webber.—C. F. Tootal.—B. R.—E. Sprague.—One in Ernest.—X. O. X.—Thos. Cridland.—An Amateur Flautist.—J. H. Cross.—Practical Wheeler.—Archimedes.—B. Riley.—T. S.—W. H.—D. Fraser.—C. Engineer.—A Mechanic.—Asor.—J. Probert.—Nandem.—Berkshire Typo.—W. Walker.—Ram Chand Biswas.—N. S. Heineken.—Woolwich.—M. W. G.—Beaver.—R. S.—Wallasey.—Artist using a Quantity.—Bernard McGuire.—I. F. Ballard.—Arthur Bethell.—W. W. B.—F. J. Jackson.—J. W. Durrad.—Dandie Dinmont.—F. H. de R.—Eillin Sivad.—A Country Subscriber.—C. J. Leaper.—Capt. Curtis.—Os.—C. L.—Athelstane.—C. W. Woodcock.

Rev. E. Hall. (You might find a customer by advertising them in our columns.)—Grey Rubber and Vortex. (Dozens of receipts appear in back numbers, from which you can take your choice.)—Ex-Lancer. (We cannot advise you as to the selection of a bicycle. All the good makers advertise in these columns, and you can hardly go wrong in trusting yourself in their hands.)—A Subscriber. (We think you could hardly make or buy anything of the kind cheaper than Mr. Striffler's "Marvel Meter," see p. 424, No. 693.)—Scientific. (Purely a commercial matter, about which we can neither give nor ask advice. Thanks for the reply, but the query has already been similarly answered.)—J. H. Turriff. (We cannot say what the rules of individual clubs are; probably an advertisement in our columns asking the secretaries of such to send you copies would be responded to, or you might write to the editor of the *Bicycling News*.)—Assevero Crawle. (Interesting, but beyond the limits of our space. There is no end to the number of magic squares that can be formed, nor, apparently, to the correspondence the subject provokes, and which we are reluctantly compelled to exclude.)—Small 'un. (No, unless, indeed, some accident has been sustained.)—F. Dodd. (Practicable enough. Many designs for steam velocipedes have been given in earlier volumes. See Vols. IX., X., and XI)—F. G. Ll. (Your difficulty with your "authorities" arises from the fact that translators sometimes translate too literally. Had you turned to Mr. Sprague's book you would have found, p. 322, "There is no difference of property, no inherent directive tendency in these ends; but in England we call the face S the south pole of the magnet, because it ranges itself in the earth's magnetic field facing to the south pole of the earth. In France they call it the N. or Boreal pole, because it has the same magnetic character as the north pole of the earth." We, however, insert your query in abstract, as it may elicit information of value to the numerous students of the telephone and microphone.)—J. Hall. (Microscopic eels are found in paste. Mix a little flour and water to a thin paste, stir it every day with a spoon to prevent it becoming mouldy, and during this weather it will speedily swarm with "eels.")—Invicta. (Are the chimneys of most new locomotives wider at the top than the bottom? That form of chimney is adopted with the idea of giving free vent to the exhaust.)—Ironclad. (We cannot advise in ignorance of your capabilities. You had better apply to the chief engineer of some steamship, but an engagement is not likely to result if your experience has been wholly acquired in a machine shop on land.)—Essex. (Nobody doubted the fact that we know of. In the case of the microphone, the *distance* at which the tramp of the fly can be heard is the wonder.)—E. Turtle. (See query 33449, and watch for a reply thereto.)—Bernard McGuire. (No.)—F. T. L. (Felt hats, according to Stow, were first made in England by Spaniards in 1510, but it seems probable that they were known in this country before that time. Felt hats, by the way, are by no means such modern articles of dress as you seem to imagine. The ancient Greeks made and wore them in all forms—broad brimmed and narrow brimmed, conical, truncated, and without brims. The slang term for a hat—if, indeed, it is a slang term—indicates its antiquity. With us *castor* means a hat, from the beaver which formerly supplied the best material, that animal deriving his name from a Sanscrit word meaning musk.)—No Flat. (You probably mean the Map of Cosmas of Alexandria, known as *Indico-pleustes*. He lived in the sixth century, and his map was the epitome of monkish geography, and was quoted by the Spanish priests as an argument to dissuade Columbus from his voyage in search of the New World. It represented the earth as a plane twice as long as broad, embracing the Mediterranean Sea, and indented by the Red Sea, the Persian Gulf, and the Caspian, and surrounded by the ocean.)—Automatic. (You must search yourself; hundreds of patents have been taken out during the last 30 years, in this country and the United States, for improvements in machines for making paper bags, so a very careful search is necessary.)—T. H. (Fireproof ink for writing or printing on incombustible paper is made as follows:—Graphite, finely pounded, 22 drachms; copal or some similar gum, 12 grains; sulphate of iron, 2 drachms; tincture of nutgalls, 2 drachms; sulphate of indigo, 8 drachms. These substances are mixed and boiled thoroughly in water, and the ink thus obtained is said to be fireproof, and insoluble in water. Earthy mineral pigments are substituted for the graphite when any other colour than black is desired.)—Talipat. (The carbolic acid paper used for packing fresh meats, for the purpose of preserving them from being spoiled, is prepared by melting five parts of stearine at a gentle heat, and then stirring in thoroughly two parts of carbolic acid, after which five parts of melted paraffin are added. The whole is well stirred till it cools, after which it is melted, and applied to the paper with a brush.

Circular Motion.—We have received another long letter from Mr. Pinnington, in reply to Mr. Hodgson, in which he says:—"That there is no case in letter 14515 of a 'numerator and denominator being divided by same quantity,' and that all authorities agree that the formula (founded upon Euclid 8th of 6) for centrifugal force is only true when the arc is infinitely small, and when it vanishes, and, consequently, is only true when no circular motion at all occurs." We have already intimated that a continuance of this controversy is not desired.

Squash.—Your query is an advt.

C. J. Leaper, H. G., Assevero Crawle, and others have replied to queries already similarly answered.

USEFUL AND SCIENTIFIC NOTES.

Phosphorescence and Fluorescence.—Favé attributes both of these phenomena to "the reciprocal action of material vibrations and ethereal waves." Even ordinary phosphorus shines in a vacuum, in nitrogen, and in hydrogen, when there is no evidence of any chemical action. But when the phosphoric vapour reaches a certain density this light ceases. This furnishes one of the simplest examples of a vapour absorbing the waves which are produced by the same body when in a solid state. Such an extension of Kirchhoff's law to solid bodies is confirmed by the nitrate of uranium, which gives eight brilliant phosphorescent lines, each corresponding to an absorption line, when a spectrum is made to traverse the salt.

Transformation by the Simple Addition of Oxygen.—Demole has succeeded in transforming bromates of the ethylene series into bromides of the fatty series by the simple agitation with oxygen in closed vessels. Dry oxygen and ethylene dibromate united with the liberation of heat; the product was not the oxide of ethylene dibromate, but the bromide of bromacetyle. Ethylene tribromate rapidly absorbs dry oxygen, and is changed into bromide of dibromacetyle. Berthelot compared these results to his own experiments upon the direct oxidation of free ethylene by chromic acid, with the formation of aldehyde. Propylene and camphene furnish, by the simple fixation of oxygen, propylic aldehydes and camphor.

A Dangerous Crossing.—Colonel Yolland, in the course of a report to the Board of Trade as to the collision which occurred between an up and a down passenger train travelling in opposite directions, on May 1, at the Charlton station of the South-Eastern Railway, says:—"The responsibility must certainly rest with the railway company's management in having constructed the railway in a manner that was not authorised, nor even indicated by the special Act or the deposited plans laid before Parliament; and, further, in permitting the careful arrangement of signals and the requisite interlocking of points and signals, designed to prevent mistakes and to cover and protect this dangerous and unauthorised level crossing at Charlton station, to be altogether set aside, and allowing down passenger trains to be called into the station by the use of hand signals, which experience has fully proved are at all times liable to be mistaken and cause a great number of collisions."

Folk-Lore.—The Council of the Folk-Lore Society have now decided on their publications for the ensuing year. The first issue of the "Folk-Lore Record" will contain a paper by Mr. Ralston on folk tales, a collection of West Sussex folk-lore by Mrs. Latham, and a selection of notes from the valuable collection of Mr. Thomas and other sources. Besides this the council have decided to print a Lansdowne MS. in the British Museum, by Aubrey, the antiquary, the first part of which will be issued this year, edited by Mr. Thiselton Dyer; the first part of Mr. Pfoundes's "Nursery Tales of Japan" will also be issued. The bibliography is now under the care of Mr. Sachell, who has been engaged on the subject for some years, and has offered the results of his labours to the society.—*Athenæum.*

The success—commercially and constructively—of the Tay Bridge has given notable impetus to the other great enterprise which is required to complete the Scottish and East Coast railway system. Mr. Bouch's design for a Forth bridge has been for some time in abeyance; but in the recent passing of an Act of Parliament, which empowers four great railway companies to guarantee the undertaking a revenue of £75,000 a year, it has taken a fresh start, with every prospect of speedy accomplishment. As originally designed the great spans were to be placed at the height of 150ft. above high-water mark, so as to admit of the free passage of Her Majesty's ships of war to the anchorage of St. Margaret's Hope. Such a height being now superfluous, the promoters ask leave to cut it down to 135ft.—an alteration which, by enabling them to shorten their piers all over the structure, would insure a very considerable saving in the cost of material. Dealing with an estuary whose depth precluded the possibility of founding piers in its bottom, Mr. Bouch was obliged to adopt an entirely different principle from that so successfully carried out on the Firth of Tay. Taking advantage of the island of Inchgarvie, about midway between North and South Queensferry, he conceived the bold idea of a suspension bridge in two enormous spans. From the high ground overlooking either shore to the edge of the deep water, the railway will be carried on a series of light-looking spans, supported on cylindrical brick columns, and somewhat resembling in their general appearance the northern section of the Tay Bridge. Where the bottom begins to shelve downwards there will be placed at each side of the Firth a lofty composite pier, consisting of four sets of iron columns resting on substantial basements, and securely braced together. Immense chains, duly anchored at points some distance landward, will be carried across the tops of these piers, and of two similar piers to be planted on Inchgarvie; and from these will be suspended the two lattice girder spans, each about 1,600ft. in length, by which the deep-water channels are to be crossed. In carrying out the work the first operation will be to construct the piers and get the chains into position. The spans will be built ashore, in lengths 150ft.; and these, being separately floated out, will be successively raised to the proper height and hung on to the chains, their relative positions being so nicely adjusted that they can afterwards, without difficulty, be worked together into continuous girders.

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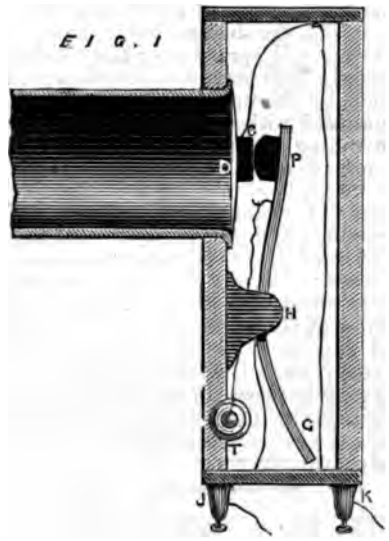
English Mechanic
AND
LD OF SCIENCE AND ART.

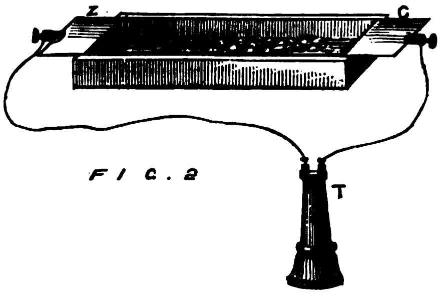
FRIDAY, AUGUST 2, 1878.

ARTICLES.

E MICROPHONE-TELEPHONE.

M a paper in the French serial *'Electricité*, we find that M. Th. du l has been experimenting with the hone with the view of discovering some of dispensing with the magneto- ;, or Bell, telephone. His results are ble, although, so far as the receiving nent is concerned, Bell's telephone emains the best instrument. The ical conclusions drawn from his ex- nts by M. Th. du Moncel show that owledge of the phenomena of the ne are far from complete, and that . views regarding acoustics require ation. So long ago as 1846 M. de la lluded to the importance of con- g molecular vibrations, and when ex- nters become familiar with the pheno- f the microphone and telephone, which appear to them incomprehen- w, will be rendered plain. M. Th. du accepts the hypothesis of molecular and demonstrated some time ago l the phenomena exhibited by the ic telephone could not be satisfac- xplained on the simple hypothesis vibrations of a diaphragm serving as ature to a magnet. It is necessary e account of a particular order of ons discovered in 1837 by Mr. Page, bsequently studied, as above men- by M. de la Rive. These vibrations an explain the transmission of words phones without diaphragms, and rigin can therefore be attributed molecular action. Recently, M. has established the truth of this de- by experiments, and has also com- the explanation by recognising that is a reaction of the helix of the -magnet upon the magnet. The later ries of Prof. Hughes and Mr. Blyth, r, demonstrated that words could be uced without the assistance of the gm—a discovery which M. du Moncel rs as the introduction of an entirely der of phenomena. He has ascer- the truth of the statement that a hone would reproduce sounds trans- by another instrument of the same but, in his first experiments, he hat it was chiefly the vibrations set he support of the microphone that us perceptible, and he was unable to that they were the result of a ical transmission of vibrations, for, he circuit was broken, or when the was withdrawn, no noise was per- e. The mercury telephone of M. t, it is true, emits sounds by means lumn of mercury oscillating under luence of electrical currents; but in rophone the vibrations can only be ed by variation in the intensity of a transmitted by means of bad con- M. du Moncel asks, then, whether ons exercised between contiguous ts of the same current produce these or whether the electric current itself a molecular vibration? He also hether the action called into play in wly-discovered phenomena is the s that which produces the sounds in wire traversed by a current?—a enon well studied by M. de la Rive moir presented to the Academy in 1846. These questions he answers by saying that, while the fact remains that the phenomena are not due to a mechanical transmission of vibrations, it would be imprudent to pronounce an opinion in the actual state of the question. Coming from M. Th. du Moncel, such an expression serves to show that, until further experiments have been made, it would be unwise to formulate any hypotheses which might lead one astray; but rather should we seek to discover the real cause by further researches. He has himself repeated the experiments of Mr. Blyth, but obtained only negative results; he has, however, devised a "very good telephone" transmitter, without a battery, as he expresses it, which is illustrated in Fig. 2, and described below. The form of microphone which M. du Moncel considers best adapted for reproducing speech is shown in section in Fig. 1. It consists of a box of thin wood, the front of which is perforated with a hole large enough to receive the tube of a common string telephone, the parchment membrane, D, stretched over the inner end of which is kept level with the surface of the board on the side at which the microphone is placed. The membrane, D, carries in its centre a small piece of metallised pine charcoal (charbon de sapin), C, which is connected by the wire, G, and binding screw, K, to the battery wire. A vertical lever, delicately pivoted on two points at H, carries at its upper end another piece of similar charcoal, P, which is lightly pressed against the piece, C. The lever is connected with the circuit by means of the wire and binding screw, J, and the pressure with which it bears on the charcoal, carried by the membrane, D, is regulated by a light spring and silk thread actuated by the tension screw, T. With a battery of six or seven Léclanché cells, words can be transmitted and received; but, says M. Th. du Moncel, they are always much less accentuated than with the Bell telephone. The apparatus, however, appears to be a neat and handy form of microphone to employ for speaking purposes, and can be made very cheaply.





In repeating Mr. Blyth's experiments, M. du Moncel appears to have employed, instead of gas cinders, which we should understand to mean coke, or perhaps pieces of retort scurf, the ordinary cinders (escarbilles) left from the incomplete combustion of coal. He attributed his failure to the proper cause, and then devised the apparatus illustrated by Fig. 2. A small shallow tray, about 4in. by 2½in., has at its opposite ends electrodes respectively of zinc and copper, which are connected in the usual way with a Bell telephone. The tray is partly filled with large pieces (gros fragments) of retort carbon, so closely packed as to form a nearly continuous bed; and when water is poured in, a "very good telephone transmitter" is obtained without a battery. The zinc and carbon plates practically form a battery, but the speech-transmitting powers of the arrangement depend entirely on the coke or gas carbon, for if the latter is removed the apparatus ceases to act. M. Th. du Moncel says that every sound and every word were exactly reproduced, and those disagreeable jarrings which sometimes accompany the sounds created by the microphone were absent. It is not to be understood that the coke tray reproduced the words, though that we believe it not impossible. The cause of the jarring noise is not yet properly understood; some attribute it to defective contacts or other faults in the circuit, but M. du Moncel, quoting some experiments of M. des Portes, expresses the opinion that certain noises heard when the telephone is connected to the telegraph wires may arise from the friction of the wires on their supports. M. des Portes found that if a bar magnet were placed in a telephonic circuit, and the two ends of the wire making the contacts are twisted around the poles, blows struck on the magnet with an iron rod can be heard in the telephone, under this condition, however, that one of the poles of the magnet is fitted with an iron plate. All the sounds produced by M. des Portes cannot be the result of mechanical transmission of vibrations, because when the circuit is broken they are not perceived. The two instruments illustrated in the figures are well adapted for the study of the phenomena, and being easily made and inexpensive, will probably attract many investigators to attempt an elucidation of the problem.

RAILWAYS FOR NEW COUNTRIES.*

THE first railway in China was practically a failure, for it offended the ideas of the Mandarins, and they bought it and stopped it, although it had been worked at a profit for twelve months. The history of the undertaking is given in Mr. Rapier's book, which contains besides a mass of information as to the cost and working expenses of machinery for building railways in new countries—*i.e.*, countries to which tramways are new. In 1865 a company was proposed for constructing a line from Shanghai to Woosung, but from a variety of causes the project was abandoned, and was not again brought up until in 1872 the author of the book before us conceived the idea of presenting the then Emperor of China with a complete railway, in the hope that experience of its working would induce the emperor to use his power in assisting capitalists to introduce railways into his country. The scheme was, however, found to be impracticable, and the emperor dying soon afterwards, was succeeded by a child of five, so that all hope of gaining a step by the personal influence of the monarch was at an end. To be prepared for all eventualities, however, Mr. Rapier constructed the Pioneer, a small locomotive able to run

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* Remunerative Railways for New Countries. By R. C. Rapier. London: E. and F. N. Spon.

15 or 20 miles an hour, weighing only 22cwt., and so small that it could be packed whole and sent out to a friend for trial on a light road, with the idea of familiarising the Chinese with steam-carriages. In 1875 it was determined to send out the engine and try the experiment of a railway upon the road laid out by the Woosung Company. The remaining capital of the company was, however, insufficient to put down a line on the full scale, and Mr. Rapier set to work to see how far the money subscribed could be made to go. A gauge of 2ft. 6in. was finally decided upon, with rails 26lb. to the yard; two locomotives of 9 tons each, and one first, one second, and four third-class carriages. The Pioneer, the first engine sent out, had cylinders of 5in. diameter, 4-coupled wheels, and a rather ugly-looking water-tank; but it weighed only 26cwt., and was easily carried by sixteen Chinese labourers. In February, 1876, it made its first trip on about three-quarters of a mile of rails, much to the delight of the Chinese, who came in hundreds to see it at work, helping in the construction of the road. The Taotai of Shanghai became alarmed, and demanded the discontinuance of the work, which was met by an agreement not to run the engine for a month to enable him to communicate with the authorities at Peking. The month having expired without any further interference, the Pioneer resumed its labours, and the populace having been advised to have nothing to do with the railway, now came in thousands to witness the operations and to get a gratuitous ride in the empty ballast trucks on the return journey. The permanent engines were six-wheel coupled, the wheels being only 27in. in diameter, and the total weight 9 tons. One of these, the Celestial Empire, made its first trip on the 12th of June, at a speed of 25 miles an hour, and on the 30th of June the opening train, containing 200 passengers, ran from Shanghai to Kangwan, a distance of five miles. On July 1 the Chinese were invited to travel free, which they did, and on July 3, 1876, traffic commenced, the receipts at once becoming of the most satisfactory character—in fact, on festivals and holidays the train with seats for only 130 frequently carried 250 passengers, and left more than that number of would-be passengers behind. In August a soldier deliberately committed suicide by walking in front of the train, and the Taotai declared that there were 500 men anxious to commit suicide on the railway. For the sake of form the driver was put on his trial, but was cleared of all blame by the evidence of his Chinese brakesmen; nevertheless, when the murder of Mr. Margary was inquired into, Mr. Wade found a disposition on the part of the authorities to look upon it as merely balancing the death of the soldier. He requested that the trains might be stopped while negotiations were pending, a proposal to which the company unfortunately acceded—unfortunately, because, as they subsequently found, they had thereby placed the undertaking at the mercy of the authorities. It was, therefore, arranged that the provincial government should buy the line, by paying in three half-yearly instalments the cost of its construction, the company working it until such time as the whole sum was paid. There were other conditions, such as no goods to be carried, which were onerous and prevented the company from earning as much as they might, but it was thought that with a clear twelvemonth in which to familiarise the people with the line, and teach them to appreciate its advantages, the great object of the promoters would be obtained. The line was extended to Woosung in December of 1876, and on the opening day many Chinese of high rank attended. Thenceforward until the last instalment of the purchase-money was due *the trains* ran regularly, the traffic, notwithstanding the "conditions," being carried on at a profit. With the exception of a few hitches, easily explained, no difficulty was experienced with the Chinese people, who used the line freely for purposes of business and pleasure, the regularity of the service in all weathers being considered of more value than even the cheapness and speed. On the 20th of October, 1877, the longest and heaviest train that had yet traversed the line started from Woosung, both sides of the railway being thronged with spectators. The final instalment was paid on the same day, but the formal handing over of the line was postponed until the 22nd, when a special train was prepared for the Mandarins, who declined it, and went to Woosung in chairs. In spite of the petition of the merchants and people, to which no reply was received, a railway that had been worked at a profit for 12 months, which was capable of returning a large percentage on its capital, was bought and paid for with the simple idea of stopping it. The author thinks, and probably he is right, that the proceeding is so much opposed to Chinese ideas of money-making that it will be more talked about than if everything had gone on, so that the time cannot be distant when railways will spread over the "Celestial" empire. This portion of Mr. Rapier's book, which, by the way, is only an appendix, is illustrated with some large photographs of the rolling stock, and the scenes on the opening days. The book proper deals with the methods of making remunerative railways, and contains a mass of technical information, with estimates of cost, that will be of considerable value to those who wish to construct light railways in new countries. There are numerous wood engravings of narrow-gauge locomotives, of railway plant and appliances, and the information is in such a form that merchants and others can readily ascertain the approximate cost of a railway without professional assistance, while the engineer will find many data very useful to him in carrying out work of the kind.

CHIEF PHENOMENA OF THE THREE PRIMARY STATES OF MATTER.

By J. Douglas Scoffern.

PART III.

I WILL confine my concluding observations to the leading phenomena attaching to water alone, as these are typical of most of the effects associated with other fluids. Glancing, then, at the subject of fluid resistance generally, we find it possessed of much interest. A body, such as a ship moving through the water with a given rate of speed, experiences a certain determinate resistance, and it follows from the laws of fluid pressure that at a double velocity the resistance will be 4 times the first; for a treble rate, 9 times; a quadruple speed, 16 times, and so on. So that in mathematical language we should render an account of this effect by saying: The resistance sustained by a body moving through water with varying velocities expressed by a, $2a$, $3a$, $4a$ * * * na, increases as the squares of the co-efficients of the several rates of motion—that is, as 1, 4, 9, 16 * * * n^2a. Taking, therefore, these values in order up to a velocity equal to $10a$, we obtain the following series—

Speed equal to	$1a$	$2a$	$3a$	$4a$	$5a$	$6a$	$7a$	$8a$	$9a$	$10a$
Gives resistance equal to ...	1	4	9	16	25	36	49	64	81	100

From a knowledge of these facts we learn that, were the power of one horse sufficient to move a vessel at a speed of 1 mile per hour, it would require exactly 25 horse-power to propel it with a velocity equal to 5 miles, and 100 horse-power if with a velocity of 10 miles an hour—that is, ten times the speed in units of time would necessarily beget a hundredfold resistance. Nor is this all, for just as the speed increases, so does the hitherto effective forward thrust of the mass of water surrounding the ship's stern diminish, and when the vessel is at rest the pressures fore and aft, of course, mutually balance; it requires yet an additional force, therefore, beyond that indicated by our theoretical tabulation, to enable the moving body to attain any speed exceeding the initial velocity. Sailing vessels almost becalmed often move along at the rate of about a mile an hour, whereas by means of a moderately stiff breeze scarcely more than about 10 nautical miles would be achieved; nor is this a matter for surprise, seeing that "when due allowance is made for the effective thrust at the stern"—a force amounting to even less than the 1-100th of that required to gain a "speed equal to $10a$," will fully suffice to insure a velocity of motion = "$1a$." Similarly also, less than the 1-400th of such power would yield a speed equal to $\frac{1}{2}a$ in similar units of time. Hence, the fact that during a complete calm a single boat's crew can lug their ship along at a sensible rate of speed. It may be well to remark here, that in the case of bodies moving through air, the effects of resistance are even greater than the foregoing. The pressure upon immersed bodies is invariably in a direction perpendicular to their surfaces, and in the case of a ship in motion, the action of a side wind is to cause her to heel to starboard or to port; therefore, the more deeply submerged side of the vessel sustains a considerable increment of fluid pressure, in this way tending to force her head round to the wind.

To effectually counteract this false motion, the rudder is caused to preserve a certain angular inclination to the central line of the hull; and to this adjustment of the steering gear the technical term of "weather-helm" is applied. Also, because of the extreme infrequency of winds directly astern, or the general occurrence of a certain degree of side-wind, the masts (and, therefore, also the entire body of canvas) are placed more forward than aft. The shape of the fore-part of a vessel affects but slightly her effective velocity; but that of the hinder portion or from the waist to the stern, and technically designated the "run," materially influences it. It is, therefore, customary to give ships a "fine run"—*i.e.*, to taper their sides, in order that the water may readily effect a forward thrust. A tree or tapering spar is capable of being moved through water much more quickly "big end on," for precisely similar reasons. Most persons are familiar with the sudden shock heard and felt along the entire length of a pipe when the cock is suddenly closed, and many need not to be reminded that the cock in reality sustains a force of impact equal to that which would be communicated to it were it "jolted" with a rigid rod of iron of equal size and weight possessed by the moving column of water, and impelled with a similar velocity; moreover, as the pressure is equably diffused, the problem of thus widening—or even rupturing a long lead pipe becomes one of considerable ease. In the "water-ram" advantage is taken of this momentum of a liquid column in rapid motion to raise water into reservoirs situated at considerable altitudes. The apparatus in principle is as follows:—A sloping pipe, furnished at its lower end with a valve opening downwards, serves to convey the stream—the valve being so constructed as to suddenly arrest the flow of water at successive equal intervals of time; near this valve is an orifice, with a valve opening upwards, and close above it is situated a globular air-chamber, from the summit of which a straight and small discharging pipe is carried immediately up to the reservoir. A falling column of water, moving for a single second through a pipe 30ft. long, 0.17ft. in diameter, and sloping downwards through a fall of 6ft., will acquire a momentum such that, by the sudden arrest to further progress of the water offered by the terminal valve being now shut, the force of impact alone will suffice to raise a similar column of water having a height of 40ft., with energy sufficient to jerk nearly half a pint of it into a tank placed at the above altitude. The use of the air-chamber is to convert the "thumping" motion of the fluid into an approximately steady flow, as in the fire-engine. A special arrangement, known as a "snifting-valve," provides a fresh supply of air to this globular vessel as required, and it is obvious that if, by a suitable mechanical provision, the lower valve be caused to close once every second, any tank so situated will be up-plied at the rate of nearly four gallons per minute—that is, it will in this way receive 240 gallons; (240 × 10) = 2,400lb.; (2,400 ÷ 112) = 21·428cwt.; or, finally, 1·0704 tons of water per hour. In actual practice the lower valve is so adjusted as to be suddenly thrown back flush with the interior of the pipe at the exact fractional part of time when the advancing stream has acquired the necessary momentum, not only to effect closure of this valve, but also to lift the required volume of water. We will now quit these theoretical considerations, and examine more minutely other phenomena connected with water generally. We already know the meaning of the "boiling point" of pure water as determined at the standard pressure; we also know the value of its "vapour tension" at this temperature and pressure. It remains now for us to examine a few of the peculiarities connected with freezing. A given bulk of water steadily contracts during the process of cooling until the temperature of 39° Fah. or 4° C. is reached, but it then commences again to expand—at first somewhat slowly—until, when almost at the actual point of congelation, or freezing, it suddenly once more increases in volume (from 1 to 1·099). In this way, then, the resulting bulk of ice formed is considerably in excess of the water producing it, and therefore of less weight—mass for mass—than water at 4° C or 39° Fah. As an actual fact, the increment of expansion between 4° and 0° C. is equal to 0·00012. Hence it is manifest that a cubic centimetre of pure water at 4° C. must actually weigh more than an equal volume taken at any other temperature, and for this reason the temperature of 4° C. is termed the *point of maximum density of water*, and furnishes the basis of weight in the beautifully philosophical arrangement of the metrical system. We have already seen that (taking air as unity) "the specific gravity of steam is 0·6219," and now, accepting pure distilled water at 4° C as unity, we find that whereas a cub. centim. of the latter weighs exactly 1 gram, an equal bulk of ice falls short of this. In order to obtain the true specific gravity of any body, we must compare it with the known weight possessed by an equal bulk of the substance which we elect to take as *unity*, and in the case of solids and liquids it is agreed to effect this comparison at the temperature of 4° C.—that is, the "point of maximum density." Evidently, then, equal volumes of ice and water could not in this way be submitted to examination because we are not in a position to estimate a given volume of ice in terms of weight *as* ice at 4° C. It will no longer be *ice*, but will furnish an *equivalent weight* of water, and the *bulk* of this *weight* of water, estimated at 4° C., will—as stated above—be in the ratio of (1—0 00012): 1, or as 0·99988: 1; that is, as 1499 82: 1500. Hence, too, as in the metrical system, measure and weight are in direct order, it is evident that equal masses of ice at 0° C. and water at 4° C. will also have the same relation in regard to weight; also as the quantities (0·99988 ÷ 1) and (1499·82 ÷ 1500) equally yield the same quotient of 0·999, it follows that (theoretically) the latter would be the actual specific gravity of ice—were it possible to estimate it as such—at the "point of maximum density of water." Thus, by calculation alone, we have just deduced the required specific gravity of ice, and as it is variously given by different authors as equal to 0·930 and 0·918 (and by ourselves at present as equal to 0·999), we may take the mean of all three values—or (2 847 ÷ 3) = 0·949; in this way we reduce the error (if any) now present in our calculation to

(0·999 − 0·949) = 0·05, or the 1-20th.

We cannot do better than bring our investigations of the fluid state to a close by working out a few simple examples. It will first be necessary, however, to offer a few prefatory remarks. When a body *sinks* in water, it displaces a volume equal to the bulk of such submerged body. When a substance is wholly suspended in water, it is pressed upwards with a force equal to the weight of the fluid mass displaced; when a body *floats* in water it sinks to a depth such that the volume of water, equal in bulk to the submerged *portion* of the substance, is also *equal to the whole weight* of the floating body. A flask having a capacity equal to 1·5 litres, is filled with pure distilled water at 4° C.; what is the weight of the fluid in grams? Because 1 litre = 1,000 cub. centim., ∴ 1·5 litre = (1,000 × 1·5) = 1,500 cbc., or grams. What would be the volume and weight of the above bulk of water if reduced to 0° C.? It would now be in the condition of ice, and would, therefore, have expanded to 1,500 + (0·00012 × 1,500) = 1,500·18 cub. centim.; also, the *weight* of this bulk of ice would clearly be identical with that of the water taken—that is, 1,500 grams. But if we required to know the weight of a bulk of ice *equal to that* of the water, or 1·5 litre, we should have to get at the result in a different fashion. It would then be necessary to multiply the weight of such volume of water by the quantity, "0·949," or that which we have just agreed to accept as expressive of the specific gravity of ice. Therefore, the weight of 1·5 litre of ice will be (1,500 × 0·949), or 1423·5 grams; but were we to adhere to our foregoing determination of the specific gravity—*i.e.*, to the value, "0·999"—the weight of such a mass of ice would be 1498·5 grams, thus giving a difference of 75 grams between the two results. We know that at the normal pressure of the atmosphere the mercurial barometer indicates a height of 30in., at what height, under similar conditions of atmospheric pressure, will a barometer stand in which use is made of a fluid having a specific gravity of only 7·5? It is necessary to remember here that the specific gravity of mercury in the fluent state is 13·568 (call it 13·6); the calculation then is extremely simple. All we have to do is to find what part of the greater specific gravity the smaller one represents, and then multiply the normal height of 30in. by such quantity. Thus: (13·6 ÷ 7·5) = 1·813, and (30 × 1·813) = (18·13 × 3) = 54·39in.—the required height. The spout of an ordinary pump is 14ft. above the level of the liquid to be raised, of which the specific gravity is known to be 1·2; it is required to determine what power (P) must be applied to the free extremity of the handle, which forms a lever of which the arms are 36 and 3 inches long respectively, when the area of the piston is 8 square inches. Evidently (14 × 12 × 8 × 1,000 + 1,728) × 1·2; or (1,344,000 + 1,728) × 1·2 = 777·77 × 1·2 = 933·324 will be the weight in ounces of the cylindrical column of fluid to be raised,* and by the principle of the "lever" we know that the forces will mutually balance when (P × 36) = 933·324 × 3: therefore 36P = 2,799·972oz., or P = 2,799·972 ÷ 36) = 77·777oz. = 4·8611lb., or 4lb. 13·777oz. What will be the specific gravity of the heaviest fluid capable of being drawn off at the normal pressure of the atmosphere by a siphon of which the shorter leg is 54·4in.? The weights of the fluid columns will, of course, be equal in either case; therefore, calling the unknown specific gravity x, (13·6 × 30) = (54·4 × x). From this it is clear that because 54·4x = 408, x alone—that is, the required specific gravity—must be equal to (408 ÷ 54·4), or 7·5. That this is correct will be manifest from the example of the barometer first above given. The last three examples relate to specific gravity and atmospheric pressure solely; we will now examine the phenomena to be met with when specific gravity and *fluid* pressure are concerned. A sphere of 6in. radius, and floating in water, is exactly half-submerged: what will be its *weight?* As the contents of a sphere are = 4-3rds × 22-7ths of the radius cubed, the entire bulk of water equal to such a globe would be 833·142 cubic inches; but, as we suppose it to be half in and half out of the water, it is clear that the mass of fluid displaced will only be equal to (833·142 ÷ 2), or 416·571 cubic inches. Then, because "one cubic foot of water weighs 1,000oz." (or 62·5lb.) the weight of our sphere must be equal to (416·571 × 1,000) ÷ 1,728 = 241 and 1.14th of an ounce (nearly), or 15·0671b. A cubic foot of fir (weighing 40lb.) floats in water. Required to know the depth to which it will be immersed? Now, if the specific gravities of this wood and water were identical, a cubic foot of the former would sink wholly beneath the surface, until, having descended through 12in., its upper face was just submerged. Thus, then, from the known weight of this bulk of water results the following proportion:—62·5lb.: 12in.:: 40lb.: x, where x = (480 ÷ 62·5) = 7·68in.—the depth of immersion sought. Let us next take the case conversely. It is found that a cubic foot of oak, when floating in water, sinks through 9in., measured from its bottom edge; what must it weigh? Again, by proportion:—12 : 62·5 :: 9 : x = (562·5 ÷ 12) = 46·875lb., or 46lb. 14oz. Take, finally, an example illustrating the principle of the "Bramah press." Into the upper face of a cylinder filled with a fluid are fitted two pistons, whose areas are respectively equal to 3·143 and 78 571 square inches. What will be the force transmitted to the larger piston when a power of 10lb. is applied to the smaller one? Here the larger area contains the smaller one (78·571 ÷ 3·143) = 24 99 times; therefore, as the pressure of 10lb. is equally imparted to every "3·143 square inches" of the larger, it is clear that (24·99 × 10) = 250lb. is the pressure sought. Similar examples relative to the phenomena of fluids will readily occur to my readers, and in all cases the practical methods of calculation are equally as simple as the foregoing. In my next paper I propose to examine some of the leading conditions affecting *solids* generally.

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* For convenience in working alone we here assume the "barrel" of the pump to be a true cylinder throughout its entire length of 14 feet; practically, however, its lower end would be considerably narrower than the upper one; but it is advisable to obviate the confusion that might arise from a calculation relative to the contents of such a figure—that is, a "cone."

SURFACING SHEET IRON.

An attempt has been recently made by an American inventor to produce sheet iron with a surface resembling that on the well-known Russian article, and apparently he has met with sufficient success to induce him to patent the process in this country. The invention of Mr. C. J. Eames, of New York, relates to a process in which iron sheets, during rolling and finishing, have produced upon them a black or blue-black glossy film or coating that is highly resistent to corrosive agencies, does not tarnish in the air, and is capable of being planished by rolling or hammering the sheet without detachment therefrom. It consists in the application successively to an iron sheet, while the same is heated and before its final rolling, first of a carbonaceous material, either solid, liquid, vaporous, or gaseous; and, second, of steam, heated to the temperature of incandescence of solid matter. The form in which the patentee prefers to apply the carbonaceous matter in the first stage is in that of vapour of petroleum or naphtha, either with or without a small admixture of steam. In carrying his invention into practice the sheets are first divested of oxide or other foreign matter by the usual methods of scouring or pickling, or otherwise.

The first stage of the peculiar process is that of carbonisation, and the method of carbonising preferred is to arrange the iron sheets or plates within a closed casing or box vertically, with spaces between them, this casing being heated to a dark red heat, just visible in daylight. A jet of highly heated vapour of petroleum or naphtha is then introduced, preferably from a suitable generator or vapourising apparatus, from which the vapour of the whole mass of oil is carried forward bodily by means of a current of incandescent steam. The sheets are subjected to this carbonising operation in an atmosphere of highly heated hydrocarbon vapour for a period of about ten or fifteen minutes. The casing may be heated to a higher degree externally, and vapour of hydrocarbon may be introduced in any convenient way, but this operation is liable to consume much time. Equivalent results also follow from the application to the sheets of solid or liquid carbonaceous matters, and external heating of the casing, but this modification of the process is expensive and tedious.

The second stage of the process consists in a treatment of the sheet iron with highly heated steam alone. This is accomplished by turning off the current of hydrocarbon vapour from the box or casing containing the sheets, and admitting the incandescent steam alone in the casing; this stage of the said process usually continues for a period of about twenty to thirty minutes. A longer period may produce a brittle coating of magnetic oxide, which is not susceptible of being planished.

The third stage of the process is the production of a planished surface by heating and rolling. For this purpose the iron is placed in piles of three sheets, which from time to time are interchanged in relative position to insure uniform planishing on all of the surfaces. If desired the mottled surface, peculiar to Russian sheet iron, is then imparted by heating and hammering with hammers having tesselated faces in the manner now commonly practised. One great advantage of this method of making planished sheet iron is the very short time required in comparison to that required by the methods now in use.

THE GEOLOGY OF CYPRUS.

THE eastern portion of Cyprus is of secondary formation, corresponding with the opposite coast of Syria. On the western side the crystalline appears, agreeing with the coast of Asia Minor. These circumstances and the form of the island would justify the opinion of the ancients that at some period it formed part of the continent.

The highest part of the northern chain of mountains is jurassic as far as Cape Elia, when tertiary limestone and marl appear. On each side of the jurassic is what the Germans call Wienersandstein. This is younger than the limestone, since it rests upon it, and belongs almost exclusively to the northern chain.

The great central plain of Messaria is quaternary, which formation is also found as a fringe along the coast from Cape Khormokite northward, turning the point of Cape Andreas and including Pandora Islands—the Kleida, or keys of Cyprus.

At Cape Greco (Pedalium), on the east, there is a patch of jurassic, and with it—but not reaching to Famagosta—a stretch of tertiary limestone and marl. Passing this we again come upon the quaternary formation of the plain which keeps the coast southward past Lanarka. This district between Famagosta and Lanarka was the site of the Idalian Forest where, according to mythology, Adonis was killed by a wild boar and changed by Venus into a flower. From Lanarka the quaternary continues down by the Kurium promontory, and also, at intervals, along the east and south coasts as far as Pumo.

The great central chain is formed of greenstone, in the highest portions surrounded by tertiary limestone and marl, on the southern part of which occur patches of Wienersandstein and greenstone, particularly between Castello and Cape Epiphanio. From the neighbourhood of Livadia to Strallus, near Lanarka, is a patch of greenstone. Very considerable denudation is manifest over all these strata.

There are patches of gypsum near Laria and Ardima, and from Vosiki to Tersephano. The hills near Lanarka abound with talc, which is used to make plaster for the houses.

Volcanic eruptions have long ceased in Cyprus, and it is not known which mountain caused extensive damage during the reign of Titus. The island is, however, still subject to earthquakes. Paphos has suffered most from them, and was once entirely destroyed. Amathus is the next.

Eruptions of gas have also long ceased, with occasional exception at a salt well near Lanarka.

The quaternary formation is abundant in fossils. There are some plants, and it is rich with foramenifferæ. A stalk of Faira was found that had been pierced through by a boring mussel, *Lithodomus lithophagus*. There are some Echinidæ and Bryozoa, and Conchifera and Gasteropoda are numerous. There are also a few kinds of Cirripedia, Ostracoda, and Brachyura.

John J. Lake.

AUTOMATIC REED ORGANS.

LETTERS patent have been granted to Mr. E. P. Needham, of New York, for a method of playing reed instruments by a novel device, which consists in an arrangement by which a perforated sheet or belt of paper or other suitable material is passed over, under, or between, the air passages, thus admitting air to the desired reeds at the proper time and for the required length of time, producing a succession of harmonic notes, so that any one, *whether a musician or not, can play any* desired melody or harmony. The sheet or belt is endless, so that any tune perforated on the same may be repeated; and it is perforated with holes corresponding with the air passages of the reeds, and the duration of the notes when arranged, so that the material of the sheet forms the valve closing the air passages, being firmly held by the suction of the bellows, which draw in the air through the perforations of the sheet only, and thus sound the required notes. One perforated sheet or belt can be readily substituted for another.

Fig. 1 is a perspective view of the new musical cabinet, the sides and top being shown open to exhibit more clearly at one view the different parts of the whole, while a portion of the belt is removed to expose the rollers. Fig. 2 is a vertical section of the instrument. The side and end of the cabinet are secured to the bottom, and form the fixed portion of the case, the other end, extending to the crank, the front and the top being hinged as shown—so that the case can be readily opened, and the endless sheets or belts of perforated music be easily inserted or exchanged; R represents the reed chamber mounted on the top of the air chamber or wind chest, which connects the reeds with the bellows, B. The crank is secured to an actuating shaft, provided with an elastic roll, E, and on its other end with a crank, K, by which the bellows is operated; L represents an endless sheet of paper or other suitable material, perforated with openings of varying length, and arranged to correspond with the reeds, so that in passing over the reed chamber the air is admitted to the desired reeds for the required time, and a succession of notes sounded to produce any piece of music desired. The sheet, L, may be made endless, as shown, perforated to sound a given musical arrangement, which can be repeated as often as desired, and with the desired interval between each reproduction, or the sheet may be rolled on one roller, and whilst unwinding from this be wound on another until the whole musical composition is played; N is a loose roller inserted in the endless sheet or belt for the purpose of keeping the same straight and even; *o* represents a hinged arm in which an elastic roller turns. When the cabinet is closed a spring presses the roller firmly against the elastic roll, E, or rather against the sheet, L, which is between the rollers, so that the turning of the roller, E, by means of the crank and handle, propels the endless sheet, and causes the various perforations to come over the corresponding reeds at the desired time, and as by the rotation of the shaft the crank, K, connected with the bellows, B, operates the same and draws the air through the perforations and the uncovered reeds, a piece of any desired music can be played accurately as to both note and time by any one, however unskilled in music. To allow the sheet or belt to pass smoothly over the reed chamber, the rollers, T T, are inserted one on each side, as seen in Fig. 2.

FIG. 1

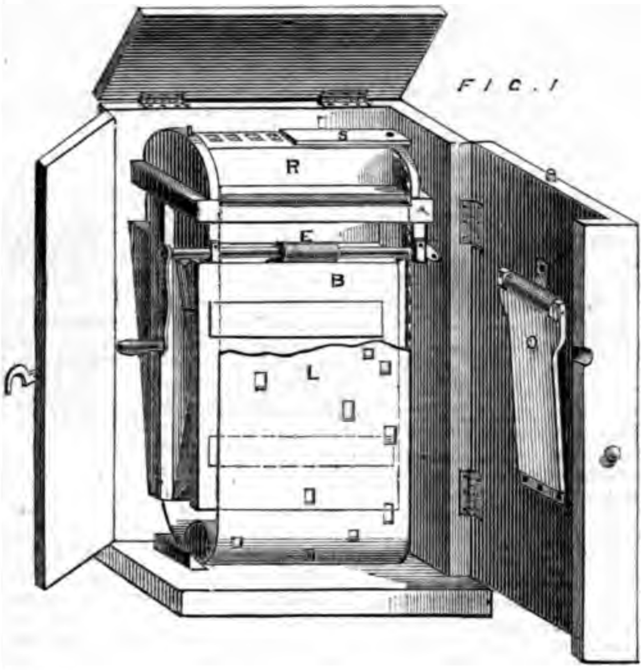
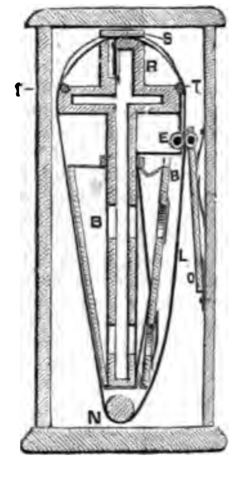


FIG. 2



S is a "resonant" placed over the apertures of the reeds, and arranged so that the same may be readily removed to allow of the insertion of the endless perforated belt or sheet of music, L. Various modifications in the construction of the cabinet and the instrument may be made, as also in the means for operating the sheet or belt. The sheet of perforated paper, prepared cloth, or other suitable material in single sheets, or in endless sheets, or belts arranged as a valve to exclude the air from all the notes of a wind instrument, except those to be sounded so as to produce the desired combination or succession of notes, can be cheaply prepared, and any desired number of tunes furnished with the instrument or afterwards acquired, so that on one instrument any tune or composition of music within its compass can be performed, and when an endless sheet or belt is used, such composition of music or tune can be repeated at pleasure with any desired interval of time.

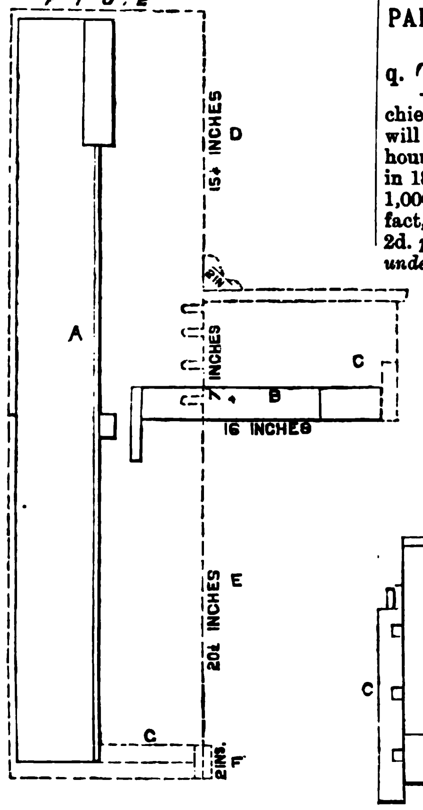
HOW TO MAKE A PIANOFORTE.—III.

THE soundboard is now ready for fixing to its place; with a wooden back it is screwed from the front into the wedges and bracings around the bent side, and nailed to the lining slips with clout-headed tacks (afterwards to be covered with varnished slips). It is better to have the holes bored and countersunk so that the soundboard may be quickly fastened before the glue (which should be rather thin, and liberally applied) has time to chill. In an iron back the linings only are to be glued, the remainder being fastened with screws from behind, or with small bolts, the heads of the screws being insulated with a felt button before "marking off;" the bridges must be planed to the proper height, so that the down bearing of the strings may not be too great; at the treble the plank bridge and lower bridge are level, and the straight edge laid across them should be ¼in. above the bent side or pinning edge, the remainder of the lower bridge being so regulated that straight edges laid on the bridge and touching the pinned edge should be of the same angle everywhere as the one at the treble; the plank bridge can then be planed to the same thickness throughout, which should be about ⅜in.; the top and bottom scales are now placed in their respective positions. It may be necessary to explain that these are ¼in. slips of wood, with holes bored at regular distances, those of the top scale corresponding with the hammers, those in the other rather er together, or, as it is termed, "contracted." convenience of reference they are also let- d to the gamut in use, a pin is placed in ı hole consecutively, and with the straight ɜ leaning against them; a line is ruled es the bent side, lower and top bridges, this representing the right-hand string of each . The first or treble hole of each should be . from outside the lining, the holes of the scale exactly covering the strike line, the ɪr laid on the bottom lining. As in an iron : the pins are already in, the lower scale be dispensed with, the straight edge being at the right side of each pin instead, and d across the bridges as before; when they ruled they must be punched with two or e holes as determined, taking care not to ch too near the edge; they are then bored the bridge pins. I find for this purpose a in. spoon bit, set in an Archimedean drill k, to be the steadiest. The holes have a ıt lean—the top bridge and top row of ɪr bridge towards the bass end, and the ɪr row of holes the reverse way. The bridges ɜ then to be glass-papered and blackleaded, wood then cut away from the front of the s, so that nothing touches the vibrating on of the wires but the bridge pins. The k is now to be marked and punched for the t pins. As it is necessary to have a "side ng," these lines must be ruled with a bevel, ngle bearing a proportion of 1 in 3, and sents the centre of wrest pin. To keep as ı as possible out of the grain line, it is r to bore the holes in four rows (or six for chord); see diagram Fig. 1, the lines pen- l and afterwards scraped out. The sizes of for stringing (music gauge) are 12 notes of 4, 12 of 15, 11 of 16, 16 of 17, 4 of 18, and 2 of 19 and 20; for a trichord 1 size less so ɜ it extends; but before putting the strings slip of baize must be laid all along the edges e bent side and plate, to prevent the wire ıg against them. The back is now ready he case. In accordance with suggestions ık a case made after the French pattern liagram Fig. 2), and of solid walnut, will ost suitable for amateurs, as it will require er special tools nor cauls for its construc-

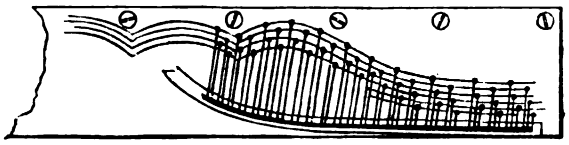
The ends are 1in. thick, 48½in. long, and wide. In glueing on, a margin must be ll round the lining; see dotted line (Fig. e cheeks (C, Fig. 2), 1½in. thick by 12 by hen being dowelled (not glued) to their ion—viz., 22½in. from bottom of end, and flush at the outside. The key-bottom, being a framework of 2in. pine, with a back rail 1in. by 4in. wide (see Fig. 3), is then fitted between them and dowelled, by template, 1½in. from their front edge, to allow for the lock-board, care being taken that the back of the key-bottom is not touching any portion of the bridge. To make sure of this it is advisable to try all together before glueing. Any measurement required may be taken from Figs. 2 and 3, they being drawn to a scale of 1 in 12. The front plinth can now be got out. This is let in between the ends with the exception of a shoulder projecting beyond them ¼in., and forming with the side plinths a border all round of that thickness. An inside bottom (C, Fig. 2) is to be fitted to fill up the space between the ends and plinth. This can be dowelled or nailed through from outside the end, as the side plinth will cover the holes.

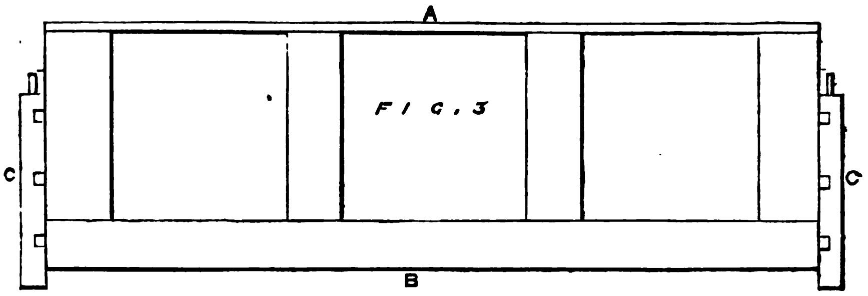
W. H. Davies.

F I G . 2



F I G . 1





THE ORGAN: A COMPREHENSIVE TREATISE ON ITS MANUFACTURE, PROCURAL, AND LODGMENT.*

By John Watson Warman,

Associate of the College of Organists, London.

PART I.—GENERAL TREATMENT IN MANUFACTURE.

q. THE objections, however, are serious. No. 1a is, obviously one, if not the chief consideration; about half a dozen stops will run away with about from 170 gallons per hour, which at 1s. per 1,000—the actual cost, in 1877, may be set at from 9d. to 1s. 6d. per 1,000—will be about 2d., and it may, in fact, be pretty confidently laid down that *under* 2d. *per hour* (or if paying by the period, say *under* 3 *to* 4 *guineas* per annum) *nothing* can be done with a Water-motor. No. 2a is, of course, very important; as has been before remarked (*see* d, *ante*) the companies guarantee to supply *material*—that is to say, the fluid itself, but not *force*; that is merely an accident of supply, and when it is considered that a fall of 65ft. is required to produce a pressure of only 25lb. to the square inch, it will be evident that much cannot be done with private Tanks or Reservoirs. The water company has performed its part when the water is, as it were, laid down at the door of the consumer; and not only can it never be expected to guarantee any given pressure for Blowing or other Motors, but it is obviously its interest, as soon as one of these is set up, to reduce the force as much as possible, for the lower the pressure per square inch *the larger the amount of water that must pass through in a given time to produce a given power*. For this reason, therefore, care must be exercised, for though there are companies which will cheerfully co-operate with the organist in the setting up of an effective and, at the same time, *moderate-priced* Motor (finding their account in an increased demand), yet, as a rule, it will be found that they object to Water-motors *in toto* unless when supplied from the consumer's own tank, alleging, as a reason, that they have not water enough. The real insincerity of the plan may be seen at a glance; with a fall of about 30ft. (quite as much as could be obtained under ordinary circumstances) the quantity used would be *considerably more than double* what is required with 30lb. to 40lb. pressure: I may add that it has been stated (*Musical Standard*, June 9th, 1877) that companies are *bound* to supply if required. No. 3a is of great moment; the companies are not bound to take any cognizance of frost, and unless the Consumer use strict precautions with respect to the thorough boxing or burying of Service pipes he may find himself frost-bound, snow-bound, and cut off from his Organ at one and the same moment. It may, however, be safely laid down that with a climate not more severe than that of the British Islands, proper precautions, as just stated, will effectually guard against frost: such a country as, say, Canada will be a very different matter. No. 4a will be obvious: water being so easily generally obtained by digging, many hundreds of comparatively large places will always remain without a water company at all.

r. No. 5a is not so serious as some of the others; still, it can be very vexatious, for the pressure may be off at just the very moment that it is most required. Thus, on Sunday mornings, in some cases, the publicans will be using a great deal to "sloosh" down their places with. For a sad tale of this description *see* English Mechanic, 1874, Feb., page 569, where a Horizontal cylinder motor, after costing from first to last about £50, exclusive of the water itself, was at last got rid of as a treacherous and intolerable nuisance. Thus, too, the engine—one of Joy's—provided for the Temple Organ, lay unused for years, until, certain alterations being made in the Instrument, some comparatively little-known person undertook, or was called in, to set the motor going; which he succeeded in doing, at the same time alleging that original incorrect construction rendered some alterations necessary. The Engine has, I believe, done duty ever since, but whether there was really anything wrong in the valves, as asserted, I am quite unable to say, but rather prefer to think that Joy, the maker, knew what he was about: and the true source of risk is unmistakably shown in the simple fact that even now a Gauge and Disconnecting pin are both placed convenient to organist, so that he can keep watch on the pressure, and disconnect at any moment when it falls below a certain point. At Winchester Cathedral a Water-motor and distinct set of French or Double-acting Feeders has been applied by Hill; but the company's pressure is so poor that not more than half the organ can be, as a rule, used on week-days; and Hand Levers are retained for instant use at any moment. On the other hand, at St. Paul's and Manchester Cathedrals the whole of the work is done by water, and efficiently; but the cost is very great. The large Organ in the Dome at Brighton is absolutely dependent on water, no other power whatever being provided; this Instrument—one of Willis's remember Registers—has a sou.-size of something like 56 stops, including a 32ft., and it is liable to be required at any moment, the corporation allowing the use of it to competent organists at 2s. 6d. per hour: concerts, religious services, and entertainments of all sorts are also constantly making large and, in some cases, sudden demands upon it; and yet, during a residence in Hove of more than two years, and in constant communication with those in the habit of using it (besides own practice), the present writer never heard of a single failure. What the cost is I cannot, of course, say; the 2s. 6d. seems suggestive: I should have liked to give some reliable figures in this case, perhaps the most illustrative of the use of Water-power of any organ in England; but the corporation of Brighton having, with the well-known large-heartedness, kindness, and courtesy of municipal bodies, refused me a simple list of the Organ-stops, I felt that to apply to them for any further information would be merely a waste of time. No. 6a is not of much weight with proper forms and workmanship in the fittings, and a little waste-pipe to provide for chance slackness will quite meet difficulty.

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s. In some cases *Eels* seem to give trouble by swimming up and finally "plugging" the small pipe: *See Musical Standard,* Aug. 1874, p. 98.

t. *See* also *Musical Standard,* May 26, 1877. *See* also Bellows arrangement for admitting of cheapest form of Hydraulic. (4, c and 18, w.).

u. Steam-engine. This will not require an extended notice here. The advantages of the Motor are:—1. Its great power, and from a single Engine. 2. Complete independence of a company, or, in fact, any outside aid. 3. Immunity from stoppage by Frost. 4. Economy in burning up odds and ends.

v. No. 1 is of no practical import: a 3 h.-p. Engine will, as already said, supply almost any Organ; if not, use two or even more distinct Motors. No. 2 is of advantage, but Gas is practically always easily accessible wherever there are gasworks; and the latter will be *almost* inevitable at any place where there stands an Organ of considerable size, except in case of a large Instrument belonging to some private person of means; and he can easily make his own Gas. No. 3 is shared by the Gas Engine in an even greater degree. No. 4 is, of course, useless except in a Factory.

w. On the other hand, the room required, the danger, the attendance and care, the dust and mess, the smoke and steam, the cleaning, the inconvenience of application, the difficulty of perfect automatic regulation, except with as many as three Cylinders, the impossibility of having ready at any moment, and the waste when Engines not actually in use, all these combine to forbid, in the most decided way, the application of Steam, except under the most peculiar circumstances, as when such a Motor is already required for other purposes besides. It may be mentioned that a Gas-heated Boiler will do away with dirt and much of attention; but the other objections remain in full force, the *expense,* at same time, being *increased.*

x. Weight. The advantage of the Weight is that the cost of maintenance is *nil,* except for wear, Mother Earth supplying the motive power. The disadvantages are the labour of winding up, the comparatively small power developed, and the chance of stoppage through neglecting to wind up, or the period of uninterrupted use being too long to admit of this.

y. The conditions render this motor somewhat valuable to the *Student.* He can do with few Stops out, or the being brought up in the middle of a Fugue, though vexing, is not serious. The labour of winding up will be healthy exercise, and the original cost (which, besides, is not excessive) will be soon made up if the Instrument be much played on, for even 1d. per hour soon tells up. On the other hand, from the defect mentioned, the Weight is obviously unsuitable for public worship or entertainments of any kind. The task of winding up may, as already stated, be got over *by Wind-engine; see* next.

z. Wind-motor.—The advantage here is, of course, a constant Motor without labour; but the power obtained is very trifling unless a very ugly affair be tolerated. I would never on any account recommend this Motor except for winding-up Weight, and then only where the expense can easily be borne, and the appearance not objected to; for it will be evident that a Winch will be required as well, wind being a force in no way to be depended on.

** Summary of Methods Compared.

[21 a.] The following are given as in the author's opinion generally useful and safe regulations; at the same time, he has no wish to dogmatise. And, after all is said, it is probable that individual predilection will in many cases prove the most powerful *motor* of all. Remember, in *all* cases where Machinery is finally decided on be sure to make provision at the same time for Manual Blowing, unless the Organ be *not* required for public worship or performances.

b. Comparison of Personal with Machine Blowing. The author would in the strongest terms deprecate all undue haste in the adoption of Machinery for Organ blowing in any country where labour is comparatively cheap, as in England; it may be with the fullest confidence laid down that, speaking broadly, the average blowist, spite of his admitted imperfections, will make as reliable a *motor* as the average machine; besides this, he is in many cases useful for a variety of other purposes which the latter can never fulfil. Exercise, therefore, the greatest caution; for whereas a stout, handy lad may, in cases where labour is not dear, do ordinary Church duty for £2 to £3 per annum, and perform a number of useful little offices besides (such as lighting up, giving out papers, looking after books, and the like) the *interest alone* on the outlay for the smallest Gas Engine and fittings will certainly reach that amount, without allowing one penny for actual Feeding or Maintenance; and the Hydraulic, which calls for much smaller primary outlay, soon makes up the difference in the great cost of the Feed. In all cases where a Hydraulic is contemplated, select some pipe (in a house or other place already supplied) that will give a fair test, and affix a Gauge indicator, taking constant readings from time to time, and for a sufficiently extended period; also inquire of householder with respect to stoppages, frost, and all other possible particulars.

c. Circumstances under which Machine-blowing may be said to be desirable may be, I think, summarised in following:—1. Daily Service; 2. Organ large, say a Sounding-size of over 25 Registers; 3. Efficient attendance with regard to lighting up, books, &c., possessed independently of blowist; 4. Organ very much in use; 5. Manual labour expensive; 6. Facility for proper lodgment and application of a Gas or other Engine; 7. Thoroughly reliable Water company, good pressure, say not under 30lb. to inch at any time, and at moderate cost, and no risk of intermittent supply; 8. Suitable Steam or other Motor required for other purposes; 9. Facility for procuring such attention, cleaning, &c., as the machine may require; 10. Difficulty in affording wages of an *adult* blowist, combined with situation of Bellows Handles, so that a boy might do mischief to Organ unnoticed (*see* Winch and Aperture, 20, j.)

d. These may be considered to speak for themselves, and the converse in each case will be a reason in favour of Personal blowing. *See* also necessity in some cases for second Reservoir, with Machine blowing (15, m.).

e. For circumstances under which a Reservoir is required solely for governing the throw off of the Engine: *see* Bellows Arr. (7, l.) and Size (15, r.).

f. Comparison of Forms of Personal Blowing. *Foot.* All forms of Power-blowing by foot, that is, using whole weight of a separate blowist, may, in the author's estimation, be dismissed at once. Foot power blowing has been for a century at least condemned, having been, in fact, the first method ever used. (*See* Rimbault, p. 12.)

g. Auxiliary Foot-blowing, that is, as a temporary substitute for separate blowist, is exceedingly useful for practise, and may freely be introduced into all small Organs, wherever placed; as regards larger Instruments circumstances must decide, as it will be, of course, only a portion of the Stops that can be so supplied. A very good rule will be to furnish with Pedal-blower all Chamber or Home Instruments, for many hours of comfortable *finger* practice can be thus insured, and so, in many cases, the expense of a harmonium or other similar instrument avoided. For small Concert Instruments of one or two imitative Stops the Blowing pedal may be said to be all required, for it will give *ample* wind; Playing-pedals do not here exist, and as space on an Orchestra is always valuable, the getting rid of the separate blowist, who is, besides, generally, in this case, visible, is very desirable.

h. As regards Church or Chapel Organs, it will not, as a rule, be worth while to supply them unless small (say 6 or 7 Sounding Stops or under), with a Foot blower; for regular pedal practice *must* have a separate blowist, and for simply finger exercise it will be hardly worth while incurring the additional expense; especially when it is considered that for half the year practising in a cold Church or Chapel is very uncomfortable; and that the particular music and exercising most likely to be used in such case—much of it, perhaps, secular—is generally such as least likely to be called for on Sunday, and, therefore, inconvenient to keep at Church. Cathedral and Concert Instruments, except as just said, or as a small ordinary Instrument, need never be troubled with a Foot-blower.

i. With regard to the kinds of Foot-blower to be used, I would limit to three. The *Treadles,* as in the Harmonium, should be applied to all Organs *un*provided with Playing-pedals, and is decidedly the most convenient form; this, however, will not include a very large number of Instruments, as Ped.-board, even in the smallest Organs, is very valuable for practice.

j. There remain the *Cranked* and the *Straight.* With respect to former, as Teacher's Blower is always of great utility in any Organ unprovided with Machine Motor, and is greatly facilitated by hanging Feeder at *side,* it will be obvious that Cranked form will here be the rule. But where for any reason Teacher's Blower is unnecessary or impracticable, the front hinging of the Feeder, and the employment of Straight Pedal will follow almost as matters of course (*see* further 6, l). The Straight form may be said to be almost imperative with front-hinged Feeder (by front is here meant nearest player).

*** PRECISE STRUCTURE AND ARRANGEMENT.

Foot-blower, all kinds.

The Component Parts are as follows: Bearings, Centres, Levers, Pedal, Plate, Shoe, Sockets, Spindle, Traces, Treadles with their Facing.

All these will be fully gone into hereafter in *Part Detailed.*

Hand-blower, Lever.

The Portions comprise these: Bearings, Centres, Fastener, Guide, King-post, Lever, Lugs, Main-beam, Queen-post, Rods, Struts, Tugs.

See fully hereafter in *Detailed.*

Hand-blower, Winch.

The Parts are: Bearings, Centres, Rods, Shaft, Wheel, Winch.

All fully treated in *Part Detailed.*

(*To be continued.*)

THE APPLICATION OF PHOTOGRAPHY TO THE PRODUCTION OF PRINTING SURFACES AND PICTURES IN PIGMENT.—II.*

By Thomas Bolas, Esq., F.C.S.

Phototypic, or raised Printing Blocks, by Swelled Gelatine Process, Zinc Etching, and other Methods.

HERE is a fatty ink transfer, similar to that which I put down on a lithographic stone during the first lecture. I now lay it on a smooth and clean zinc plate, and pass through the press. On removing the paper, by soaking, we find that the ink firmly adheres to the zinc, just as it previously did to the stone. A treatment with gum now protects the clear parts of the zinc plate against the adhesion of printing ink, and the application of the ink roller adds more ink to the fatty image already on the surface of the zinc plate. So far, our present process resembles the photo-lithographic process described last week; but, instead of printing from the zinc plate, I dust powdered resin over it, in order to give firmness to the fatty image, very slightly warm the plate, and make the resin and ink partially blend, and then put it into dilute nitric acid, containing one part of acid to about forty parts of water, and here it remains for about three minutes, during which time the acid dissolves away those parts of the metal which are not covered by the waterproof coating. Now, let us take the plate out and examine it. We find that the covered parts stand slightly in relief, but only very little, and if we were to continue the etching without further preparation, the acid would gradually undermine the lines, and the image would be lost. Now, the undermining action of the acid can easily be prevented by washing the plate, drying it, and then heating it sufficiently to just melt the resin. Under these circumstances the melted resin blends with the printer's ink, and runs down over the sides of the little ridges left by the etching, and protects these sides from the further action of the acid. Having done this it is well to gum the plate once more, ink again, dry and dust with resin before proceeding to another etching. This second etching may be done with stronger acid than the first, say one of nitric acid to 30 of water, and it may be continued longer, say, for six or seven minutes, and when this second etching is finished, the whole series of operations must be repeated, until sufficient depth is obtained, care being taken that the melting of the resin is only carried far enough to allow it to flow just over the sides of the relief left by the previous etching. In ordinary cases ten etchings are enough to give the necessary depth, but in the case of important work it may be necessary to give twenty or thirty very slight etchings in order to obtain the same depth, without endangering very fine lines or details.

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* Being the Cantor Lectures delivered before the Society of Arts.

On the table are some zinc plates illustrating the various stages of the process, and there are also some admirable specimens of finished work by Messrs. Leitch and Co., and by Messrs. Dellagana and Co.

The process of zinc etching has been largely employed for the production of typographic blocks from fatty transfers, either drawn by hand or printed, and this phase of the process bids fair to compete successfully with the art of wood engraving.

There are other methods of producing phototypic blocks, among which may be specially mentioned the method which is founded on the swelling of gelatine. These admirable phototypic blocks, which Mr. Dallas has lent me, are done by a method which he has perfected, but the nature of it has not been made public. Mr. Dallas was the first to introduce phototypic blocks into the English market, and if you carefully examine some of his specimens you cannot fail to be struck by the fineness and perfection of the details.

By the following modification of the swelled gelatine process I have succeeded in overcoming many of the difficulties of the methods already published

We start with some clear sheet gelatine about one-thirtieth of an inch in thickness. This can be prepared by drying a layer of gelatine solution on a sheet of waxed glass, or it can be purchased from Mr. Cornelissen, of Great Queen-street. To make this gelatine sensitive to light it is soaked in 3½ per cent. solution of potassium bichromate until it becomes flaccid, it is then laid on a piece of clean glass, and the excess of the solution is removed by an application of the squeegee. The plate bearing the wet gelatine is then placed in a warm, and photographically dark, place to dry, and when dry it can be easily separated from the glass by raising one corner with a penknife. We obtain in this way a flat sheet of sensitive gelatine, having a smooth surface, and all ready for exposure under the negative, and this exposure may last from 10 to 20 minutes in sunshine or correspondingly longer time in the shade.

I now take the exposed film, and put it into water to soak, and you will perceive that those parts which were protected from the light begin to swell immediately, while the exposed parts refuse to swell in the water. The soaking should last several hours, but as we cannot spare that time I will take a gelatine which has already soaked the necessary time, and make a cast from that. For this purpose I lay the wet gelatine film on a piece of glass, exposed side upwards, and squeegee it down as before; you see that it adheres to the glass quite easily, and after having made its surface dry by dabbing with a soft cloth, a little oil is applied, and distributed over the surface. Now that the excess of oil has been removed by a soft cloth I pour on plaster of Paris to a thickness of about an inch, taking care to remove any air bubbles by the application of a camel's hair brush through the liquid plaster.

Now, this plaster will take about ten minutes to become solid—so let us take another one, which was cast just before the lecture, and which is now set. If we violently tear the plaster and the gelatine apart the fine details of the cast are almost sure to be damaged. But instead of doing this, let us hold the glass plate in one hand, and gently push the plaster cast with the other. Now you see that the gelatine is slowly sliding over the glass, and finally it will slide quite off, the plaster still being adherent to the gelatine. It is now merely necessary to turn up one corner of the gelatine film, and slowly fold it back so as to draw it off the plaster gently, and without fear of damage, either to the gelatine relief or the plaster, just as a lithographer draws a thin paper proof from the stone. The next step is to make a cast in stearine from the plaster, and for this purpose the plaster should be soaked in rather warm water, about 50° Centigrade, and on this soaked and warm plaster, just as I have it here, a layer of stearine about an inch thick should be cast. Such a cast takes a long time to cool, so I have provided myself with one previously done. There it is; see how easily the stearine separates from the plaster. I now dust the stearine cast over with bronze powder, the best being a kind specially manufactured by Mr. Allen, of Mansfield-place, Kentish-town; and, this done, I put the cast into the electrotyping bath, and when a sufficient quantity of copper has been deposited it is merely necessary to back up with type metal and mount on a wood block, as in the case of this example, our work being then ready for the typographic press. If the process I have described is gone through with an ordinary half-tone negative, an exceedingly beautiful electrotype is obtained, in which the gradations of light and shade are represented by varying degrees of relief. These, or even plaster casts, ought, I think, to have a very good sale, if photographers would only take the matter up. The ease with which they can be made is surprising.

I may mention that, instead of taking a cast from the plaster in stearine, guttapercha may be used, a press being employed to force the plaster cast—which should be in an iron chase—into the soft guttapercha. Here is a cast, and here a piece of soft guttapercha. I now put them into the press, and apply pressure, and in a minute you will see what a good impression it is possible to get by this means. Of course, electrotyping on the guttapercha is very easy, but the examples on the table will illustrate the matter sufficiently.

The depth of the relief obtainable by the swelled gelatine process is about equal to that of an ordinary visiting card, and, where large surfaces of white occur, it is necessary to deepen the plate in these parts. This may be done either by cutting out the metal from the finished plate, or, in most cases, more conveniently by raising the surface of the mould, let it be wax, stearine, or guttapercha, on which the electrotypic copper is to be deposited. This is best done by holding a stick of stearine or wax in the left hand, and a warm pencil of metal in the other hand, and so holding the wax or stearine as to let a thin melted stream flow down the warm pencil. This stream is allowed to flow on those parts of the mould which require raising.

Most commercial phototypers content themselves with producing a very slight relief by photography proper, and they then deepen by hand work.

ON THE MICROPHONE OF HUGHES.[*]

AT the meeting of the Royal Society on May 9th, Professor Huxley presented a paper by D. E. Hughes of London, on the action of sonorous vibrations in varying the force of an electric current. The results described were obtained in an attempt to investigate, by means of the telephone, the effect of sound vibrations on the electrical behavior of matter. Using a Daniell battery of three cells, with a telephone in circuit, the wire conductor was subjected to strain until it broke; no sound was heard except at the instant of rupture. It was then noticed that the sound could be reproduced on making and breaking the circuit with the broken ends of the wires, or even more simply by connecting the wires with two nails placed side by side, a third lying upon them at right angles breaking or lessening contact whenever subjected to jar, even by sound waves. Ten or twenty nails piled up log-hut fashion, increased the effect, and a piece of steel watch chain worked very well. Still better results were obtained by the use of a metallic powder in a glass tube, the instrument in this form being so sensitive as to produce articulate speech. All finely divided conductors which do not readily oxidise, such as platinum, mercury and carbon, or still better metallised carbon (willow charcoal heated to whiteness and plunged into mercury) may be used for the purpose, a glass tube filled with such substances, and provided with wires for insertion in a circuit, being called a "transmitter." Exposed to sound, even when quite inaudible to the unaided ear, the resistance of the transmitter varies in consequence of the vibration, thus varying the current strength and producing in the telephone a distinct noise. The slightest touch on the table where it is lying, the merest contact with a feather or a camel's hair brush, is distinctly heard in the receiver, and both instrumental and vocal sounds are transmitted with power. Acting on these facts, Hughes devised an instrument especially adapted for magnifying weak sounds, to which he gave the name microphone. It consists simply of a piece of gas carbon, an inch long, one-fourth of an inch wide at the centre, and half an inch thick, pointed at the ends and supported vertically between two blocks of the same carbon which have small cavities hollowed out to receive it, the upper end being more blunt than the lower, and rounded. The weight of the upright piece is only just sufficient to make a feeble contact. With this form of transmitter the beating of the pulse, the tick of a watch, the tramp of a fly can thus be heard at least a hundred miles from the source of sound. In explanation of these facts, the author says: "It is quite evident that these effects are due to a difference of pressure at the different points of contact, and that they are dependent for the perfection of action upon the number of these points of contact. They are not dependent upon any apparent difference in the bodies in contact, but the same body in a state of minute subdivision is equally effective."

The results which have been obtained by Hughes, as above described, are clearly anticipated by more than a year by those of Edison. In January, 1877, while engaged in perfecting an articulating telephone, Edison made use of the fact discovered by him in 1873, that semi-conductors have the peculiar property of varying their resistance with pressure. To the centre of a diaphragm was attached a spring faced with platinum, in front of which, and movable by an adjusting screw, was a small cylinder of graphite. This arrangement gave great volume of sound, but its articulation was poor. After extensive experimenting, using the graphite mixed with various substances, lead peroxide, copper iodide, pulverised gas retort carbon, manganese peroxide, amorphous phosphorus, finely divided metals, many sulphides, tufts of silk fibre coated with metals by chemical means and pressed into discs, &c., he was led to adopt a disc made of the lampblack from petroleum smoke, and to use it in the primary circuit of a small induction coil. This constitutes the carbon telephone, which certainly, for long circuits, is the loudest trasmitter known. In June, 1877, he described a new form of relay, based on the principle of varying resistance by pressure, using dicss of carbon on the poles of the receiving electro-magnet, on which discs the armature rested. The coils of this magnet were in the primary circuit, the cores, discs and armature in the secondary. When a current passed through the magnet, the armature was attracted, compressed the carbon disc, diminished its resistance, and so increased the current strength in the secondary circuit. Since the diminution of the resistance is exactly as the pressure, the relay translated the varying current strength of the one circuit into a varying current strength in the other, of precisely similar character; thus for the first time making it possible to relay telephone currents. That the effects thus obtained by Edison are due simply to varying external contact, was first proved by C. Richards, of Hartford, in July, 1877. Placing a graphite cylinder between the jaws of a vice, platinum battery-contacts being provided at the ends, he found that the resistance of the cylinder to an electrical current diminished as the jaws of the vice were brought together, exactly as asserted. But if, in place of contacts at the ends, the connections were made by winding platinum wire round the cylinder just inside the ends, no variation of the galvanometer deflection was observed on increasing the pressure: thus proving conclusively that the phenomenon discovered and utilised by Edison depends upon the simple fact that a great variation in the resistance of a semi-conductor takes place on varying the surfaces of contact by pressure, the variation of resistance being directly as the pressure exerted.

It would seem sufficiently evident that the phenomena, of Hughes and Edison alike, are due to the varying resistance of an electrical circuit at the point or points of contact. The correctness of this explanation is proved by the increase of the effect with multiple contacts. This is accomplished by Hughes with finely divided materials such as metallised carbon, or metallic filings or carbon fragments in a glass tube; and by Edison; by layers of silk covered with graphite, by several cylinders of graphite placed in a row, or by increasing the surface of his carbon button. The extreme sensitiveness of the Hughes apparatus is fully equalled by that of Edison, all the phenomena described with it being readily repeated with Edison's carbon transmitter, especially if a carbon button be used which has been worked over several times so as to be in a state of minute division. The tick, the brush, the fly tramp, can all be heard with it. For purposes of practical telephony, however, this sensitiveness is a serious objection, and was overcome by Edison only after long experimenting. It is mainly a matter of adjustment of the contact pressure, as well in the carbon telephone as the microphone, the apparatus being the more sensitive the less the pressure. Moreover, the fact that Hughes transmits speech without the use of a diaphragm does not affect the question. Edison, months ago replaced the vibrating diaphragm of his telephone, by a plate of metal rigidly attached to the carbon, and serving to increase the loudness by increasing the surface on which the sound acts. This however, is not at all necessary. It is easy to talk with the carbon transmitter of Edison, by projecting the sound waves directly against the carbon itself as in the microphone. Finally, Edison has utilised the varying resistance of carbon contacts by pressure, in the construction of an apparatus by which minute differences of pressure may be measured, and has applied it to the construction of a thermometer, barometer, and hygrometer of extraordinary delicacy, and to the production of a rheostat of great simplicity.

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[*] By G. F. BARKER Prof. of Physics' University, Pennsylvania. From *Silliman's Journal* of July, 1878.

ELECTRICAL INDICATOR TO SHOW THE ROTATION OF THE EARTH.[*]

ALTHOUGH the apparent displacement of the plane of vibration of the pendulum had long been noticed, it was not until the year 1852 that the fact was coupled with the diurnal rotation of the earth. In September of that year M. Foucault a distinguished French physicist, suspended a ball, by means of a fine wire, from the dome of the Pantheon at Paris, and for the first time in the history of the world made visible the rotation of the earth. The pendulum thus formed, after receiving an impulse, vibrated for many hours, and preserved its plane of vibration while the earth slowly turned under it. This splendid experiment was subsequently repeated at the Capitol at Washington, and at other places, and is now about to be again performed in Paris. Soon after the pendulum experiment, Foucault, to illustrate the same thing, constructed a gyroscope which was a modification of Bohnenberger's machine. This gyroscope received a rotating impulse from the hand of the operator, and the momentum of the disc was depended on to continue the rotation for a sufficient length of time to exhibit the movement of the earth. The duration of the rotary movement thus produced must have been short, and the result unsatisfactory. Recognising the desirability of a more practicable means of making visible the diurnal movement of the earth, I have made the action of the gyroscope continuous by applying electricity as a propelling power. In Fig. 1 (which represents the machine arranged for the purpose named) the rectangular frame which contains the wheel is supported by a fine and very hard steel point, which rests upon an agate step in the bottom of a small iron cup at the end of the arm that is supported by the standard. The wheel spindle turns on carefully-made steel points, and upon it are placed two cams—one at each end—which operate the current-breaking springs. The horizontal sides of the frame are of brass, and the vertical sides are iron. To the vertical sides are attached the cores of the electro-magnets. There are two helices and two cores on each side of the wheel, and the wheel has attached to it two armatures—one on each side—which are arranged at right angles to each other. The two magnets are oppositely arranged in respect to polarity, to render the instrument astatic. An insulated stud projects from the middle of the lower end of the frame, to receive an index that extends nearly to the periphery of the circular base piece, and moves over a graduated semicircular scale. An iron point projects from the insulated stud into a mercury cup in the centre of the base piece, and is in electrical communication with the platinum-pointed screws of the current breakers. The current-breaking springs are connected with the terminals of the magnet wires, and the magnets are in electrical communication with the wheel-supporting frame. One of the binding posts is connected by a wire with the mercury in the cup, and the other is connected with the standard. A drop of mercury is placed in the cup that contains the agate step, to form an electrical connection between the iron cup and the pointed screw. The instrument is covered with a glass shade to exclude air currents, and the base piece is provided with levelling screws.

The current-breaker is contrived to make and break the current at the proper instant, so that the full effect of the magnets is realised, and when the binding posts are connected with four or six Bunsen cells, the wheel rotates at a high velocity. The wheel will maintain its plane of rotation, and when it is brought into the plane of the meridian, the index will appear to move slowly over the scale in a direction contrary to the earth's rotation, but in reality the earth and the scale with it move from west to east, while the index remains stationary, or nearly so. If the index were absolutely motionless, the scale would move under it at the rate of 15° an hour (at the poles), but owing to friction the motion of the scale or apparent motion of the index is less. It makes no difference whether the index points northward or southward—its apparent motion is always westward, thus affording visible evidence that the earth rotates.

The instrument I have thus described may be easily modified, so as to illustrate other interesting phenomena of rotary motion.

By removing the index and point from the insulated stud at the lower part of the frame, and unscrewing the supporting piece from the top of the frame, the frame may be suspended in a horizontal position upon pointed screws in a fork which is supported upon a vertical pivot, as shown in Fig. 2.

The pointed screw that enters the insulated stud is insulated, and communicates, by an insulated wire, with mercury contained in an annular vulcanite cup on the fork supporting pivot. One of the binding posts is connected with the pivot of the fork and other communicates with the mercury in the vulcanite cup. When the instrument is connected with a battery, the wheel revolves rapidly, and if undisturbed will remain in the position in which it was started. If a small weight, such as a key, be hung upon one of the pivot screws of the wheel spindle, the frame containing the wheel does not turn quickly on its pivots as might be expected, or as it would if the wheel was not revolving, but the entire apparatus immediately begins to revolve slowly on the vertical pivot, while the weighted side of the frame descends almost imperceptibly. Transfer the weight to the opposite pivot, and while the wheel still revolves in the same direction the apparatus will revolve on the vertical pivot in the opposite direction. The rotary movement on the vertical pivot is in opposition to the friction of the wheel—that is, the apparatus if rotated on the vertical pivot by the friction of the wheel on its pivots would be in the opposite direction.

FIG. 1

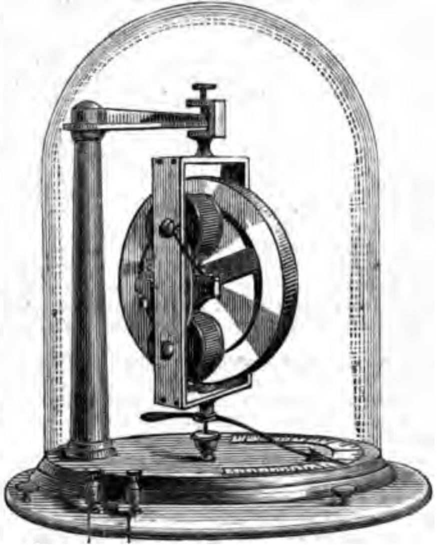
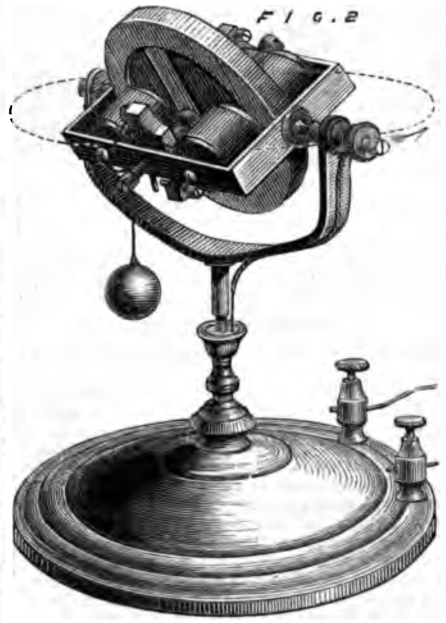


FIG. 2



By removing the weight from the pivot screw, and turning the apparatus on the vertical pivot, the converse of what has just been described will result; that is, the wheel besides revolving on its own axis will turn in a plane parallel with its axis. If the apparatus be turned on the vertical pivot in the opposite direction, the rotation of the wheel on its new axis will be reversed, and by oscillating the apparatus on the vertical pivot, the wheel and frame will revolve rapidly on the pointed screws that support the frame.

The law controlling these movements is as follows. "Where a body is acted upon by two systems of forces, tending to produce rotations about two separate axes lying in the same plane, the resultant motion will be rotation about a new axis situated in the same plane between the directions of the other two."

By means of this continuously operating gyroscope, Dr. Magnus' experiments showing some of the causes of deviation of projectiles may be nicely exhibited.

In a letter by Prof. A. M. Mayer in a subsequent number of our contemporary, the writer says:—The reading of the article by Mr. George M. Hopkins on the "Electrical Indicator for Showing the Rotation of the Earth," has suggested an addition to the apparatus which will render the experiments with it more delicate, and make manifest the rotation of the earth after the gyroscope has run for only a minute. If he will attach a plain or concave mirror to the frame of the gyroscope, and reflect a beam of light from the mirror to a screen he will have an index which may be of considerable length, of no weight, and have no momentum. If the distance of the screen from the mirror is, say, ten feet, then the spaces over which the light passes on the screen will be the same as those which would be passed over by a rod 20 feet long attached to the gyroscope as an index. This is because the angle of deflection of the reflected beam is always double of that of the angular deflection of the mirror.

The apparent angular motion per hour of Foucault's pendulm, and of his gyroscope for showing the earth's rotation is equal to 15° multiplied by the sine of the latitude of the place where the pendulum or gyroscope is mounted. Calling the latitude of New York 40° 43′, we have 9° 47′ as the amount of hourly motion in azimuth. But as the reflected beam moves through double the angle of the mirror attached to the gyroscope, we have 19° 34′ as the hourly angular motion of the reflected beam of light. In one minute of time the beam will move through 1-60th of 19° 34′, or through $19\frac{1}{4}$ minutes of arc. This angular displacement of the beam will equal ·678 of an inch, on a screen ten feet distant from the mirror. In ten minutes of time we will consequently see the spot of light on the screen, move through $6\frac{7}{100}$ inches. This quantity, however, gives the motion during the first ten minutes, if we suppose the beam to have started for a direction at right angles to the screen. The distance through which the spot of light travels will be greater during succeeding 10 minutes of time, for the distances will be the tangents of the angular deflections. If, however, the screen have a cylindrical surface, with a radius equal to the distance of the axis of rotation of the gyroscope to the screen, then the spot of light will travel over equal distances in equal successive portions of time.

For accurate measurements of the motion of the gyroscope, it will be better to place a horizontal scale of equal parts, facing the mirror at the distance of, say, five to ten feet, and view the reflection of this scale from the mirror by sighting through a telescope with cross threads in its focus. With such an arrangement, two or three minutes' observation on the motion of the scale over the cross threads of the telescope, will suffice to give the amount of angular motion, which may be compared with that which theory requires, and which is computed by any one who has a table of natural sines. He will find the sine corresponding to the angle of the latitude of the place, and multiply this by 15° (the hourly angular motion at the poles of the earth); he will then take 1-60th of the product for the angular motion in one minute, and double this result to allow for the doubling of the angle of reflection.

Foucault suspended his gyroscope by a strand of untwisted silk fibres, and if Mr. Hopkins will adopt this mode of suspension in place of the steel point, he will get rid of the friction, which should be avoided. There is a good description of Foucault's gyroscope, with four engravings, in Arago's "Astronomie Populaire," volume 3, page 50, *et seq.*

I have during the past winter repeated the Foucault experiment with the pendulum, and the apparent hourly angular motion of the instrument correspond quite well with the theoretic value. The bob of my pendulum was a thirty pound cannon ball, which I floated in a hemispherical bowl containing mercury, and thus found out the position the ball has when its centre of gravity is in a vertical line with its centre of figure. The ball was suspended in the same position it had when it floated in the mercury.

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[*] *By G. M. Hopkins, in the Scientific American.*

ERT'S "LIGHTNING" PROCESS.

Philadelphia Photographer gives the fol-
ing as Lambert's "lightning" process (?),
res its readers that it is genuine:—
enising.—Albumenise your glass as usual.
ion.—The lightning negative collodion will
finitely, and is sent ready for use. Care-
the albumenised plate, allowing the film
e well set before immersion in the bath.
plate in motion in the bath, and remove it
s the greasy lines have disappeared. The
n must be absolutely free from all actinic
o have the maximum of rapidity the plate
xposed as soon after removal from the bath
e. Filter and thin the collodion as usual,
ry.
-Usually the first bath sent is of proper
and ready for immediate use; afterwards
sent in concentrated solution. Test it, and
with distilled water or ice water, so as to
y grains to the ounce, keeping a little of
ntrated solution to strengthen the bath,
essary, to keep it at forty grains to the
After the bath has been in use for some
ll naturally deteriorate, from the absorption
l and ether and an excess of iodides. It
nen be rendered alkaline with liquid
or weak cyanide of potassium, adding
vater equal to one-half the quantity of the
and evaporate in the usual way to its
uantity; then expose to the sun until all
ion ceases, and when cold filter twice
clean filters. See that the bath is in
orty grains to the ounce, or make it so by
her distilled water or some of the reserved
ted silver solution; also add sufficient C.P.
to show the slightest trace of acidity on
s paper after one minute's immersion; for
works best when as nearly neutral as

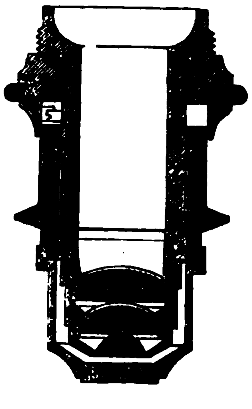
the plate be fogged, try to remove it by
ghtly with the fingers; if it comes off it
that the bath is too acid, so treat it with
monia or weak cyanide of potassium. If
in the body, and cannot be rubbed off, it
that the bath is too alkaline; then treat it
le C.P. nitric acid.
er.—This developer will keep indefinitely,
be mixed with its own bulk of distilled
re using. The development must be con-
ong as possible, being unusually slow; it
p again any precipitation without injury
ative. Use just enough developer to cover
te. Some photographers catch their
in a tray, and after filtering it use it over
out any bad results. Should the subject
red an unusually short exposure, allow the
main in the holder a few minutes after
efore development. If the picture flash
nly in the development, throw off the
developer, and rock the plate quickly
proper density is obtained. Should the
velop with too much hardness, reduce the
f the developer.
-Fix in hyposulphite of soda, as usual;
negative looks too hard, a dash of cyanide
am will soften it, but it must be used
and not too long.
ator.—The continuator is rarely needed,
dd to it an equal quantity of water, and
s of a ten per cent. nitrate of silver solu-
moment of using. It is only used after
it, to bring out the details of an under-
gative when the developer fails to do so.
ifier.—Very seldom necessary, being only
tain greater intensity, when it takes the
e continuator. Dilute it with five times
y of water, and add, at the time of using,
of a weak silver solution. It should be
lly, as it gives a very strong colour.
e careful to have the glass perfectly clean,
organic matter causes fog, and stops
velopment.

COVER ADJUSTMENT FOR ROSCOPE OBJECTIVES.*

ell-known fact among microscopists that
n glass used to cover microscopic objects
e light so as to seriously disturb the
image formed by the object-glass of the

t of the disturbance, caused by the inter-
the cover refraction with the corrections
rations of the object-glass, is the greater,
re the more annoying the greater the
power of such object-glass, and for this
more delicate must the adjustment for the
of the aberrations necessarily be. The
de of overcoming this difficulty consists
al means for increasing or diminishing
of the front lens of the object-glass used
her lenses composing the system. This
ils its purpose only within narrow limits,
d these, various secondary faults appear which seriously deteriorate the performance of even otherwise most excellent objectives.

The cause of this imperfection lies in the circumstance that the change in the relative distance of the lenses composing the objective, by which the adjustment for cover thickness is at present sought to be effected, affects principally the chromatic aberrations, while the optical influence of the covering glass preponderatingly disturbs the correction of the spherical aberration. For instance, if both aberrations of an objective are corrected in the best manner for such rays as are reflected from an uncovered object, these rays will, as soon as the object is placed under a cover glass, suffer from a spherical over-correction, corresponding to the thickness of the covering glass—in other words, the rays passing through the peripheral parts of the object-glass intersect at a greater distance from the object than those passing through the central part of it, while the chromatic aberration is scarcely affected by it. In the adjustment for cover thickness at present, however, the relations of the aberrations are exactly the reverse, for by moving the front lens away from the other lenses of the system the object-glass will become more chromatically than spherically corrected. An object-glass, therefore, which has been properly corrected for medium-cover thickness, for instance, can by means of this adjustment be adjusted so far only as to correct either the spherical aberration absolutely, and leave the chromatic aberration under-corrected, or, in the most favourable case, under-correct the chromatic aberration and over-correct the spherical aberration in such a way as to leave off both remmants of equal value. Besides this the distortions, spherical as well as chromatic, are only at a minimum when the lenses are at a certain relative position to each other, and as in objectives of high angular aperture these defects can anyhow not be quite removed, the extreme position will so increase them as to make not only the distortion and colour appearance at the margin of the field unpleasantly apparent, but to interfere seriously with the definition.



Furthermore, the changing of the relative distances of the lenses composing the object-glass seriously disturbs the focal relation of these lenses, causing a change in the magnifying powers of the object-glass which interferes seriously with micrometric measurements.

To obviate all the above-mentioned difficulties, Mr. Gundlach has invented a new cover adjustment for object-glasses, in which he places before the front lens of the objective a transparent disc with parallel sides capable of being moved by some mechanical means closer to or further away from the front lens. The general mechanical construction or arrangement of the objective is shown very clearly in the accompanying engraving, which we copy from the Patent-office report. In the space intervening between this disc and the front lens he places a transparent fluid of a refracting power equal to or nearly equal to that of glass, affording thus, by increasing or diminishing the distance between the parallel disc in question and the front lens, and increasing or diminishing thereby the thickness of the layer of refracting fluid between them, a direct compensation for the increased or decreased glass cover of the object, and consequently of the aberrations, without disturbing the focal relations of the lenses of the object-glass, thus avoiding the increased distortions, and the disturbance of the magnifying powers of the objective consequent upon and inseparable from the disturbance of the focal relations of the lenses composing the system of the object glass.

The advantages of this arrangement are obvious, and we hereby summarise and recapitulate them; they are as follows:—1. The adjustment exerts no deleterious influence on the corrections of the aberrations, and is equally as efficient for any thickness of the covering glass as for uncovered objects. 2. The working distance is the same for any cover thickness except for immersion objectives; for this reason objectives of very short working distance will with this adjustment admit of even the thickest covering glass. 3. The magnifying power is unchanged. 4. The image is placed but slightly out of focus by this adjustment. 5. The adjustment is very sensitive, thereby facilitating the exact rectification. 6. It can very easily be so arranged that the graduations on the adjustment rim indicate exactly the thickness of the cover. 7. Any casual and unavoidable defect in the movement of the adjustment, has no influence on the centreing of the objective, as any lateral displacement of the parallel disc causes no optical change whatever. The fluid between the front lens and the transparent parallel disc is glycerine, which has so far answered all expectations in a most satisfactory manner. Objectives made seven months ago have been sent long distances by rail without impairing their efficiency, and without loss or renewal of the glycerine. They might perhaps be used for years without the presence of any fluid being suspected. This new adjustment is applicable as well to immersion as to dry working objectives. It deserves to be mentioned, however, that for immersion objectives the advantages of equal working distances for every cover glass thickness do not exist. It is, however, the reverse of what it is with the old adjustment, as the working distance will be the further the thicker the covering glass happens to be.

THE COMPOSITION AND WORKING OF ALLOYS.—I.*

OF all the known metals in use at the present time iron and platinum are the only metals that bear welding and forging well, and iron or steel is the only metal that admits of being hardened beyond that degree which may be produced by simple mechanical means, such as hammering, rolling, &c. Yet all the metals, with the exception of platinum and its kindred metals, admit of ready fusion; and their fusibility offers an easy means of uniting them, and many of them combine with other metals with great readiness, and by mixing two or more of these metals by means of fusion an alloy may be formed that is of an entirely different nature from any of its constituents, and by the process of founding alloys may be cast into any desired form. The malleability and ductility of these metals, as well as their hardness and brittleness is often increased by alloying with each other, and these qualities are often turned to many useful and varied purposes. The ready fusion of these metals also affords a ready means of uniting two or more metals by the fusion of a third metal by the process of soldering. Some of these metals will unite with others in almost any proportion, and form a perfect chemical mixture, which in many cases produces a superior metal to either of its constituents, while in others the chemical affinity is limited, and they will only unite in certain proportions; and when mixed beyond these proportions the alloy is only a mechanical mixture, and often forms an inferior metal to either of its constituents. I have given several recipes for the formation of alloys by mixing these different metals; but in using these or other recipes in forming alloys the founder must not be guided entirely by the recipe, but he should use his own judgment as well, for the metals may contain certain impurities, or, as it is termed, be a poor metal, which will produce different results; and in order to produce good alloys a long practical experience is as essential as good recipes, for a man who has not had practical experience in forming alloys can no more produce a perfect alloy from arecipe than a schoolboy can produce perfect writing from his first copy.

Alloys of Iron.

All admixtures added to iron make it more fusible than when pure, although the admixtures added may not be a metal. Lead can be alloyed with iron in small quantities. A small amount of lead causes iron to be soft and tough, but too much causes it to be extreme cold-short. Copper, if alloyed with iron, causes it to be extreme red-short, and more than 1 per cent of copper will cause it to be cold-short; but a small amount of copper will increase the strength of iron when cold. Arsenic imparts a beautiful white colour to iron, resembling silver, but it makes it very brittle. Tin, when alloyed with iron, makes a beautifully fine white metal, and when the tin and iron are alloyed about half-and-half the alloy is as hard as steel, but it cannot be forged. Chromium, alloyed with iron, makes an alloy that is as hard as diamond, but it is very difficult to make this alloy. Silver, alloyed with iron in small quantities, causes the iron to be very hard and brittle, and very liable to corrode. Gold can be alloyed with iron in any amount. It causes the iron to be more yellow and tough. This alloy is principally used as a solder for small iron castings. Carbon makes iron more fusible. From 1 to 2 per cent. of carbon added to iron makes hard cast iron, and from 5 to 6 per cent. makes No. 1 foundry iron. More than 5 or 6 per cent. of carbon causes iron to be very brittle, and

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n the *American Journal of Microscopy*.

* From a series of articles by Mr. E. Kirk, published in the Iron Age.

less than 1 per cent. of carbon causes iron to be very hard and brittle. Sulphur causes iron to be both hard and brittle, either when hot or cold, and it causes molten iron to be short-lived. Fuel with sulphur in it should not be used for melting iron in contact with the fuel. Phosphorus is very injurious to iron. One-half of 1 per cent. will cause iron to be very hard and brittle when cold, but it imparts a brilliant and white colour to iron more perfectly than any other metal. Silicon makes iron brittle and hard. It has a similar effect on iron to phosphorus, but it is not near so injurious to the iron. All cast iron contains more or less carbon, sulphur, phosphorus, and silicon, and as these substances predominate they form hard or soft, strong or brittle irons; and as all anthracite coal and coke contain more or less of these substances the anthracite or coke iron is less pure and more variabie than the charcoal irons, and on account of the uncertainty of the amount of these impurities contained in cast iron it is very difficult to make an alloy of iron and other metals with any certainity as to the result, and for this reason alloyed iron is very little used.

German Silver Alloys.

German silver is composed of 80 parts copper, 20 parts nickel, and 33½ parts zinc. The best quality of German silver is composed of 100 parts copper, 50 parts nickel, and 50 parts zinc. The white copper, or packfong of the Chinese, which is the same as the German silver of the present day, is composed of 41 parts copper, 17 parts nickel, 13 parts zinc, and 2½ parts iron. A very hard German silver is made of 8 parts copper, 4 parts zinc, 2 parts nickel, and 1 part iron. This alloy is very tenacious and ductile. A still harder German silver is made of 16 parts copper, 8 parts zinc, 4 parts nickel, and 3 parts iron. The finest quality of German silver that is made is composed of 16 parts copper, 8 parts nickel, and 7 parts zinc. Ten parts copper shavings and 4 parts arsenic, arranged in a crucible in alternate layers, and covered with a layer of common salt, make a beautiful white alloy that is almost equal to silver. In making this alloy care must be taken to avoid the fumes of the arsenic.

Brass Alloys.

A very good brass is made of 16lb. of copper, 8lb. of zinc, and 1½lb. of lead. This lead should be added after the copper and zinc have been melted together. These proportions of the different metals make better brass than can be made with zinc and copper. For very light castings the lead should be omitted, as it makes the alloy less fluid; but in heavy castings it makes them more solid and clean. Button brass consists of 24 parts copper to 15 parts zinc. Red brass is made of 9 parts copper and 1 part zinc. Red brass made at Hegermuhl consists of 5½ parts copper and 1 part zinc. Brass that bears soldering well consists of 16 parts copper, and 6 parts zinc. Brass for ship nails consist of 20 parts copper, 16 parts zinc, and 2 parts iron. Red sheet brass is made of 9 parts copper and 2 parts zinc. Brass for sheathing, bolts, fastenings, &c., is composed of 6 parts copper and 4 parts zinc. This composition forms an alloy that may be rolled and worked at a red heat. Brass for pumps, and machinery requiring great tenacity, is made of 32lb. copper, 3lb. tin, and 1lb. zinc. Brass for gear wheels, to have teeth cut in them, is made of 32lb. copper, 3lb. tin, and 2lb. old brass. If it is desirable to have the wheels harder a little more tin may be added. An alloy for turned and finished work is made of 32lb. copper, 4lb. tin, and 3lb. old brass. For nuts of coarse thread one half-pound more tin may added. As more tin is added to alloys of copper and zinc, or copper and old brass, the alloy becomes harder. Razors have been made of an alloy of 32 parts copper, 5 parts tin, and 5 parts zinc. The best white hard metal for buttons is made of 16 parts copper, 2 parts zinc, and 1 part tin.

Lead and Copper Alloys.

Seven parts lead and 16 parts copper make a very cheap alloy, but it is rather short and easily broken. Two parts lead and 8 parts copper make a red-coloured alloy that is very tough. A red-coloured and ductile brass is made of 2 parts lead and 16 parts copper. Ordinary pot metal is made of 6 parts lead and 16 parts copper. This alloy is very brittle when hot, but tough when cold. The alloys of copper and lead are all very brittle when hot. More than one-half pound of lead cannot be alloyed with one pound of copper, for the copper will not unite with the lead, and the lead will ooze out in cooling. Alloys of lead and copper are very little used. Lead and copper alloys have a bluish, leaden hue when much lead is used, and are principally used on account of their cheapness.

Indestructible Writing Ink.—According to the *Pharmacist*, an ink that cannot be erased even with acids is obtained by the following receipt:—To good gall ink add a strong solution of fine soluble Prussian blue in distilled water. This addition makes the ink, which was previously proof against alkalies, equally proof against acids, and form a writing fluid which cannot be erased without destruction of the paper. The ink writes greenish blue, and afterwards *turns black.*

SCIENTIFIC NEWS.

THE death is announced of Dr. Thomas Oldham, who was, from its origination in 1850 until 1876, at the head of the Geological Survey of India. Dr. Oldham was born at Dublin in 1816, and died at Rugby on July 17. He was professor of geology at Dublin in succession to the late Prof. Phillips, and was appointed local director of the geological survey of Ireland. In 1861, eleven years after the Indian survey was commenced, he originated the publication of the "Palæontologia Indica," the sheets of which are still issued as an official publication by the Government of India. Apart, however, from his official reports, the papers he wrote were not numerous. He received one of the medals of the Royal Society in 1875, and another medal was conferred upon him by the Emperor of Austria in recognition of his work.

The joint committee of the Society of Arts, and her Majesty's Commissioners, have made excellent arrangements for sending artisan reporters to the Paris Exhibition. Each man will receive £5 at starting, and £3 on delivering his report. The fare to Paris and back will cost him 20s., either by the South Eastern or the London, Chatham, and Dover line, the ticket available for fourteen days being obtainable on presenting the certificate provided by the Society of Arts. Route cards will be furnished to the artisans, which will serve as "passports" at the railway stations, and insure the attention of guards and other officials in France, with free admission to the Exhibition. Artisans may be sent direct, selected by the joint committee or by the local committee, and they may also be sent out by employers at the rate of one for each £10 subscribed to the fund. It will greatly facilitate the comfort of the reporters if they can arrange to go in parties of ten or more, giving 10 days' notice to the Secretary of the Society of Arts; but those who travel by themselves should report their arrival to the British Commission. Every artisan reporter will be expected to spend his time in a study of the exhibits, and in visiting industrial establishments in Paris. Suitable lodgings have been secured near the Exhibition at a maximum charge of 16s. per week, and three meals a day will be supplied for 3s. The £5 advanced will thus cover all necessary expenses, so that with a couple of pounds in his pocket the artisan reporter may combine pleasure with profit, and the £3 he will receive for his report will balance the loss of wages, as each artisan will be expected to devote not less than eight days to the visit, including the journey.

The small planet discovered by M. Borrelly on August 2 last (No. 173) has been named Ino, and No. 181, discovered by M. Cottenot, on Feb. 2, has been named Eucharis.

On July 8 a comet, said to be new, was discovered by Mr. Swift, of Rochester, New York State. It is described as faint and diffused.

Mr. Edison denies (by implication) the authenticity of the telegram alleged by the *Figaro* to have been addressed by him to Sir W. Thomson (see p. 442). He denies it by saying that he never sent any dispatch whatever to the *Figaro.*

People who have been complaining of the heat here will be pleased to learn that, on the 10th of January last, the thermometer in the Botanic Garden at Adelaide, registered 116° in the shade, and 166° in the sun.

The Midland Railway Company have, as usual, taken the lead of their rivals. It was announced the other week that in future glasses of iced water would be supplied at certain stations on one of the southern lines at a charge of one penny per glass. The Midland Company will supply it gratuitously at any of the refreshment-rooms on their line.

A deputation representing the bicycle-makers had an interview with Mr. Sclater-Booth last week, and obtained an assurance from that gentleman that the clause inserted in the Highways Bill, and the bye-laws framed upon it, would meet the wishes of the deputation, and be satisfactory alike to the public and to bicyclists.

It is stated that a Russian inventor has improved the type-writer, so that capitals and small letters can now be employed at the pleasure of the operator. There is, as usual, "no difficulty in working the machine," and we are assured that 60 words a minute can be printed, as no time is lost in shifting the paper.

Sir Thomas Bazley has done a good thing by calling attention in the House to boiler explosions, and it is satisfactory to learn that the President of the Board of Trade has already come to the conclusion that further inquiry is necessary. We are to have the views of the Government next session.

To a deputation who waited upon Lord John Manners last week, in connection with the Telegraphs Bill and the telephone, the Postmaster-General suggested that probably a friendly conference between the parties interested and himself might result in a satisfactory modification of the objectionable clause. Inventors, however, are not likely to obtain much consideration from the Government.

At a meeting of the Yorkshire College of Science last week it was stated that £56,000 had now been promised in donations. There are 355 students on the books. It was stated that the communications between the Yorkshire College and Owens College on the question of the proposed new university could not at present be made into a public report.

The Giffard captive balloon has at last been "passed" for public use on certain conditions. M. Carrol has designed an apparatus for directing an elongated balloon, and it is to be tried, when ready, over the lake at Enghien, the balloon being held by a rope attached to a buoy. The most extraordinary news in the world of aërostation comes, however, from America. Mr. F. W. Schroeder is the inventor of an air-ship, the balloon of which is 91ft. long and 20ft. in diameter. The car carries an electric engine of ¼ h.p., and the requisite gearing for working the screw propeller, rudder, and pair of wings. The ship can, it is said, be held almost stationary in the air, and the inventor is confident that he could make the trip to Europe and back in five days. The cost of the ship is £1,000. Mr. Schroeder intends to build a large air-ship and start for Europe in September next.

At the séance of the French Academy, on July 1, M. J. Regnauld stated that the metal gallium exists in two states, liquid and solid, and forms an electric couple, the liquid metal being negative to the solid. He has constructed a galvanic element by means of a stratum of neutral aqueous solution of sulphate of gallium placed between the solid and liquid portions of the metal.

After the invention of the microphone it was natural to think of applying it to detect obscure sounds in the human body. But the efforts in this direction have not been very successful. M. Du Moncel announced, at a recent meeting of the Paris Academy, that the problem has been solved by M. Ducretet, who employs in his "stethoscopic microphone" the very sensitive tambours of M. Marey. The only drawback to the apparatus is, that it is rather too delicate in its action, and transmits to the ear a host of sounds, whose existence was not suspected, and the causes of which need investigation. This new instrument should greatly facilitate the work of medical men.

We may here call the attention of physicists to an illustrated account (in *Les Mondes* of July 11) of M. Ducretet's collection of electrical instruments at the Paris Exhibition. These instruments are made with the latest modern improvements.

A speaking machine is now being exhibited in Paris, at the Robert Houdin theatre, Boulevard des Italiens. A reporter in *La Nature* suspected ventriloquism on the part of the person exhibiting it; but after further examination, on invitation by the inventor, he confesses the machine gives the sound itself. The mechanism is not shown or explained. It deserves the attention of those interested in acoustical science.

A very difficult engineering work, in the construction of the lighthouse of Ar-Men, on a rock beyond the island of Sein, out from Cape Finisterre, has been in progress for some years (an account of the work appears in the *Bulletin de la Société d'Encouragement*). The rock is of hard gneiss, about 12 to 15 metres long and 7 or 8 metres broad at low water, and it is followed by reefs reaching 10 kilometres out to sea. It is very difficult of access. The first work consisted in punching a number of holes at 1 metre intervals on the rock; this was done by fishermen of the island of Sein, who came in their boats, when opportunity offered, and two of them (having cork belts on) got out and lay on the rock, which they clutched with one hand, while the hammer or jumper was held with the other. Thus they worked with feverish activity, incessantly covered with the spray dashing over them. They were sometimes carried away by the water, and had to be rescued by a boat. By the end of the working season of 1867 it had been possible to visit the rock 7 times, and have 8 hours of work; 15 holes were made. Next year there were 16 visits, 18 hours of work, and 40 new holes were made. The building was begun in 1869, and at the end of that season 25 cubic metres of masonry had been erected. At present the amount reached is 703 cubic metres, and the tower is 12·30 metres above the highest tides. The average cost of the cubic metre, which was nearly 3,000 francs in 1873, came down to 375 francs in 1875. In 1877, from various causes, the cost rose again to 750 francs. The lighthouse will be of the second order, and its light will be 28·80 metres above the highest tides.

The chemical composition of organs at the same stage of development in a particular plant-species, is, within certain limits, different in different individuals. The seed grains of wheat, *e.g.*, contain now more, now less, phosphoric acid, albuminous matters, and starch. The composition is affected, *inter alia*, by conditions of climate and weather, soil and manuring. An exposition of the facts hitherto known, and an attempt at elucidation of the laws of the phenomena, are proposed as a subject for prize competition by the Göttingen Academy (Beneke Foundation). The prizes are about £85 and £34. Papers, which may be written in German, Latin, French, or English, are to be sent in (with sealed letter and motto) before August 31, 1880. The award of the prizes is to be on March 11, 1881.

After the investment of Paris, MM. Hervé-Mangon and Durand-Claze, who had been charged to make experiments in order to determine the resistance of the air to the motion of balloons, did so at the Orleans station. One set of experiments was on a balloon of 650 cub. metres; this was attached to a small truck, which was pushed along by men, and carried also a dynamometer, which indicated the force of traction of the balloon, &c. Space and time were carefully noted. The authors arrived at a formula, which makes it possible to draw up a table indicating the ascending force which should be given to balloons at the moment of starting, so that they shall rise with a certain vertical velocity; also to regulate the velocity according to direction and intensity of the wind, so as to avoid trees, houses, &c., at starting. It was proved that every directable balloon must not cease to be completely inflated, else a large portion of the propelling force is lost. The bombardment obliged the experimenters to desist, and it is matter of regret that they were not in a position to experiment on balloons of elongated form, &c. (See *Le Technologiste*, July 7.)

A curious example of parasite-development and migration has been discovered by M. Galeb. A small worm, which has attained the adult stage in the alimentary canal of the rat, deposits its eggs there, which are carried out with fæcal matter. These eggs are swallowed by the cockroach, which devours the excrement of the rat. The embryos are developed in the alimentary canal of the cockroach, penetrate its walls, and become encysted in the fatty matter, until the cockroach in its turn is devoured by the rat, when the cycle becomes complete!

Having been struck with the beauty and hardness of cobalt obtained by the galvanic method, M. Gaiffe thinks it might be advantageously substituted for iron or nickel as a protective layer on engraved and typographic plates, and used in various other ways. It does not oxidise like iron, and so requires less care; and it is very easily dissolved by weak acids which do not attack copper, whereas it is not possible to remove the nickel deposited on a plate of copper without altering the latter. By virtue of its white colour, further, it should be prized for decolouration of other metals. M. Gaiffe uses, for the bath, a neutral solution of double sulphate of cobalt and ammonia; the anode is a leaf of platinum, or, better, a plate of cast or forged cobalt. To obtain an adherent white deposit, the current is regulated at first to about 6 B. A. units, and it is brought down to 3 units only when the whole surface has become white. With suitable intensity of current, the deposition may be effected almost as rapidly as that of nickel.

A patent has recently been taken by M. Heilmann, of Cannes, France, for production of mosaic-clay plates. Bands of clay, variously formed and coloured, are arranged in a bundle in such a way, that a section made right through, vertically to the axis, gives a particular figure. Discs of different thickness, separated from the bundle, are placed on clay blocks having the same circumference, and the union of the two parts is then effected by means of strong pressure. Of course, the entire bundle, or only certain parts of it, may be coloured irregularly, so as to produce a marble-like or variegated appearance. The chief advantage of the process is that a considerable number of similarly covered clay-plates may be produced with quite a small quantity of material, whose price would not allow of its use for the entire mass of the plate; and that a given mosaic pattern has to be prepared only once for hundreds of these clay plates. As regards durability, it is only necessary to give the plates a suitable thickness, as the wearing away of the outer surface does not disturb the pattern.

The second June number of *Dingler's Polytechnisches Journal* contains an instructive paper on petroleum. In a paper on the work of steam in the steam engine, M. Kauffer pronounces the theoretical basis of the steam jacket in expansion engines untenable, and considers a good envelope in all cases preferable.

Tire Fastenings.—A new and valuable method of fastening tires, invented by Mr. Kaselowsky, a German engineer, has successfully stood the test of a series of experiments. A dovetailed groove is turned in the inner face of the tire, and a similar one in the outside of the skeleton, so that, when the tire is slipped on, the two come opposite to each other and form a channel of dowel-shaped section going all round the wheel. Into this channel is run some easily-fusible metal (by preference pure zinc), which, on cooling, makes a firm connection between the tire and wheel. In carrying out the operation the tire is only slightly heated, a shrinkage of 1-1200th being found ample, and is then brought over the skeleton, which is laid in a horizontal position, and forced upon it. The zinc is then immediately run in through holes cast in skeleton, if of cast metal, or drilled in other cases; thus the zinc is at once prevented from cooling while being run in, and is compressed, and thus rendered much stronger, by the subsequent contraction of the tire. That this mode of fastening, in addition to its simplicity and cheapness, offers full security, both against sideways shifting, and in case of breakage of the tire, has been proved by experiments made in the central workshops at Frankfort.

A Large Piano Factory.—Hale's new pianoforte factory, Philadelphia, is said to be the largest building of the kind in the United States. It is of brick, with walls 24in. thick, and is eight stories in height. On the top floor three immense iron tanks have been placed, which are filled with water from the roof. Connected with these are iron pipes extending through each floor. To the pipes hose is attached, so that a flood of water can be poured upon any part of the building. On every floor rows of pails filled with water are kept constantly standing. The building is a vast storehouse of inflammable material, however, and a fire once under headway could not be extinguished. The only hope would be that the 1,200 workmen could all get down the stairways at either end of the building, or make their escape by the endless chain fire escapes which hang outside the windows on each of the four sides of the building. Iron shutters protect the exposed windows, and the drying rooms are of solid iron. The stoves and glue pots stand on immense brick hearths, and on every floor is stationed a man whose duty it is to keep an eye on inflammable material. When all the machinery is in place the capacity of the factory will be 200 pianos a week.

LETTERS TO THE EDITOR.

[We do not hold ourselves responsible for the opinions of our correspondents. The Editor respectfully requests that all communications should be drawn up as briefly as possible.]

All communications should be addressed to the Editor of the English Mechanic, 31, *Tavistock-street, Covent-garden, W.C.*

All Cheques and Post-office Orders to be made Payable to J. Passmore Edwards.

*** *In order to facilitate reference, Correspondents, when speaking of any Letter previously inserted, will oblige by mentioning the number of the Letter, as well as the page on which it appears.*

> "I would have everyone write what he knows, and as much as he knows, but no more; and that not in this only, but in all other subjects: For such a person may have some particular knowledge and experience of the nature of such a person or such a fountain, that as to other things, knows no more than what everybody does, and yet, to keep a clutter with this little pittance of his, will undertake to write the whole body of physicks: a vice from whence great inconveniences derive their original."
> —*Montaigne's Essays.*

PATH FOLLOWED BY LIGHTNING—DISTANCE OF HORIZON — THE "BLACK DROP"—POWER OF PANCRATIC EYEPIECE — MULTIPLYING CONCRETE QUANTITIES—ASTRONOMICAL BOOKS—HIGHFIELD HOUSE OBSERVATORY — FOSSIL SHELLS — COMET.

[14651.]—A sentence in the concluding paragraph of Mr. Webb's interesting "Notes in Travelling" (letter 14591, p. 470) reminds me that, some years ago, I witnessed a very violent thunderstorm from the neighbourhood of Tunbridge Wells, and that I very distinctly saw one flash of lightning strike upwards from the earth into a dark lowering cloud, poised at some distance above it. Theoretically, of course, this is a phenomenon which must not unfrequently occur; but the occasion to which I refer was the only one on which I ever myself observed it.

Had query 33494 (p. 483) been addressed to Mr. Lancaster only, I should not have presumed to reply to it. Inasmuch, however, as "E. B. F." appeals to "other . . . correspondents," I may tell him that his horizon was about 34 miles off. Without entering into any elaborate trigonometrical calculations, involving a knowledge of the Earth's radius at the place of observation, there is an old rough-and-ready rule giving results quite sufficiently accurate for his purpose. It is this: 1·3 times the square root of the height of the eye in *feet*, gives the distance of the visible horizon in *miles*. Thus, taking your correspondent's own example, the square root of 700, we may call 26·4575; and 26·4575 × 1·3 = 34·39175—say, 34·4 miles.

In reply to query 33505 (p. 483), the so-called "Black Drop" doubtless has its origin in the fact that the great brilliancy of the Sun causes him to appear larger, and Venus to seem less, than they respectively would do could the Solar light be sufficiently subdued. This is the familiar effect known to astronomers and physicists as irradiation. Then, again, the undulation of the Sun's limb comes into play. Further, the aperture and quality of the telescope (very notably its quality) may affect the amount of diffraction very materially; as will, in fact, even bad focussing. Moreover, optical personal equation comes into play; for the eye is very far from being a perfect optical instrument, and the mere fact that the image of a point on the retina is not itself a point, but a minute circle, must tend, in combination with the other causes at which I have hinted, to render the exact instant of separation between the limb of the Sun and planet doubtful. Mr. Theakston should read pp. 63 to 66 inclusive of the last edition of Proctor's "Transits of Venus."

"Scotland" (query 33518, p. 483) may calculate the power of *any* eyepiece whatever by the method so repeatedly given in these columns—viz., by measuring the precise diameter of the spot of light formed upon the eye-lens (which is an image of the object-glass), and dividing the diameter of the object-glass itself by the quantity so found. Suppose, for example, that your correspondent has a 2¼in. objective, and finds the spot of light on the eye-lens of his telescope to be ·045in., then $\frac{2\cdot25}{\cdot045} = 50$; so that under those conditions of adjustment his pancratic eyepiece magnifies 50 linear. Now, pulling out the eye-tube, we will imagine that the diameter of the light spot diminishes to ·03in., then $\frac{2\cdot25}{\cdot03} = 75$. The power has thus increased to 75.

Before discussing the question raised by "Erasmus" in query 33548 (p. 507), as to the propriety of the employment of the word "multiply" in connection with the combination of fractions, it might be worth his while to reflect for a moment as to the possibility of multiplying two concrete numbers together at all. 4 feet × 4 = 16 feet; but 4 feet into 4 feet is utterly meaningless. How can we conceivably imagine 4 *feet* times anything? If feet, why not nuts, hay-rakes, or candles? What would be the arithmetical result of 3 cows × 2 coal-scuttles, and yet this is every whit as sensible and intelligible an operation as ½ inch × ½ inch.

I am afraid that it is out of my power to assist Mr. Truro (query 33553, p. 507) to any extent. If Black, the publisher of "Herschel on the Telescope," has no longer a copy in stock, one would be puzzled where to ask for it. As for Coddington's "Optics," it came out before I was born. I should think that Messrs. E. and F. N. Spon, of 48, Charing-cross, London, are about the likeliest people to procure a copy, even should they not have one for disposal already. Failing success in this way, an advertisement might not improbably secure your correspondent what he requires.

In answer to query 33555 (p. 507), Highfield House Observatory is close to Nottingham.

Can "Hibernian" (query 33557, p. 507) possibly be aware that there are some thousands of varieties of Fossil Shells? The Society for the Promotion of Christian Knowledge publishes "A Tabular View of Characteristic British Fossils," in which numerous admirable drawings of the leading kinds of Fossil Mollusca are given. Your querist should obtain this. He will find it useful for identifying many other Fossils, besides Shells.

I have seen nothing of the announcement of the comet discovered at Washington, of which "Tyro" speaks in query 33580 (p. 507), but did observe in a newspaper paragraph that Mr. Lewes Smith, of Rochester, U.S., at 2 a.m. on July 7, found "a large faint comet . . . with no tail or nucleus, but with central condensation." At the time of its detection its R.A. was 17h. 40m., and its Dec. 18° N. This would place it in the barren region of Hercules to the N.E. of α Ophiuchi. It had "a slow motion southward." The part of the Heavens in which it is situated is on the Meridian now a little before 9 p.m., so "Tyro" can sweep for it for himself. It is quite needless to add that no notice or ephemeris of this body has been issued by the authorities of the Royal Astronomical Society.

A Fellow of the Royal Astronomical Society.

THE LAND QUESTION.

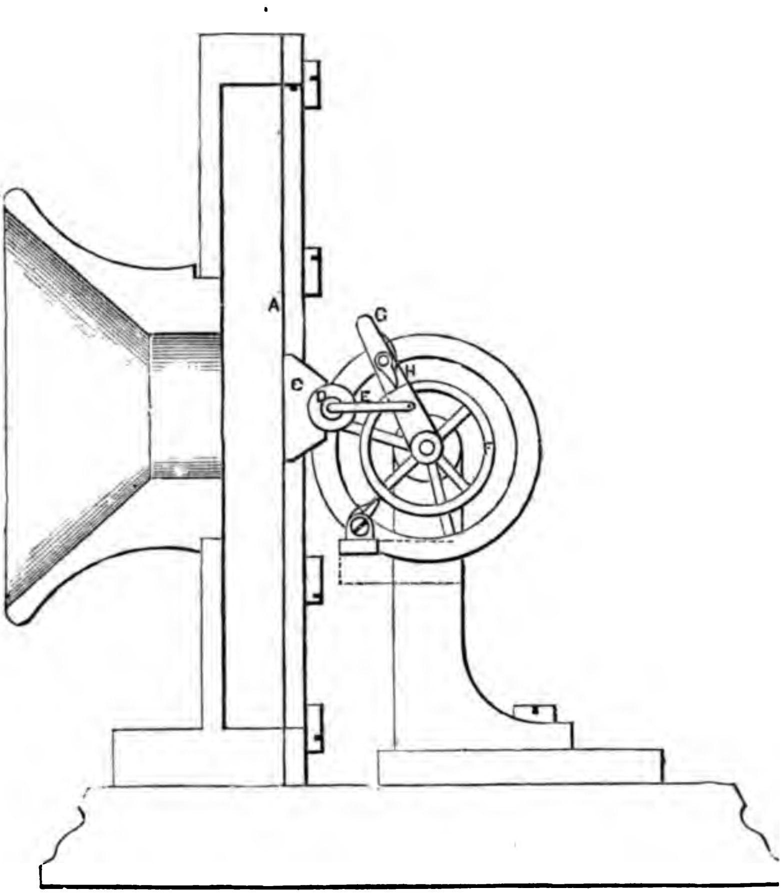
[14652.]—"Ruin," p. 500, like all who look at the land question from his point of view, omits to mention that no human being made the land: a human being did make the brooms, even if they were stolen from him. This broom-maker and his fellows helped to make the land as valuable as it is; they were the labourers and produced the capitalists. Without the former there could not have been the latter. Some one must be recognised as the owner of the land, but it is a moot question whether any one should be allowed to hold the land to the detriment of his fellows. Some great landowners, for instance, actually pay poor-rates on a smaller assessment than many houses in London. I do not see that it is logical to accuse a man of coveting his neighbour's land because he points out that if one man persists in holding so much for his own pleasure or advantage he should pay for it. It would be better to make a law limiting the amount of land to be held by any one person. You cannot well say that a man shall not keep as many shops as he pleases, because, presumably, he has made those shops—although you would object if one man had all the public-houses in London. But Lord Noeshu did not make the land over which he keeps so tight a grip, and on which he feeds the bounding deer instead of the men who made it worth what it is; but it is probable his ancestors stole it, obtained it by fraud, or had it given them in return for some not very creditable service rendered to a king (by the grace of his courtiers). The "intelligent of the working class" are quite as well able to learn in the "school of adversity" as those represented by "Ruin," who have a happy knack of yielding when they find that their sophistries no longer blind the populace. Working men know what is a real "school of adversity," and are being educated to understand how they have been bamboozled by those who, for the want of some better thing, talk about the "Berlin peace" doing them, the working men, good! "Everybody knows that the chief reason why houses cost twice as much as they did 30 years ago is, that the workmen do less work for the same wages than they did then." I fancy I have seen that statement before, as new, unaccompanied by any attempt at proof. We are to understand, then, that a house which, 30 years ago, cost £300, now costs £600, the extra money being all spent in the labour. Your correspondent says that less work is done for the same wages, which, in other words, means that more money is paid for the same quantity of work; but he apparently disdains figures, which would be interesting if he would kindly go into them. I venture to think that such a demonstration as I have suggested would do more to open the eyes of the working classes than any rhodomontade about a "school of adversity," maintained at a "rate ten times more burdensome," &c. Dear, dear, what *fools working men are to* be sure! **S. Mayer.**

THE PHONOMOTOR.

[14653.]—A very ingenious scientific toy has just been devised by Thomas A. Edison, of Menlo Park, N.J.; its object being to show the production of rotary motion from sound-waves. The instrument is exceedingly delicate to vibrations of air, the lowest possible talking and singing making the shaft revolve with great velocity.

It will be easily understood from the following sketch:—A is a diaphragm of ferrotype plate, card, or parchment, in the centre of which, and attached to it, is a small piece of cork, C, to which also is attached a small piece of rubber tubing, D. F is a smooth-faced wheel driven round by a friction click, H. This click is mounted on a lever, G, which receives its motion from the diaphragm by a connecting rod, E; this rod being screwed into the rubber tube and afterwards linked to the lever, G. It will easily be seen that every vibration of the diaphragm will cause the click to carry the wheel forward a little, and as the vibrations follow each other so quickly in ordinary talking the wheel revolves rapidly.

The shaft on which the wheel, F, is fastened also carries a fly-wheel, J, and a small pulley grooved for transferring the motion. The wheel, F, is also provided with another click, which is stationary, and set so that the wheel will not be carried back when the driving click goes back.



The idea of making this little toy suggested itself to Mr. Edison during his recent visit to Washington. Whilst showing the phonograph before a senate committee, one of the gentlemen present wished to know if he could make a machine that would "talk a hole through a board;" he immediately drew out a device similar to the above, but with a worm wheel and auger attachment (which has since performed this feat), by which a man can talk a hole through a ¾in. board in less than half an hour. It caused great merriment at the time, and was called the "Phonomotor." It possibly might be employed to store up the power expended by those persons who have a habit of "talking people to death."

Asor.

AUTOGRAPHIC PRINTING.

[14654.]—Your correspondent, "Selim," in your issue of the 19th July, refers to my invention of autographic printing as specified in my patent. He would have interested your readers more by discussing the merits of the operation, rather than by expressing his doubts of the validity of my claims. His opinion is adverse, because I say I am not confined to ordinary paper. My claim is not in reference to the quality of the paper. It is essential that the quality is such that, when my ink is used to write the original, the paper should retain ultimately the smallest possible quantity of ink, and present such a surface as can be written on comfortably. These qualities are presented in a paper prepared : old and entirely distinct patent. My claim is t method of using that or any other paper, and ing on to paper or any other substance, b original use of pens of ordinary or extraor construction. Practically, the invention is ext simple, yet positively new, and has been greatly improved and cheapened. I inclose ill tion printed on calico. I could do the same on wood, iron, metal, &c. **J. Pumph**

CHROMIUM.

[14655.]—Since the insertion of my lett the acidity of the bichromates, I have watch succeeding issues of "our journal" with degree of interest. Mr. Pitt, in his letter, "Is it not likely that the bichromates (w solution) act just in the same way as othe salts?" This, I may state, is just the poin desirous of proving, for considering the defini an acid salt as one in which the hydrogen i partially exchanged for a metal, &c., in the way as $M'HSO_4$, why not consider the mates (when in solution) as M'_2H_2CR $_2(M'HCRO_4)$, as shown by my friend Mr. This view of the case does not imply "deco tion" taken in its proper signification.

Mr. Allen (letter 14543, p. 421), says, " anhydrosulphate of potassium ($K_2S_2O_7$) is d in much water and evaporated, it cannot covered, being converted into $KHSO_4$, but reaction occurs with the anhydrochromates when the excess of water is driven "anhydre" bichromates crystallise out. this not be satisfactorily explained when w der the comparatively unstable character bisulphates? The mere action of heat su drive off SO_3. Would Mr. Allen kindly refe the numbers of the English Mechanic con his evidence of the non-existence of H_2CR conclusion, allow me to thank your corresp for kindly noticing my letter. The experime the spectroscope and potassic bichromate me by Mr. Grey is interesting. I shall bear it in and should an opportunity occur put it to t

Holloway. **Fredk. W. Streatf**

A MULTIPLYING MACHINE.

[14656.]—So many of your readers appear an interest in magic squares that I venture their attention to something in the figure rather more utility. I have called it a mult machine, but it may be used for other proce arithmetic, and may not unlikely lead to more useful invention still. The device ha patented by Mr. J. Sawyer, of 3, Adelaide E.C., and will be readily understood from t g description. The figures may be engraved or d upon any suitable material, but their gement must be carefully attended to. As will n by a reference to the figure, they are placed gular distances apart from one another on ste pieces or strips of paper, linen, cardboard, ment, wood, metal, or any other suitable mate-

The numbers from 1 to 9 inclusive are l on one piece or strip; the numbers 2, 4, 6, 8, 2, 14, 16, and 18, on another piece or strip; imbers 3, 6, 9, 12, 15, 18, 21, 24, and 27, on er piece or strip; the numbers 4, 8, 12, 16, , 28, 32, and 36, on another piece or strip; imbers 5, 10, 15, 20, 25, 30, 35, 40, and 45, on er piece or strip; the numbers 6, 12, 18, 24, , 42, 48, and 54, on another piece or strip; imbers 7, 14, 21, 28, 35, 42, 49, 56, and 63, on er piece or strip; the numbers 8, 16, 24, 32, , 56, 64, and 72, on another piece or strip; be numbers 9, 18, 27, 36, 45, 54, 63, 72, and another piece or strip.

abovementioned nine pieces or strips constihe first row of pieces or strips, and beneath is placed another row of nine stripe, with the numbers on the respective strips (the numbers consist of one figure only being preceded by a).

cipher may also be placed in the first or top and in addition a tenth piece or strip, with pher 0 repeated and placed in the same posias the numbers on the other strips. As many of pieces or strips as may be considered necesre placed beneath—that is, lower down than cond row, each successive row containing ten precisely similar to those in the second row. dvisable that over the respective numbers in piece or strip in the first row should appear in ntive order the respective numbers from 1 to usive. For facility of reference to any re l strip, it is advisable that an index figure be on each strip, the index figure being the s the first and lowest number on the respecrips, and the strips being so arranged that lex figure on each strip is exposed to view. ws of strips may be so placed that each row ave the unit figure of each number the space figure to the right of the unit figure of the r in the row immediately above; or the in each row could be placed perpendicularly each other. In the latter case it would be le to show the connection between the by a line drawn from the figure in the units' f each number towards the figure in the tens' of the number in the row immediately . Various mechanical means may be l for exposing to view the numbers on any strip of any desired row or series, and the n of the respective columns of numbers falleath each other (on the adjustment in any way), of any two or more of the rows of vill give the product resulting from the multin by the numbers from 1 to 9 of the number by the figures (excluding such ciphers as efore numerals) which stand at the extreme the rows of strips.

lrawing shows one way in which the rows or strips may be mounted to enable any one or f the strips of any of the rows to be exposed . In this arrangement the slips composing ries or row of slips are connected together, form a jointed endless band. Each band is d on a square roller; each roller can be by a handle at its end, so that any one or f the strips composing the endless chain he roller carries can be brought uppermost. prings may be used to bear against one or the flat sides of the rollers to hold them in ition in which they may be turned.

ollowing is the manner in which the appato be used for multiplication:—

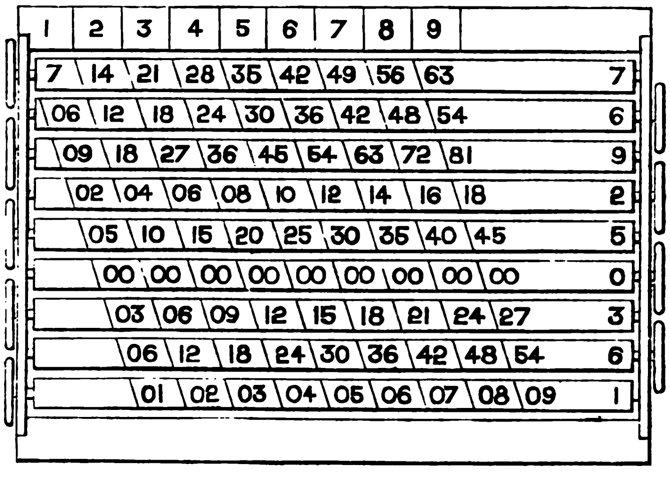
mple: Multiply 769250361 by 98765432.

The roller carrying the top row or series of strips is turned until the strip with the figure 7 at its end is brought uppermost; the roller carrying the second series of strips is turned until the strip with the figure 6 is uppermost, and so on for the several rollers. The drawing shows the apparatus with the requisite strips thus brought uppermost. The numbers upon the strips under the heading 2 are now added up as they stand one under the other; the total will be seen almost at a glance, and is written down. The numbers under the heading 3 are then similarly added together and written down below the first line, as in ordinary multiplication, and by adding together the eight lines of figures so written down the product, 75975344220320952, is obtained.

For division the tables are used in the same way as for multiplication. The divisor takes the place of the multiplicand, and, like it, having been once found in the tables, is dismissed from the mind. In other respects the process is similar to ordinary division. The dividend is set down, and dealt with in the usual way. The divisor must be looked out in the tables, and need not be written down.

Example: Divide 75975344220320952 by 769250361. The drawing shows the apparatus set for this divisor.

It is not necessary to consider at each step of the process how many times the divisor is contained in the figures to be dealt with, as an inspection of the first two rows is sufficient to show approximately the first three figures. In this example the first three figures are 759, and a glance at the top rows shows that the "9" column will give for the first three figures over 685; the total of that column is therefore set down and deducted in the ordinary way. The first three figures of the remainder are 674; the top rows of the "8" column show 615, therefore the total of that column is taken, and so on.



75975344220320952(98765432
6923253249

6742811730
6154002888

5888088423 &c., &c.

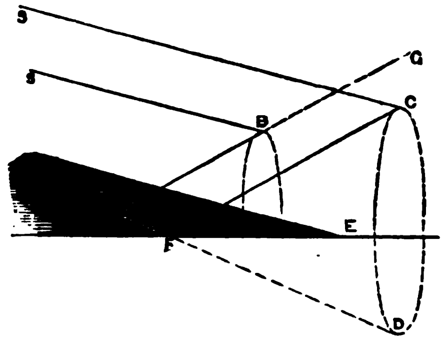
Various other ways than the one above described might be adopted for mounting the slips in rows or sets, so that any one or other slip of each row or set may be exposed to view whenever required. For example, a very convenient arrangement is to bind them together at their left-hand ends, and so keep them together in the form of a book. In this case the several slips of each row or set come one below the other, and are made successively longer one than the other, the lowest being longest, so that the index figure at the end of each of the slips may be exposed to view. With this arrangement any one or other of the slips of any of the rows or sets can be exposed to view by turning back the several slips which are above it, in a similar way to turning over the leaves of a book.

I should be glad if some of your correspondents, who are practised arithmeticians, would try the sums given in the ordinary way, and with the assistance of the drawing, and let us know, what is the economy (if any) obtained by the use of this machine.

Oberhof.

RAINBOWS, &c.

[14657.]—I MUST confess to a feeling of surprise that the rainbow question, referred to by Mr. Webb in your issue of the 19th ult., should be a puzzle to any of your readers. I send a diagram, which, with these few notes, may, I hope, make the matter clear. S and S represents the direction of the solar rays, A the spectator, and E the surface of the water. The angle, S B A, being about 42°, A would see a bow whose summit is B. At C the emergent pencil of refracted (and reflected) rays would proceed in direction C F. At F they would be reflected by the water to A, who would see the inverted bow, D. Although this is a larger bow than B, perspective would make it appear smaller than it, as the reader may see; the bow should reach up to G before its inverted image would coincide with bow B. The diagram also shows the cutting off of B by the shadow of the mountain. A boatman at F would see

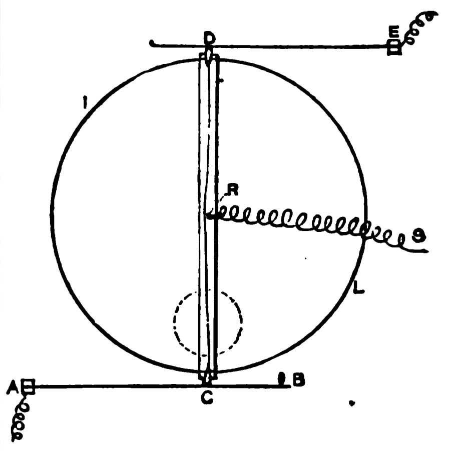


the bow, C, while A only sees its inverted image, and, as Mr. Webb remarks, each eye has its own bow, so that one person standing by the side of another sees another bow altogether; and as the spectator walks along (to the right or left of the bow) the bow will really move with him past trees, &c., and it is, therefore, impossible that a phenomenon so purely optical and intangible could be reflected.

J. W. Durrad, F.R.A.S.

TELEPHONIC ALARM.

[14658.]—As I have lately seen numbers of telephonic alarms described in your paper, I send the following, which I have devised, and hope it may be of use to some of the readers of the ENGLISH MECHANIC. Its chief recommendations are its cheapness, and the ease with which it can be worked. I have not yet had time to make one myself. I D L is a brass wheel, the edge of which is milled, and which runs on the axle, R, which is connected with the wire, R S. The end of the wire, S, is connected with one of the poles of an electric battery, the other pole of which is connected with the earth-plate, or return wire. E D and A B are springs, A being connected with the earth-plate through the telephone, and E with the line wire. C R D is a flat piece of ebonite (or wood steeped in paraffin), with two brass studs, D and C, fixed into each end, and in metallic connection with one another by a wire; this ebonite is firmly fixed on the wheel, so as to insulate the studs, D and C, from it. The dotted circle at the bottom of the wheel represents a lump of lead, fixed behind, so as to keep the wheel in the above position when not being turned by a handle, which should be fixed in front. It will be seen that when the wheel is turned out of the above position, the spring, E D, will press upon the milled edge of the wheel, and thus establish electrical communication between the wire, E, and the wire, S, which is connected with a battery. But when the stud at D is moved round, the stud at C will also move, and the spring, A B, will then be released, and tend to press on the edge of the wheel, from doing which it is restrained by a small pin in front of the spring at B. In the



position shown in the figure, a current entering at E from the line wire would take the course, E D C A, and then go back through the telephone and earth. When the wheel is turned, however, any connection between the spring, A B, and the wheel is impossible on account of the pin at B, but the spring, E D, presses on the milled edge of the wheel, which is connected with the battery, and thus, while the wheel is being turned, numerous small currents are sent along the line, which generate a loud musical note in the telephone at the other end, and thus call attention.

It will be seen that no bells are used, and when attention is to be called at the other end of the line, a handle has merely to be turned; the trouble is thus extremely slight.

Bath, July 23, 1878. **T. A. Garrett.**

THE LAWS AND PRINCIPLES OF ACOUSTICS IN REFERENCE TO THE TELEPHONE, MICROPHONE, &c.

[14659.]—If a microphone had been invented twenty years ago, sufficiently powerful to make important but unappreciated announcements in science audible enough to compel public attention, I should not, at this late date, be under the necessity of reiterating the only theory of the structure of matter which satisfies all the requirements of modern scientific experience, and which more especially explains the new phenomena of phonics which the telephone, microphone, megaphone, &c., are bringing to light.

In 1856 I announced, as the result of a careful correlation of all the scientific facts then known and relevant to the subject, that the primary structure of elementary matter did not consist of either infinitesimally divisible particles on the one hand or round solid atoms on the other, but of hollow elastic shells, or globules, spherical when taken singly, and like the soap bubble, polyhedral over all their surfaces of contact, and without interstices between them, when in clusters or masses, and in both these conditions capable, like the soap bubble, of elastic vibration, expansion, and contraction, the inflating and expanding influence of the shells or globules being light, heat, or electricity. That this alone would account for the expansion and contraction of matter; that each elementary substance had a specific expansibility and electrical condition of its own; that this accounted for the limits within which the combining power of different elements was found to operate, and explained the whole phenomena of compound bodies, and of electrolysis, chemical analysis, and synthesis, and why concrete and opaque bodies became, under atomic expansion and fusion, incandescent, fluid, diaphanous, transparent, and gaseous, and why concrete explosive substances manifested such highly elastic expansibility when deflagrated or exploded by light, heat, or electricity.

Had the supervening discoveries of science been then at my command, and especially the compressibility, liquefaction, and solidification of the three elementary and other gases, I could have greatly intensified the force of this explanation, but my present limits will not allow, and my present object does not require, that I should here repeat the entire scientific announcement then made, far less the vast number of subsequent correlative discoveries which have since then, in every instance, not only corroborated but imperatively necessitated such an explanation. My purpose in this communication is to deal with that portion of the subject which explains the principles and laws of phonics or acoustics, as exemplified by the phenomena of the telephone and other instruments by which Prof. Bell and other gentlemen have done such eminent service to recent science, and to day down lines by which further discovery may be guided to, possibly, still more important results.

Let me begin by correcting an impression which seems to have arisen in connection with the new discoveries—viz., the idea that electricity conveys sound. It is found that the application of a current of electricity to the wire of a telephone increases the audibility of the sound transmitted in proportion to the intensity of the current or power of the battery. But, to make sure that we rightly appreciate this part of the phenomena, it is necessary to correlate it carefully and candidly with the fact that a vacuum will not conduct sound. Now, a vacuum is a condition which has not yet, I venture to think, met with correct scientific definition. The only vacuum man is able to make I hold to be a space void of everything but electricity, and this definition is capable of almost, if not altogether, absolute demonstration. Thus, a vacuum will not impede the transmission of light in and through it; neither will it impede the transmission of heat, but it will impede the transmission of sound. The reason is that light and heat can be transmitted through vacuum, and through free space, as between the exterior surface of the sun's matter, and the exterior surface of our terrestrial matter or atmosphere, without vibration, while sound absolutely requires vibratory media as its means of manifestation and conduction. But a vacuum, though it can be shown by a variety of experiments to contain electricity and to admit of electric action within it, does not contain any vibratory matter, and therefore, though filled with light, heat, or electricity, has no vehicle within it for the action, manifestation, or transmission of sound. Light and heat then are transmitted by vibration through vibratory media, but are not impeded by reason of the absence of vibratory media in their passage through spaces in which *no vibratory medium exists.* At this stage quite a crowd of explanations and corrections of existing scientific misapprehensions tempt one to parenthetical deviation, but by your permission I will defer details running into collateral lines of explanation to a subsequent and more general communication, for the sake of dealing in the present instance with that only which bears more immediately on the acoustic phenomena which have excited so much recent interest.

From what has just been stated it is manifest that light and heat do not require any conducting medium, vibratory or otherwise, to enable them to pass either through a vacuum or through free interplanetary or interstellar space. Neither does electricity require any conducting or vibratory medium to enable its current to pass from its positive to its negative pole when brought approximately near to each other in vacuo. But electricity, when it passes through other material media, does so by means of vibration, and this peculiarity is not due to the nature of electricity itself, but to the atomic or molecular structure of the medium, elementary or compound, through which it passes, acting from polyhedral atom to atom.

In phonics a weak voice or low tones or sounds will be heard throughout a room of considerable capacity, and will cause vibratory action in the entire atmosphere it contains, and in every vibratory body with which they come into acoustic contact within it. Notwithstanding the new phenomena of phonics, the vibratory action and sound-transmitting power of the atmosphere is greater than the vibratory action and sound-transmitting power of other vibratory media. That portion of any sound which is intercepted by the receiver of a telephone connected with a conducting wire, is readily addressed to so much metallic space drawn out in a particular direction, instead of radiating from the point of interception in the direction in which the sound would otherwise proceed. But the actually inferior conducting power of the telephone, unaided by electricity, as compared with the atmosphere, is shown by the fact that, though words be spoken directly into the receiver, they will not be heard so far, and at the same time so loudly by the mere unaided transmitting power of the wire, as they would be throughout an atmospheric space equal to, or which would be filled by, the metal of the wire if reduced to a mass radiating from the point of interception.

It is here that electricity takes effect in favour of sound when applied to the telephonic or megaphonic wire in aid of its transmitting power. Electricity proceeds through transmitting wires by means of vibration, and so does sound, but the vibrations of electricity in such media do not conflict, but cooperate with the vibrations of sound, and thereby facilitate and intensify the phonic vibrations. The atomic structure of the transmitting wire being that of a series of atomic globules, in polyhedral contact and continuity, filled with electricity, and the vibratory character of matter being due to this elastic structure, electricity in a state of transmission through the conducting wire increases its elastic action, and its sensitiveness to acoustic vibration, and hence the phonic phenomena of the telephone, megaphone, microphone, &c.

J. Alexander Smith.

98, Gower-street, London, W.C., July 24.

MICROPHONES.

[14660.]—I FIND on re-reading my letter (14603, p. 472) that a few words have been omitted. Instead of "I got a white flickering spark, which, to my astonishment," &c., &c., it should read "I got a white flickering spark, accompanied by loud jarring sounds in the telephone, which, to my astonishment," &c., &c. **J. Probert.**

TO WHOM ARE WE INDEBTED FOR THE RAILWAY TICKET SYSTEM?

[14661.]—I HAVE observed in the Notes and Queries corner of various newspapers and periodicals lately a request for information as to the originator or inventor of the ticket system, which is now adopted by almost every railway company throughout the world. I say advisedly "system" for the whole affair, not only tickets but the machinery for printing them, and arrangements for using them, originated in the mind of one individual, Thomas Edmondson, a member of the Society of Friends, who was born at Lancaster, June 30th, 1792. His parents, John and Jane Edmondson, of that town, were of humble but respectable extraction, and educated their children to the best of their ability, giving to each that share which his or her talent seemed to warrant, and inclination as to literary or mechanical pursuits seemed to require. Of the twelve children that were born to them only five reached maturity—three sons and two daughters. Thomas's brothers both attained good and useful positions as principals of educational establishments. The name of the older one, Joseph, is the less known of the two, as he gave up the post of instructor in middle life, but that of his younger brother, George, is no doubt familiar to many, and among the readers of this paper there will probably be a number who received their early training under him either at Lower Bank near Blackburn, Tulketh Hall, near Preston, or at the scene of his latest labours, Queenwood College, Hampshire. Thomas early displayed an inventive turn of mind, which led to many ingenious contrivances for the good of the household. One piece of mechanism in particular has been mentioned to us by which the busy housewife was able to churn the butter and rock the cradle at the same time. With this tendency he was very suitably placed as apprentice to a cabinet-maker, and he afterwards worked as journeyman in the same line of business with the eminent firm of Messrs. Gillows and Co. in his native town. While there he made sundry improvements in cabinet-making implements which elicited the approval of his fellow-workmen and those who were practically acquainted with their use. Thoroughness in manufacture, completeness in detail, and adaptability to the work required were points about which he was conscientiously particular, a habit of mind which conduced greatly to his future success. Indeed, the training altogether was of the utmost service to him in after life, for it enabled him to work out his own notions quietly in his own workshop, and prevented the necessity for confiding to other hands a crude idea or a half-finished invention. In due time he entered into partnership at Carlisle with others, in the business of cabinet-making, but the firm becoming bankrupt, he found himself in a reduced position from circumstances over which he had not full control. Although he endeavoured to retrieve himself, and had the kind assistance in so doing of many of his creditors, he did not feel he was making that progress which warranted his proceeding further, and finally relinquished the undertaking. He next, for a short period, engaged in the tea and grocery business, but he was not fitted for commercial pursuits, and very willingly turned his attention to another source of livelihood, which just then came in his way. The Newcastle and Carlisle Railway, now a portion of the North Eastern system, opened for passenger traffic, and a station-master being required for the small road-side station at Milton, since called Brampton, he applied, amongst a number of competitors, for the post, and fortunately obtained it, the directors remarking in making the selection that they thought "Mr. Edmondson would prove a credit to them." Thus, then, about 1836 when in his 44th year, he made his first acquaintance with the railway world at the solitary little station of Milton, situated about 14 miles from Carlisle—a point at which the traffic was then so small the duties of station-master and booking-clerk were performed by the same person.

In the first days of railway travelling it was natural that the kind of tickets which had served for coach passengers should still be used as vouchers that a traveller had paid his fare. But as travellers increased in number these scraps of paper proved inconvenient in many ways, and Mr. Edmondson at once felt that a change was needed in them. Another want, and one of still more importance, soon became apparent to him. He found that little or no systematic check was imposed upon the station clerks, it being left to their integrity to account correctly for moneys paid to them. His ingenuity was therefore soon at work, endeavouring to organise a system which should be a complete check in the first instance upon himself, a task congenial to his constructive head and honest heart. He still retained his bench and tools as old friends, and his perfect familiarity with the use of them, combined with ample leisure between the train services of that day at Milton, enabled him to produce the various little pieces of apparatus which he required to carry out his plans. He first constructed a small wooden block, or hand stamp, in which he inserted the necessary type, say "Milton to Carlisle," with the class, fare, &c., which he wanted printing; also a small rack, divided into equal spaces, in which the stamp was fitted to slide. Having previously placed under the rack a strip of stiff paper or cardboard, he supplied the stamp with ink by means of an ordinary pad, and inserting it in the first division of the rack, he brought it by the tap of a mallet down on to the cardboard, and thus obtained the needful impression. By a repetition of this process in the various divisions of the rack he completed the strip, producing in fact a series of tickets printed "Milton to Carlisle," &c. These he progressively numbered with pen and ink, separated with a pair of scissors, and laid aside for use. When a sufficient number were prepared of one kind he re-set the stamp, substituting the name of some other station for Carlisle, and altering the fares, &c., in accordance with the change. He then repeated this slow tedious process until he was provided with a supply of tickets from his own station to all others on the line. His next study was to make a case in which the various description of ticket could be safely kept, and at the same time be handy for issue to passengers when they presented themselves at the counter. As the tickets were progressively numbered they must of course, be progressively issued, for upon this principle depended the check which he proposed to institute.

With the idea of having the tickets to be next issued always in view, his first attempts were d rected to its being removed from the top. For this end he prepared a series of tubes with loose bottoms, having tapes fastened to them which passed over small pulleys at the top of each tube, the ends of the tapes having leaden weights attached in order that, as a ticket was extracted at the top, the next would be lifted to take its place. But the advantage of seeing the ticket was more than counterbalanced by all this cumbersome machinery, and he soon decided to abandon his tapes, weights, and pulleys, and, allowing the tickets to drop by their own gravity, he removed them as required from below. The new tubes were therefore so constructed that, while affording every facility for being filled and replenished, they only allowed one ticket at a time to be withdrawn at the bottom. This being the most simple plan possible, has not been departed from or improved upon since, and has continued to be the principle upon which the icket-issuing cases at the various stations have een constructed to the present time. A number f these tubes are ranged side by side in one case, nd across them, for the convenience of the bookng-clerk, as the face of the ticket is invisible, runs wooden strip or label, on the upper part of which pace is left for inserting the name of the station, lass, and fare of the tickets in each tube. The ower portion of the label forms the frame of a trip of slate, the use of which will be hereafter entioned. A suitable receptacle having now been rovided, only one other contrivance was necessary efore making the trial he contemplated, and this as some expeditious method of putting a date upon he ticket when it was issued to the passenger. robably it was accomplished in the first instance y hand, but the plan was liable to error and a ause of delay. Something was, therefore, to be ought of which, by a quick and instantaneous otion, would stamp the date at once. When the ind is absorbed day by day in seeking after that hich for the moment seems to elude its grasp, it is a condition to seize an idea from trifles which ould otherwise pass unnoticed. In this frame of ind his pocket-comb was the trivial instrument that denly suggested to Mr. Edmondson a way accomplishing his object. It was an oldshioned pocket-comb working on a hinge, and e two edges, the end of the comb and the end of e handle when pushed together suggested a motion d convenience of nip or pressure which he thought ight be utilised for his purpose, and that if type, d the means of supplying it with ink, could be troduced into the mouth or angle formed by the o edges before-mentioned, it would, on receiving a arp push after the ticket was inserted, close, and ing the type against the cardboard. This idea, ter being duly matured, was practically developed his little workshop, and resulted in a small oden machine which so completely answered the rpose intended that he never had occasion to alter e principle of construction, and though the dating ses were afterwards made of iron, this principle, mbining efficiency with expedition, has not been proved upon. The problem of supplying the type ith ink he solved by passing a ribbon saturated ith it between the type and card. In the first place e length of inked ribbon is wound on a roller below e type, whence it passes over the face of the type to another roller above. By the act of dating a cket a certain length is drawn from the supply ller, and at each stroke a fresh surface of inked bbon is thus presented for the next impression.

All being now ready he commenced to give his stem a trial, and to issue to each passenger a cardard ticket, which, though smaller than the prent one, represented the station to which the aveller was going, the class in which he wished to be conveyed, and the progressive number of the ticket, the date, of course, being added at the time f issue. After the departure of the last train at ight he proceeded to examine the tubes of his ket-case. A matter of importance should here be erred to. He had commenced the progressive mbering of his tickets at 0, and that being the st issued of each description of ticket it followed at the figures on the card lowest in the tube at y time represented the actual quantity sold. Had e commenced them at 1 an additional process of btraction would have been necessary at each tube, ading to inadvertence and error, but by comencing at 0 he had only to copy the lowest umber in the tube which was done on the ip of slate before alluded to as running in ont of the case. The result of the day's issue being us clearly before him, and the fares being marked the label or frame above the slate, it was not fficult to ascertain what ought to be the amount in s cash-drawer. On the following night, by subacting the number left on the slate from the lowest ket again in the tube, he found the quantity of kets sold on the second day, and so forth. These tails may, to the general reader, seem a simple atter to dwell upon, but if he will remember the mber of ticket-tubes to be inspected each night at ne of our large stations—at one or two of them arly two thousand—he will see that it is of great portance to the booking-clerk in making out his turns to have the most simple yet exact method of ascertaining the number of each kind of ticket issued at his station during the day in order to balance his cash, and forward it with a correct return to the head office. To facilitate the last operation, Mr. Edmondson drew out a set of forms for making the needful returns to the audit or chief office, which, after being duly filled up, presented an accurate summary of the daily or weekly business transacted, and showed at a glance the amount of traffic at each station and the sum due from each clerk on behalf of the passengers booked. To extend to other stations what was found so applicable to his own was his next consideration, but for unexplained reasons his propositions were not at first entertained, and it was only after repeated efforts that he was able to induce the directors of the Newcastle and Carlisle Railway to arrange for the adoption of his plans at some of their stations. There was a proposition to remove him to Newcastle, but it was not carried into effect, and the repeated delays were very disheartening to him. While in this state of discouragement he received a visit from Captain Laws, at that time the enterprising and energetic manager of the Manchester and Leeds Railway, who, having heard of the plan adopted by the clerk at Milton Station for "checking himself," came over to inspect it, and, having had the details thoroughly explained to him, was clear-sighted enough to perceive its immense value to the railway interest, then becoming an important feature in the country. He therefore at once proposed to Mr. Edmondson that he should remove to Manchester, with the object of introducing his system on the above railway, making the promise "that his salary should be multiplied by two," an offer which, after due consideration, was gratefully accepted. This unexpected recognition and timely acknowledgment of his invention paved the way for its general adoption, and for the next ten or twelve years the introduction of his plans on to new lines of railway as they rapidly developed themselves, in addition to his duties on the Manchester and Leeds line, involved a great amount of labour on the part of the inventor. At length that company, with a complimentary minute of the board, liberated him from their service, in order that he might devote his whole time to the further development and introduction of his system.

Mr. Edmondson's brother, Joseph, having for some time relinquished his academical pursuits, was now very helpful to him in the supervision of his establishment, thus setting him at liberty for personal instruction to the booking clerks at the different stations—a work which compelled him to leave home frequently and for long periods. The previous occupation of Mr. Joseph admirably fitted him, amongst other duties, for the accurate and methodical superintendence of accounts during the minority of his brother Thomas's only son.

As we observed, when describing the first apparatus used for carrying out the ticket system, the principles of construction in the ticket-case and dating-press were almost perfected from the commencement, but the more complex machinery for printing and progressively numbering the tickets has been the result of gradual improvement. Of course long before this the slow process of the hand-stamp had given place to machinery. It was simply the first effort of a man thrown on his own resources. Many persons suppose the dating-press, the little machine on the counter of the booking office, to be all that is required for printing the tickets, but a moment's reflection ought to convince them that, as there is only one machine containing only type sufficient for the date of the day, it cannot print the multiplicity of letterpress which is required for booking passengers in different classes to their various destinations. That is all done elsewhere, and a combination of machinery is needed for it, the leading feature of which, the inventor saw from the first, must be that of *printing one ticket at a time.* Experience has proved that this original conception was the true basis upon which to proceed in ticket-printing, as although hundreds of millions in the aggregate are annually produced, the amount is so divided and sub-divided by the various stations and classes that the average number printed of any one kind is not large, and the quantity supplied of each description at one time being only that of a few months' stock to each station, it will be readily seen that the time required to set up the number of forms of type for a sheet would be fatal to an expeditious supply.

Mr. Edmondson was only a worker in wood, and feeling now the need of a stronger material he consulted a practical friend of his, Mr. John Blaylock, of Carlisle, by whose assistance he was enabled to put together a printing machine which carried out his ideas, and was sufficient for the requirements of that period. This machine, however, has been greatly improved upon from time to time, and while the original feature of printing one ticket at once has always been maintained, its general completeness and efficiency have been materially increased by the ingenuity and careful study of Mr. James Carson, who, from the early rise of ticket-printing as a business, has occupied the responsible position of foreman in the principal manufactory in Manchester, where Mr. Edmondson's son still continues the business which his father established. There not only are tickets printed, but the printing machines, ticket-cases, and dating presses, together with other ticket apparatus, are manufactured, and supplied to railway companies as required. Before attempting to describe the present printing press, we may say a few words as to the routine of ordering tickets. The station clerk, on finding that his stock of tickets of any kind is getting low, makes out a "requisition," on which are stated the name of his own station, and that of the one to which he requires a further supply. The class is also given, and the lowest number of the tickets in stock, together with the highest, which was of course, the closing number of his last quantity. The difference between them, representing the stock in hand, he enters in an additional column. Having passed the audit office, where the amount of the new order is added to it, the "requisition" is forwarded to the company's printer, who arranges his form of type in accordance with its particulars. Wheels for printing the progressive numbers so often mentioned are attached to the press, and can be set to anything between 0 and 9999, embracing a quantity of 10,000 tickets. In this instance the printer sets them to the number next above the highest named as in stock, and then proceeds to fill the feeding tube with the proper coloured cardboard, for indicating the class and single journey, return or excursion ticket, as the case may be. The feeding tube is an upright case at the back of the machine, and is capable of holding 500 blank tickets. We may here mention that the blank cardboard is received from the manufacturers, Messrs. De la Rue and Co., in tightly packed boxes, less than two feet square, each box containing about 48,000 tickets, ready cut into the required size. The machinery and arrangements for preparing these would be matter for a paper by themselves, and do not come within the scope of this. Suffice it to say, they are beautifully complete, and worthy of the firm whose name is now so celebrated.

The printing machine being ready is put in motion• when a catch, set to nearly the thickness of a ticket, and working horizontally, draws the lowest card forward in the direction of the type and numbering wheels, one set of wheels (used for return tickets) being situated before and the other after the type frame, and all receiving at each stroke of the machine a supply of ink for the next impression. The first card is left in position under the first set of numbering wheels. If it is to be a return ticket it there receives a number, if not that set of wheels has been raised, and the ticket waits to be pushed forward to the type by the introduction of a second card from the feeding tube. A third card pushes number one under the second set of wheels, where it receives its appropriate number, and by the push of a fourth it falls, printed and numbered, into a receiving tube at the front of the machine. Any stop in the delivery shows the attendant that something is wrong. The mechanism, while capable of being driven at a great speed, is regulated to that of about 200 tickets a minute, this being found a rate at which the attendant can most readily superintend the supply of blank cardboard to his feeding-tube and give the needful attention to the other movements of the machine. The printed tickets are next conveyed to the counting machine, which is simply an additional check as to the accuracy of the progressive numbering, the necessity for it arising from occasional inequalities in the size and thickness of the tickets, and a liability to warping on the part of the cardboard. As the thickness of an average ticket is the only available gauge by which to adjust the catch of the printing-press, it will be easily understood that, in case of a warped card, the catch misses it, and as no blank ticket is drawn in, the printed one is not pushed forward, and therefore, receiving repeated impressions, is spoiled. As soon as the attendant finds that "something is wrong" he stops the machine and puts it right, but in re-arranging the numbering wheel, which has been going on and changing with every stroke, he may possibly set it a number in advance, or otherwise, of the last good ticket. Hence the necessity for an additional check. The counting machine is furnished with feeding and receiving tubes, and with accurately-numbered wheels, similar to those of the printing machine. The attendant having placed his pile of tickets in the feeding-tube, the lowest number at the bottom, he draws it into view by means of a catch similar in arrangement to that of the press, observes the number of the ticket thus produced, and sets the corresponding number on the counting wheel to an index or eyelet-hole situated conveniently for the eye of the counter. When the machine is in motion for every ticket that is drawn out of the feeding-tube the counting wheel moves a number forward, and so long as the two numbers agree all is right. In order to ascertain if they do so the attendant stops frequently to examine. Errors, if any, having been corrected by the man who printed the tickets, these are now ready for packing. As progressive order is so essential in the issue of the tickets no danger of that being broken must be left unprovided for; they are therefore placed in bundles of 250 in a frame or screwing up apparatus, by which they can be tightened almost into a solid mass. While in this condition a band of string is passed round them, and, being secured by a suitable knot, they retain their solidity when liberated from pressure, and are in a state for distribution to all parts of the world.

In this way are prepared the little tickets which the travelling public receive at the booking office window, and stow away in their pockets or slip into their gloves or hats without thought of the ingenuity and industry required to produce even so small and insignificant an object. Insignificant as each ticket may seem, however, the annual aggregate of the railway fares which these trifles represent amounts to millions of pounds sterling, and every fractional part in that great total is duly and easily registered by this simple ticket system. It is always interesting to look back to small beginnings, and compare them with the results of a few years' thought and work. The contrast is often startling, and to no one would it be more so in this case than to the originator of the railway ticket system itself, could he behold the immense increase of traffic which must now be provided for. Little did he think at that lonely Milton station as he worked at his bench in the still hours of the night, of the ultimate extent and success with which his labours were to be crowned, and we are tempted to regret that he did not live to a more mature age to witness the extended development of his plans. One thing he did live to accomplish, which we are inclined to estimate at a higher value than anything we have yet spoken of. From the time when the firm, in which he was a partner at Carlisle, became bankrupt it had been his cherished wish to be able to pay their creditors in full, and he did not depart from the frugal style of living which at first was a necessity until he had fulfilled this moral though not legal claim. A leading Manchester paper, in recording the death of Mr. Edmondson, says, in conclusion: "With the character of Mr. Edmondson in private life it is denied us to deal, inasmuch as knowing well his retiring habits we fear we should be acting in opposition to his declared wishes; suffice it to say, however, that not the least noticeable trait of his character was that, though at an early period of his life misfortunes had involved him in difficulties, he hardly permitted better times to dawn fully upon him before he nobly and voluntarily exerted himself, and as nobly succeeded some time before his death, in 'rendering to every man his own' who had chanced to be his crediter."

At the close of a period of infirmity extending over a year or two, and arising from overtaxed energies, he died at his residence in Manchester after a short illness on the 22nd of June, 1851, having nearly completed his 59th year.

John B. Edmondson.

Knowsley-street, Cheetham, Manchester.

SINGLE v. COUPLED ENGINES.

[14662.]—I am sorry "W. J. S." (letter 14633, p. 499) should think any one wants to fall foul of him. I can assure him I have no desire to do so, but do not like to see the Cheshire lines causelessly glorified at the expense of the L.N.W. "W. J. S.'s" remark about the speed of the 10 a.m. has drawn my attention to a misprint in my letter. Leaving King's-cross and Euston at 10 a.m. ought to read leaving King's-cross and Euston at 10.10 a.m., the trains leaving the foregoing stations at 10 a.m. being the Scotch expresses, not the Manchester trains.

In answer to "W. E. H." (p. 507) the engraving of the bogie engine was one of those built by Kitson, cylinders 17½ × 26, coupled wheels 6ft. 6in. in diameter. These are numbered 1,311-1,320. The big 7ft. engines of which "C. E. S." was making a drawing, and is not sending, greatly to the sorrow of many readers of the Mechanic, are numbered up to 1,341.

I beg to thank "Egeria" (p. 499) for his interesting information.

L. L.

L. AND N.W. LOCOMOTIVES.

[14663.]—I, for one, should be very glad to be told the L. and N.W. engines in classes as "Egeria" kindly proposes, and should be much obliged if he would also give the leading characteristics of each class—I mean the size of the wheels and cylinders, whether single or coupled, and whether the cylinders are inside or outside?

As regards cabs and weatherboards, I have always observed that the L. and N.W. seem to rush into opposite extremes; some engines have nice large cabs, like the new Midland locomotives, while others only have weatherboards, whose diminutive proportions rival the G.W. in smallness. I should be glad to know the reason of this, and whether the class to which a L. and N.W. engine belongs can ever be identified by means of the cab or weatherboard?

If it is not asking too much, would "Egeria" give an outsider a rough idea of the L. and N.W. links, and say whether engines ever change their *stations, or whether they* run on different links?

W. E. H.

DISTINCTIVE TAIL LAMPS UPON THE MIDLAND RAILWAY.

[14664.]—A correspondent, upon p. 352, asks why "on the Midland he sees the red lights on the back of many trains in a line." If your readers will refer to Vol. XX., p. 328, they will see that "An Express Driver" clearly pointed out the necessity for distinctive tail lights to be carried by trains running upon goods lines parallel to the main lines; and upon p. 376 of the same volume I suggested that on the passenger lines the lamps should remain in the form of a V—thus, ⁘; but that upon the goods lines the tail lamp should be placed high up, or upon the top of the van, to form an A—thus, ∴. This suggestion was sent to Derby, and six vans were at once fitted with the necessary lamp irons. A trial was made, which I was informed was very satisfactory, and soon afterwards the plan of placing the tail lamp as high up as the side lamps was adopted on all parts of the Midland Railway where there are goods lines running parallel to the up and down passenger lines.

The following diagram shows the arrangement of tail lamps, which has been adopted in order to enable drivers to know whether a train in front of them is on the line upon which they are running, or upon the line running parallel with it.

Fig. 1 denotes that the train in front is running on the main line, as the three red lights are in the form of a triangle.

Fig. 2 indicates that the train is running on the main line, and also that a special train is to follow upon the same line, as an additional red tail lamp is placed low down by the side of the ordinary one.

Fig. 3 denotes that the train is running upon the goods line, as the tail lamp is placed high up, so that the three red lights shall be in a straight line.

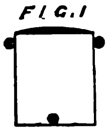
FIG.1


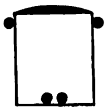
FIG.2


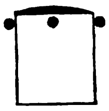
FIG.3


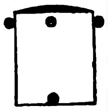
FIG.4


Fig. 4 indicates that the train is running on the goods line, and also that a special train is to follow upon that line, as, in addition to the three red lights in a straight line, an extra red tail lamp is placed low down. This arrangement of lamps answers admirably. I will also prepare a diagram of the Midland system of head lights for a future number of the English Mechanic.

July 25th.

C. E. S.

SPEED OF TRAINS.

[14665.]—I send a table of speeds for a short run on the Midland Railway by the 7·28 p.m. train from Luton, due at Kentish-town at 8·8 p.m. The train consisted of about 11 ordinary coaches, drawn by a large 7ft. bogie engine.

	Distance from London.		Speed in miles per hour.		
	m.p.	p.m.			
Luton leave	30¼	7·42			
pass	25	7·50·15	38·182	38·182	
"	20	7·56·2	51·873	51·873	
"	15	8·1·3	59·8	59·8	
"	12¼	8·45	49·451		
"	10	8·7		50·420	221·109 ÷ 4 = 55·277
"	9¼	8·7·30	52·683		
"	7	8·9·55	62·069		
"	5	8·12·5	55·385	59·016	
"	3¼	8·13·45	54		
Kentish Town arr.	1¾	8·17	32·308	39·661	
			9)455·751	6)298·952	
			50·639	49·825	

28½ miles in 35 minutes = 48·86 miles per hour.

The first column gives the speeds as between stations, omitting four small ones, and the distances are, where not exact, within a quarter of a mile of those given in the time-tables. The second column shows the speeds for 5¼ miles, and then for 4 sections of 5 miles each, and, lastly, for 3¼ miles, and it will be seen that the average of these equal sections is 55·277 miles per hour; whereas 20 miles run in 21m. 50sec. gives 54 962 miles per hour. This confirms "Itzaex's" views of his method, showing better the high speeds necessary to make up time lost up the bends. I did not anticipate any difference in these results for equal distances, but have convinced myself that it is correct, and that the more even the speeds the less the difference will be. It may interest "L. L." and "W. J. S." to know that the 10 a.m. expresses from Euston and King's-cross do not run to Manchester but to Scotland, also from Euston to Liverpool and Chester; but the 10·10 trains from those stations, and the 10 a.m. from St. Pancras run to Manchester. I for one should be glad to see some letters from "Egeria" about the types of the L. and N. W. locomotives. Would "C. E. S." kindly say whether it is necessary for a pilot engine to be fitted with same brake, if continuous fitted rest of train?

V.

THE IDENTIFICATION OF A ACID ACETATES AND ALBUM

[14666.]—Acetic acid is a colourles
having an acid taste and the odour of vine
17° C. it crystallises, and in this concentra
it is known as glacial acetic acid.

It boils at 117° C., and suffers distilla
changed, leaving no residue on evaporati
vapour on combustion yields CO_2 and OH_2.

Ferric chloride, when added in small qu
an acid or neutral solution of acetic acid, gi
colour that is not bleached by $HgCl_2$.
substance contains this acid it gives the
acetic ether when heated with C_2H_5HO an

It is soluble in water and alcohol.

The acetates are sold in the form of li
solids.

Acetates are decomposed on ignition
$CO(CH_3)_2$. When heated with $CaHO_2N$
give CH_4, &c.

When a solid acetate is treated wi
H_2SO_4 and C_2H_5HO it yields CH_3COE
acetic acid is obtained when an acetate i
with dilute H_2SO_4.

FE_2Cl_6 when added to an acetate, produ
red colour.

Acetates are soluble in water.

Plumbic acetate, $Pb(CH_3CO_2)_2 + 3OH$
lises in right rhombic transparent pri
usually consists of an agglomeration of acic
crystals. It has an intense metallic sweet
a faintish odour.

When the crystals are heated on a sli
they melt and give off an inflammable va
a peculiar agreeable odour, and leave a red
residue of carbon and globules of lead.

Fe_2Cl_6 gives a red solution of ferric ace
white precipitate of plumbic chloride. A
of iodine in iodide of potassium gives a y
cipitate.

On adding KHo till alkaline, and stirri
cipitate is produced, which dissolves in
acetic acid.

It is easily soluble in alcohol, and soluble
which latter solution has a sweet taste.

Plumbic tribasic acetate, $3Pb(CH_3OCO_2)$
crystallises in opaque needles; but is gen
in solution, and has a sweet taste and a
reaction.

On ignition acetone is produced. A piec
dipped in the solution burns like tinder.

On breathing into a test tube containi
of the solution, and shaking, a white pre
plumbic carbonate is formed, and comn
added to it likewise renders it milky.

Ferric acetate, $Fe_2(CH_3CO_2)_6$, forms a
a deep red colour.

It produces acetone on ignition. W
with four times its volume of OH_2 it yield
precipitate of basic-ferric acetate.

HCl changes the deep red solution to a

Potassic acetate, KCH_3CO_2, forms w
drous opaque masses, that are very del
having a faintish acetic odour.

On ignition it yields acetone, and leaves
ate. It fuses easily.

Fe_2Cl_6 gives a bright red colour. I
soluble in water and alcohol.

Basic acetate $\prec$ $Ba(CH_3CO_2)_2 + 3$
$Ba(CH_3CO_2)_2 + OH_2$ occurs, crystallised i
or flattened prisms. On ignition it yields

H_2SO_4 gives a precipitate with the so
Fe_2Cl_6 gives the red colour. It is sparin
in alcohol, and more soluble in cold than

Sodic acetate, $CH_3CONaO + 3OH_2$, f
rhombic transparent crystals.

The crystals easily fuse to fibrous gr
which on further heating yield acetone
bonate. If it is heated in the dry state
lime, CH_4 is evolved.

The carbonate does not deliquesce in a
of potassium. It gives the characteristic
with Fe_2Cl_6. It is very soluble in water.

The aluminic, ammonic, argentic, cu
curous, &c., acetates have generally
characters as the above, with peculiar
istics of their own.

Albumen ($C_{72}O_{22}N_{18}H_{112}S$) consists
yellow shining tasteless scales. When
opaque and white, and when dry bec
lucent or transparent, yellow, and ho
heated in a tube it swells up, blackens,
a disagreeable odour. The solution in
is coagulated, by boiling; it first turn
coagulates about 70° C., becoming op
soluble. When strong nitric acid is
heated it is dissolved. Strong HNO_3
the solution in water. Millon's re-agen
it a bright red or rosy colour. KHO
when heated. When acetic acid is add
to a solution it produces a flaky precip
is redissolved in excess of the acid.
dissolves it slowly, giving a violet colo
solution furnishes syntonin. Creosote
coagulates it. Alcohol also coagulate
if alkaline. Ether does not coagulat
dissolves it, giving a reddish brown col
phosphoric acid gives a white precipit

taphosphates do so if acetic acid is added. solution about one-tenth of acetic acid, ne strong potassium ferrocyanide, a pre- produced. Take a large quantity of ate and add a drop of cupric sulphate, little of the solution and warm, when a ir will be produced. If AmHo is added d precipitate given by HNO_3, when cold the yellow colour to orange. Albumen ne appearance of gum in cold water, and it has a slightly acid reaction. It gives l rotation to a ray of polarised light. It in cold, but insoluble in boiling water, d ether. **Hugh Clements.**

BBING IN THE BRASSICÆ.

—For a considerable number of years I a great deal of this disease. I invariably the clubs from the cabbage plants, and met a single one in which there was not or more small white maggots or larvæ, or cells in which they had been, with holes from them. I have this day questioned , who has been in the habit of planting plants every year for over 50 years, and w, always breaks off the clubs from the he says the same. I am therefore very ed to think that the disease mentioned by nea" in letter 14630, p. 498, is not the t which is generally known as clubbing try, no matter how like it it may be in pearance, or in its effects on the plants. ne or two things which I would much wish ared up in "Saul Rymea's" letter. In ce, is his very minute and detailed de- the disease taken from his own know- bservation, or is it copied from Mr. E. right's article in *Nature*, of July 11th? the latter, is it in that article given as Vright's own knowledge and observation, anslated from the memoir read by M. fore the botanical section of the Natural ciety of St. Petersburg, on the 5th of 7? If the latter is the case, as I am in- nk, though "Saul Rymea" does not say here a single mark of quotation in his , I am strongly of opinion that the two entirely distinct.

last paragraph of the letter I entirely f those of your readers who are properly investigate the subject with the micro- t up they will soon find out all about it.

G. J. H.

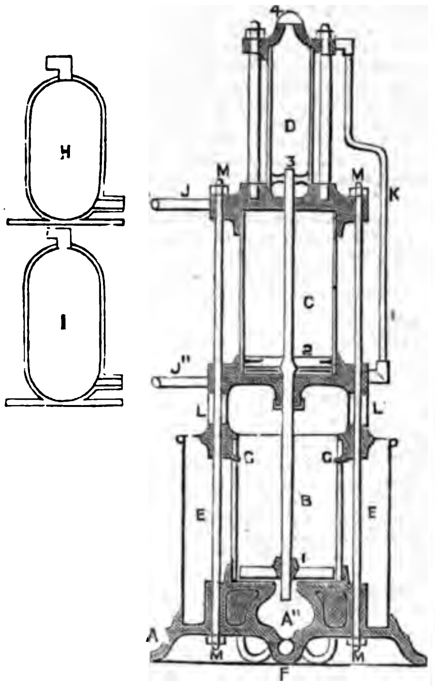
RESTORING IVORY.

In 'a book of recipes which I have by following for restoring ivory:—Wash in ne and water with a small quantity of soda ery slowly in a cool place, and then expose n a close glass case. I send this, as I see noticed the subject.

Ram Chand Biswas.

E APPLICATION OF GAS- ES AS MOTORS FOR STREET VAYS.

The gas-engine in its present form is t satisfactory, and I have a notion that ct agent is a great mistake; and I think s to be used at all it must be used as an mpress air. If we can do this, we can y out of all difficulties. Here is a may have some weight—open to improve- not the least doubt. I have had the ead for some considerable time, and if here it may bear fruit. At any rate, it tilating in our journal. Explanation of is a basement of cast iron, with four A" being explosion chamber, the three below—centre one, F—to take off pro- xplosion; those on each side mixing id supply valves. There are three ilt above this: B, the gas cylinder or r vacuum and compressing air; and D The dark shaded parts are cap, cover, of cast iron; the cylinders wrought iron ith Muntz metal, sheet, jump joint. The linders and basement are held together , or six long bolts, M M M M; the top being bolted to cover of C; C and B d by parting pieces, L L, or collars of e, that air may circulate between them. rounded by a light galvanised iron cis- for water, which is requisite, as the will become heated by the explosion of et for compressed air; J", connection chamber; H, air receiver; I, vacuum low the cylinders are to be of one length vo top. The bottom will be in excess, as vision is made for a small portion of p piston tight and lubricate it. Now, for of this, the gas is exploded in the riving the pistons up. In the top of C mpressed, and passes into chamber, H, to engine feed. At the same time a vacuum is formed under piston, 2; and chamber, I, connected to exhaust of engine, is exhausted or partially. Now the combined effects of vacuum in gas cylinder engine and weight of pistons bring the pistons home for another stroke. In the falling of the piston, 3, a partial vacuum is formed, which relieves the under side of piston, 2, taking its draught through pipe, K, to top of cylinder, D. There is a valve in the foot and top of pipe, K; an outlet valve at 4, one at J", and J" being an inlet valve. By these arrangements your engines would be of the simplest, and under control—namely, equilibrium, barrel valves, and, preferable, vertical engines; if horizontal, equilibrium D valves for this class of engines. I should dispense with all metal bearings, and find a substitute which very few know the value of. In fact, if I had anything to do with the cars, I would not have a metal bearing upon an axle. Everything is not illustrated here (valves, &c.), as time and space are objects. **Beaver.**



MUSICAL TONES.

[14670.]—"H. C. K." (letter 14618) writes incorrectly respecting the answer (letter 14583) I gave to his question. I did not say that "the sharp of the note below (in the scale) is higher in pitch than the flat of the note above." This is simply an inconsequent inference from what I wrote as my opinion of the author's intention in the employment of the notes transcribed by "H. C. K." If he had asked the question, which of the two sorts of notes is the higher, I should have replied, the flat of a higher note in the diatonic scale is higher than the sharp of the note next below—*e.g.*, B flat is higher than A sharp.

Adopting the illustrations supplied by "H. C. K.," and treating them to some extent in the manner he indicates, I will here show how I obtain this result (Fig. 1):—

FIG. 1

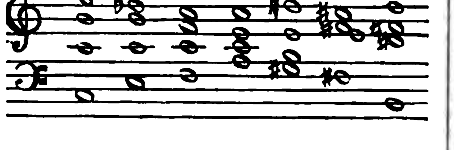
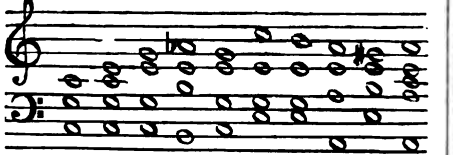


FIG. 2



Now, I take it for granted, as beyond dispute, that the B flat in the second chord is of the ratio 16 : 9 to the note C as the tonic or standard note of comparison, or of 8 : 9 to the octave C^1. Then that the ratio of B natural is 15 : 8, or a semitone (15 : 16) below C^1. Also that A sharp is a semitone (15 : 16) below B natural—that is, exactly two semitones below C^1—consequently the ratio of A sharp is

$$\frac{2}{1} \times \frac{15}{16} \times \frac{15}{16} = \frac{225}{128}.$$

Now the difference between the ratios 16 : 9 and 225 : 128 is 2048 : 2025—that is to say, that in perfect notes B flat is higher than A sharp by a small fraction over one vibration in a hundred vibrations of the latter. The smallness of the difference shows how futile "H. C. K.'s" method must be without the employment of the tonometer, the necessity for which he appears just now to overlook.

Greater inequalities, unsuspected by "H. C. K.," exist in other instances of proximate notes of this description than is found in this one—*e.g*, between A flat and G sharp. A flat being a semitone above G is of the ratio 8 : 5; and G sharp being a semitone below A is of the ratio

$$\left(\frac{5}{3} \times \frac{15}{16} = \right) 25 : 16.$$

The difference between the two is, that A flat is higher than G sharp by the ratio 128 : 125, or by about 2¼ vibrations in each hundred vibrations of the latter note. Let the progression, shown in Fig. 2, illustrate these two notes in an approximately close connection, and such as may be found appropriate to the above method of calculation.

I can hardly imagine "H. C. K." (letter 14649) to be writing deliberately when he asks the question, have the exact ratios of the diatonic scale ever been experimentally obtained excepting in the key of C? when I suppose he must know of the existence of such instruments as General Thompson's organ, and the several harmoniums of Dr. Helmholtz, Mr. Bosanquet, Mr. Colin Brown, and others, which are constructed upon and test the principle of the ratios being the same in every key. It is no objection of moment to say that these instruments are not the voice or stringed instruments, for the ear decides what are true notes, whether they proceed from voice or instrument. Independently of the fact that this principle is exemplified in the construction of the instruments referred to, I consider it utterly inconsistent with the nature of the human mind that the many diligent searchers into this subject should have all overlooked or disregarded every key but the key of C; and it is, moreover, in the highest degree probable that the same pitch, even though it has been nominally C in some instances, has not been in every case the same note.

If "H. C. K." does not admit that the consonance of notes with each other (for example, that of the octave with the keynote, or that of the fifth, or of the third with the same note, or that of the acute second with the fifth, or that of the sixth with the fourth, &c.) is the test of their being in tune, and that simplicity is the cause of this quality of consonance, then "H. C. K." and I must part company in this discussion. We have no common ground on which we can meet and debate, for my own experiments and acquaintance with the experiments of others have perfectly satisfied me that such is the importance of consonance, and such its nature as above described, and that it is absolutely the same at every pitch—see Dr. Helmholtz's "Sensations of a Tone," p. 18-24.

July 26th. **Fredc. J. Jackson.**

[14671.]—In letter 14616 it is stated that "if C flat is higher in pitch than B natural, B flat, the 7th of the key of C flat, is higher in pitch than A sharp, the 7th of the key of B natural; if lower, lower; and if equal, equal." What need of all these "ifs," and the implied doubt where no doubt exists? Take C at 256 vibrations and build up the vibration numbers of all the notes. Omitting fractions C flat above will be 479, and its 7th (B flat) 449; B natural will be 486, and its 7th (A sharp) 455. A sharp is thus higher in pitch than B flat by six vibrations, and there is no "if" about it.

"H. C. K." (p. 502) puts a pertinent question when he asks whether the relative vibrations have ever been actually measured in any other key than C major. I expect to find some note from Mr. Ellis about that part of the subject, but as I cannot answer "H. C. K.'s" question I leave it with the remark that there can be very little difficulty in making the experiment, and very little doubt but that the intervals as worked out by mathematicians are more nearly correct than any actual counting of vibrations could possibly be, for, whether we use tuning forks or reeds, temperature plays an important part, and force of blow or pressure of wind is another element producing diversity of result. Appunn's tonometer contains 65 reeds, each giving four vibrations more than that immediately preceding it in numerical order, and each is capable of being flattened, say two vibrations, so that every possible enharmonic change can be obtained within the octave from 256 to 512 vibrations (see a paper on "The Measurement and Settlement of Musical Pitch," by A. J. Ellis, B.A., read before Society of Arts, May 23, 1877). Forks have varied from 546 to less than 480 for C, or about the difference between the key-notes of C sharp and C flat—so that, if the effects of the keys depend upon the difference in their relative number of vibrations, it is impossible to play old music as it was intended, so long as we keep to our present pitch and do not know the author's. But it does happen that, so so far as four keys are concerned, we know their relative number of vibrations, with, I suppose I may say, absolute accuracy. Thus, taking C at 256, the same number of vibrations will give the 2nd in the key of B flat, the 5th in F, and the 4th in G, and each of these forms the base for a fresh start until all the key-notes are obtained. If an octave or a 5th in one key has a different ratio to what it has in another, our vibration numbers will be all abroad; but, until that can be demonstrated, I think we may fairly assume that the intervals in all the keys are relatively the same. The modern system of tuning is called the equal temperament, but it is probable that no two tuners tune exactly alike; major thirds it is notorious are very bad, no matter who tunes. It is not impossible that the ear tolerates imperfections in some keys of the unequal "equal-tempered" piano, which has almost invariably some keys smoother than others, but is unpleasantly affected by the imperfections in others. I believe if "H. C. K." can get hold of a singer who can sing true he will find that the scale is the same in every key, and that any difference in the effect produced is due entirely to pitch. I hope, however, that Mr. Ellis will be able to settle the question by giving experimental results as to the vibration numbers in the different keys.

Musicust.

CATEL'S MATHEMATICS OF MUSIC.

[14672.]—I AM glad to perceive from Mr. Ballard's letter, 14620, that he is on the right path in his pursuit in the study of musical mathematics; but at the same time I see it remains for him to discover that Catel's mathematics, the principles of which he summarises in his letter, are by no means perfect, and that there is something more to be known beside what they embrace. As instances of error in them, I would call his attention to the measures Catel ascribes to the minor seventh and minor ninth. That of the minor seventh corresponds with the vibration ratio 7 : 4. Now it is evident that in practice the interval is equal to a major sixth plus a semitone or minor second—*i.e.*, $\frac{5}{3} \times \frac{16}{15} = 16 : 9$. That of the minor ninth, according to Catel's thesis, is 17 : 8. Its true ratio, however, is 32 : 15, it being a note a minor second higher than the octave of the note from which its interval is counted up. These are facts obtained from experience, and go to prove that the relations of notes are naturally restricted to the ratios arising from the primes 1, 2, 3, 5, and their products; a truth which is always open to the experimental investigation of every one possessing the requisite qualifications and means for undertaking it. So far, therefore, as Catel employs these primes and their products to obtain notes, he obtains true ones, and so far only.

But there is another thing which calls for Mr. Ballard's regard—one, by showing which, had Catel hit upon it, he would have just doubly earned in his day the approbation bestowed on him by that distinguished association—the Conservatoire de Musique of Paris. If after he had found the satisfactory results he did find by the division of the string (whereby he obtained the notes, which in the specific and exact tonic sol-fa nomenclature are known as doh$_2$, doh$_1$, soh$_1$, doh, me, soh, doh^1, rah^1, me^1, soh^1, te^1, doh^2, and are the results of the division of the string by the numbers 1, 2, 3, 4, 5, 6, 8, 9, 10, 12, 15, 16)—if after doing this, I say, he had reversed his process, and instead of beginning with the whole string he had now chosen a small portion of it (say the twentieth part, which would be the measure of me^2, as pertaining to the above series) for his first note, then doubled this length for the second note, trebled it for the third, multiplied it by four for the next, then by five, by six, by eight, and so on through the set of numbers he had used before as divisors, he would have obtained a descending musical series as perfect as the harmonic series he did obtain, with just the same set of intervals between the successive notes, but in the descending order instead of the ascending—one which, though consisting in part of the same elements of the diatonic scale, differs from it in others. Now it must be evident to all that this reciprocal or converse process is just as simple, mathematically, as the former one; and I shall be obliged to Mr. Ballard if, by experiment or calculation, he will make out what are the notes this hypharmonic series consists of, and give us them in whatever notation or nomenclature he prefers; for I trust he will see that the series is just of the same importance as the harmonic series, and that in the structure of the diatonic scale the two equally supplement each other. Hitherto I have felt surprise that I have been unable to open the eyes of a single correspondent to see this fundamental truth of the mathematics of music—a truth which establishes the fact, that what is called minor in music, and what is called major, are on an equal footing as to the character of their origins—the one being just as natural as the other.

Although I have addressed my request more especially to Mr. Ballard, I do not suppose he would object to other correspondents undertaking to work out the proposition I have placed before him.

July 27. **Fred. J. Jackson.**

MATHEMATICS OF MUSIC.

[14673.]—As Captain Steel (letter 14023) joins with Mr. Jackson in support of the contested fact of there being rah as well as ray in the major diatonic scale, and thinks he proves it (as perhaps he does) by showing that from D to F is a false interval, I would like to point out to him (a fact with which he is doubtless well acquainted) that there is a false fourth, fifth, sixth, and seventh in the scale, as well as a false third. And if it being a false third is a sufficient reason why its base should be duplicated in order to make the interval a just third, why not do the same with the imperfect fourth, fifth, sixth, and seventh? Any one of these intervals has as good a claim to adjustment as the defective third. In way of illustration, I give the vibration ratios and the scale tones in the key of C.

4ths.	$^4/_3$	scale tone.
C to F	256 —341·3	341·3
D to G	288 —384	384
E to A	320 —426·6	426·6
F to B not a fourth.		
G to C	384 —512	512
A to D	426·6—568·8	576
B to E	480 —640	640
5ths.	$^3/_2$	scale tone.
C to G	256 —384	384
D to A	288 —432	426 6
E to B	320 —480	480
F to C	341·3—512	512
G to D	384 —576	576
A to E	426·6—640	640
B to F not a fifth.		
6ths.	$^5/_3$	scale tone.
C to A	256 —426·6	426 6
D to B	288 —480	480
F to D	341·3—568·8	576
7ths.	$^{15}/_8$	scale tone.
F to E	341·3—659·9	640
E to B	256 —480	480

The scale is systematically uneven in its intervals, which makes it the more beautiful, and gives it greater variety. But this unevenness is proportionate and mathematically regular. Taking the relations each note bears to the tonic, we have the ratios 1, $^9/_8$, $^5/_4$, $^4/_3$, $^3/_2$, $^5/_3$, $^{15}/_8$, 2, expressed in tonic sol-fa as doh, ray, me, fah, soh, la, te, doh^1; the relation each tone bears to the one preceding it, or the intervals between each tone, being represented by the series 9, 8, 5, 9, 8, 9, 5, or $^9/_8$, $^{10}/_9$, $^{16}/_{15}$, $^9/_8$, $^{10}/_9$, $^9/_8$, $^{16}/_{15}$. These series comprise the diatonic scale, and, I think, the whole of it. They are as simple and satisfactory to the mathematician as they are to the musician. I do not know of anything that is more simply and completely proved than the mathematical construction of the diatonic major scale.

I cannot understand why Mr. Colin Brown has not better understood or more fairly met Mr. Jackson's arguments in favour of the establishment of rah as a note of the major scale, as Mr. Jackson presents his views in such a clear and direct way, omitting nothing that can help to a full understanding of his meaning. I am as much surprised at Mr. Jackson, with the clear knowledge he possesses on the subject on which he writes, not perceiving that the introduction of rah into the scale vitiates the simplicity which he so strongly insists upon. As has been shown, combinations of notes of the scale do not always agree with those notes singly in the scale; but that is a matter which concerns melody and harmony and not simply the construction of the major scale. For instance, from doh to fah is a perfect fourth, and if sung in succession they may be considered as melodious, and if sung or sounded together, as melodious and harmonious. From la to ray^1 is an imperfect fourth, but if sung consecutively in a melody their consecution would not offend the ear, because they are notes that have their place in the scale of nature; but if sung or sounded together the harmony would not be as smooth as that of doh and fah. But they hold as just and true a place in the major scale as doh and fah.

I hope the Editor will not think this too late for insertion, but though I received the number containing Captain Steel's letter some three or four months ago, I did not see it till this week.

Picton, N.S. **D. Fraser.**

NEW MUSICAL NOTATION.

[14674.]—IF "Cello," letter 14582, writes all his music on the key of C he may succeed, but if he changes his key from C to D he will have to change the names of all his lines and spaces; he will then be in the same predicament as the sol-faists who play the piano from the sol-fa. When they change the key they have to forget the old lesson and become familiar with the new lesson in any way they best can. Besides, if "Cello" changes his key from C natural to C sharp, his plan will be an utter failure. "Cello's" method is to have the mi, fa, and the te do always on spaces, but this cannot happen on the key of C sharp and some other keys, for then the mi fa and the te do will be on a space and a line, and how can "Cello" make a space and a line to be only a space? Impossible! "Cello's" invention is nothing but confusion worse confounded. Besides, "Cello's" plan has another defect; the wide spaces holding the mi, fa, and the te do will require large notes to fill them up, and if "Cello" puts on square notes like square stones in a building, his musical landscape, to use an artistic phrase, would be out of drawing. There is no necessity for more landmarks than one, for when music is on the stave the semitones will speak for themselves, whether they are natural or accidental, and it cannot be expected that any person will fully appreciate the advantages of a notation, however perfect it may be, till once he is familiar with it.

Wark.

[14675.]—ROBERT WARK (letter 14617) makes a very sweeping charge when he asserts that sol-faists look on his notation "with indifference." Have the majority ever seen it at all? I am an enthusiastic sol-faist, but am much pleased with it, and I have no doubt others will be also. I have thought for years that if sol-fa music were printed so that it showed the "ups and downs," instead of being in a straight line, it would be a great improvement.

Dandie Dinmont.

THE MINOR 9th, DIMINISHED 7th, ENHARMONIC DIFFERENCES.

[14676.]—I AM obliged to Mr. A. Coates for his rejoinder (letter 14615), which I take to be corroborative of the assertion I made; and I as certainly agree with him that, assuming the existence of the note A below C sharp in the chord C sharp, E G B flat, we have the minor 9th in full, agreeing with my definition of it in letter 14620, as consisting of one major and three minor thirds. I also agree with him in what he affirms of the general utility and elasticity of the diminished 7th in passages of modulation, but I cannot altogether admit that my letter was *nihil ad rem*, seeing that he had raised the collateral question to which I addressed myself. With reference to the original one propounded by "H. C. K.," as to whether A sharp or B flat is the more acute in pitch, I waited until he should more clearly express the idea he meant to convey; and as he has now, in letter 14618, given us illustrations of the positions of the respective notes in question, a basis is presented for further argument. He has determined, he informs us, by an appeal to the ear, or, as phrenological doctrines are again coming into fashion, by the mental satisfaction experienced by the operation of sound upon the organ of tune, that, in the chords submitted, B flat is lower in pitch than A sharp. I could have wished that he had established this by mathematical measurement, because evidently the readers of the ENGLISH MECHANIC generally may not be able to determine this matter, by an appeal to the decision of the organ of tune, so readily as "H. C. K." may be; but all of them may be satisfied in the matter by a mathematical demonstration. I purpose to attempt the latter, and to reverse the conclusion at which he has arrived.

B flat in the chord in which he has presented it is the minor 6th of the key of D minor; and A sharp, as he has presented it, is the major 7th of the key of B major. To determine whether one is more acute in pitch than the other, we must have a common stand-point from which to measure the respective intervals. That common stand-point here is the note E, since that is the only one which is common to the two scales of D minor and B major. From the note E to B flat is a diminished 5th, and from that note to A sharp an augmented 4th. The question, then, is whether a diminished 5th, or an augmented 4th, is the greater or lesser interval. A diminished 5th consists of two tones and two major semitones; an augmented 4th of three whole tones. Musicians of the old school used to divide a note into 9 commas, of which 5 constituted a major, and 4 a minor semitone. Here, then, in the diminished 5th we have one comma more than in the tritone, and this would seem to establish the point that B flat is one comma more acute than A sharp.

But we appear to be not without corroboration in this matter. Captain Steel, in his enharmonic scale, given on page 509, Vol. XXV., ENGLISH MECHANIC, regarding the note C to be represented by a circle of 360 degrees, partitions every note of the scale into 7 distinct orders, consisting of the note itself, and then separate degrees of flatness or sharpness with reference to it. Disregarding decimals, he makes the note B 34 degrees lower than C, the first B flat, 40; the second, 55; the third, 62; the third A sharp, 68; the second, 74; the first, 89. Thus, according to Captain Steel, the lowest B flat is $\frac{1}{60}$ more acute than the highest A sharp. Before, therefore, we proceed to the discussion of "H. C. K.'s" second question, it may be as well to ascertain if we have yet escaped the confines of his first.

P.S.—Since writing the above I observe that the bsence of ledger lines in "H. C. K.'s" illustration f the comparative acuteness of B flat, contrasted ith A sharp, has led me to consider B flat, as he troduces it, as occurring as a 6th in the key of D inor, when the insertion of the ledger line shows at it is a 4th in the key of F major. This does not validate my reasoning, however, for, as in D minor in F major, E is the only note common to it and e key of B major. **Isaac Fowler Ballard.**

[14677.]—May I suggest to Mr. A. Coates that e chord G, E, C♯, B♭, which he states in letter 4615) to be the first inversion of the minor 9th on without the root, might also be the first inveron of A without the root, with the 5th, dominant h, and minor 9th, as that chord would contain all e given intervals without the necessity of terming ♭ as C♯. But on examination of the passage in which e chord occurs, it will be seen that it is the first version of F♯, the dominant to B minor, with the th, dominant 7th, and minor 9th, the root being mitted; the notes immediately following being the spersed chord of B minor. A♯, the third of the minant, resolves, as it should, by rising a semine to the tonic. I am disposed to regard the B♭ having been inadvertently written for A♯, and at there is here no enharmonic change.

W. Walker.

BTAINING THE ADDRESSES OF CONTRIBUTORS TO THE ENGLISH MECHANIC.

[14678.]—When a person obtains the addresses of ntributors to the English Mechanic by the gitimate method of advertising in the paper, it rely is not fair either to the English Mechanic elf, or to the gentlemen who so obligingly respond the advertisement, to communicate such addresses parties applying privately by letter to the adverer. For my part I shall not do it, and I beg to y, that parties sending me stamped envelopes to tain the desired information will only lose their amps, as I cannot undertake in every instance to ite my refusal back to each one.

Edward M. Richards.
Grange, Killann, Enniscorthy, Ireland.

[A well-deserved reproof, which we trust will not be st on those who have incurred it.—Ed.]

CREASE OF POPULATION AND THE ANTIQUITY OF MAN.

[14679.]—I believe the antiquity of the human ce to be considerably more than 5,882 years, and I not think that population increased at anything e the same rate in former times as it has done ring the present century in Europe. If we go ck to a period a little after the death of Solomon find that the Israelites could raise one million of en to fight against each other, also that King Asa d an army of 580,000 men to fight against one llion Ethiopians, so that at that time the scendants of Jacob would probably number more an 10 or 12 millions, and were surrounded by merous other tribes and small kingdoms. Then ere was the great kingdom of Assyria, with a pital (Nineveh, 60 miles in circumference), the ngdoms of China, India, Egypt, Greece, and Baby-n, some of which had been in existence at that riod more than 1,000 years. North Africa was ll stocked with inhabitants, and there is plenty of idence to show that mankind was spread over the ole of Europe in a semi-barbarous state. So at it would be unreasonable to suppose that less an 100 millions of people existed at that period— y 2,850 years ago. If so, assuming the rate of ogression prior to that time was the same as it has en since, and taking the present population of the rld at 1,400 millions, it would give 21,994 years the age of the human race, which, I think, will more in accordance with geological evidence than 382.

Manchester. **B. Riley.**

[14680.]—Permit me to thank "J. A." for his teresting contribution (letter 14566), and to supment it with a few additional particulars. The esent high rate of increase in the English populan cannot have been maintained throughout the glo-Saxon period of occupation of this country, r is it likely to continue for any considerable riod in future; because the period from the year to the year 1878 is 1,429 years, and this is 81 times 53·3. Suppose our first term, say 1,000 y (that we may err on the safe side), and we uld have ratio = 2 number of terms = 26·81, ich gives a population many times greater than present population of the entire globe.

gain, this is corroborated by the data lately ught out and published by Whitaker, p. 196, ere we find that from 1570 to 1750 the rates ried so as to give periods of doubling from 137 919 years. The higher rate results from the period 1600 to 1630, and the low rate results from the period 1630 to 1670. Thus the rate appears to be a variable quantity according to some law at present unknown. Mr. Malthus arrived at the conclusion, from some selected data, that the period of doubling was only 25 years. Now, this would give 40 terms in a thousand years with a ratio of 2, giving a population, from two persons only, of upwards of 700 times the entire population of the globe. Can any correspondent state where Malthus obtained such extraordinary data?

On examining the census returns from 1801 to 1871, I find that the rate of increase reached a maximum between 1821 and 1831, giving a period of doubling of 49 years. Since that time the rate has diminished to a period of doubling in 61 years. This lower result is obtained from the period 1851 to 1861.

In reply to letter 14641, I may state that by using the period from the flood to the year 1878, we obtain a ratio = 1·0057 as against 1·0034 when using the date 4004 B.C., and that what I said as to this rate being lower than the English rate, but higher than the French rate, still holds good when applied to the higher rate, 1·0057. **J. Steel.**

THE FLY WALKING.

[14681.]—I was at a lecture on the telephone, &c., the other day, and when I took up the telephone to put to my ear, I observed that I could distinctly feel, with my first finger around it near the diaphragm, every movement of the fly. I don't know whether this has been noticed. **Brickwall.**

USEFUL AND SCIENTIFIC NOTES.

The Water Supply.—Major Bolton again calls attention to the fact that from many causes the water supply of London frequently deteriorates after having been delivered by the companies into the cisterns of the consumers. The remedy for this deterioration is doubtless to be found in a constant supply. Such constant supply, however, is not yet general; meanwhile it is of the utmost importance that the attention of householders should be given to the fittings and cleanliness of their cisterns, as well as to their house drains and the water pipes connected therewith, upon which depend in a great measure the purity and sufficiency of the domestic water supply. An inspection of the cisterns too frequently shows that they are in a state of foulness totally unexpected, and generally caused by local circumstances and faults.

Deep-sea Soundings.—Commander W. S. Schley, of the United States steamer Essex, has recently reported to the secretary of the American navy that he has successfully run a line of soundings from St. Paul de Loanda, Africa, to Cape Frio, Brazil, *via* St. Helena. The greatest depth found between Africa and St. Helena was 3,063 fathoms, or 18,376ft.; and between St. Helena and Brazil the greatest depth was 3,284 fathoms, or 19,704ft. (nearly 3¾ miles). The soundings taken eastward and westward of St. Helena exhibit in profile that that island stands almost perpendicular in nearly 12,000ft. of water. After leaving the coast of Africa there is an abrupt descent of 900 fathoms in the first sixty miles from the coast, deepening up to 3,000 fathoms in a distance of about 700 miles, whence to St. Helena gradual reductions in depth occur, and an entire change takes place in the character of the bottom from mud to coral, rock, and sand.

The Eclipse of the Sun.—The astronomers assembled at Denver (Col.), to watch the total eclipse of the sun on July 29, succeeded in taking satisfactory observations and photographs along the line of totality. The corona was unusually bright, extending 70,000 miles from the sun in all directions. The chromosphere appeared to be about 2,000 (?) miles in depth. The protuberances only were seen, very faintly visible, on the western side of the moon. There was an entire absence of the pinkish red flames observed on previous occasions, and the spectroscope did not reveal any extra red or violet lines. At the moment of totality the Fraunhofer lines and both the "H" lines were reversed. Very bright lines near large B, and bright lines F, and 1474 Kirchhoff were observed. The temperature fell considerably in different localities during the eclipse. No intramercurial plant was observed. The weather was perfect. Mr. Norman Lockyer reports that the solar protuberances were fainter and fewer, but that the corona was ten times brighter than in the eclipse of 1871, thus indicating a variation with the maximum and minimum sunspot periods. A telegram from Lajunta, Colorado, states that the eclipse was successfully observed. The weather was perfect at all contacts. Several photographs were taken. The corona was radially polarised; Vulcan was not observed. The prominences were insignificant.

REPLIES TO QUERIES.

**** In their answers, Correspondents are respectfully requested to mention, in each instance, the title and number of the query asked.*

[31976.]—**Compound v. Single-Cylinder Engines.**—This discussion has dropped out in a very unsatisfactory manner, the opponents of the compound doubtless still believing that their opposition is well grounded, and based on fact. I believe the only way to convince any one on paper is to get him to work out the sums from two imaginary engines, the dimensions of which are so proportioned as to make them apparently equal; but no one has yet ventured on that task. I quote a piece of a paper read before the American Civil Engineers by Mr. C. E. Emery, and when I have time I shall be prepared to go further into the matter:—"Compound engines, says Mr. Emery, in addition to advantages of a mechanical nature, in better distributing the strains and rendering more uniform the rotative efforts, serve also to reduce cylinder condensation by the distribution of the differences of temperature between two cylinders. The radiation to and from the steam and its inclosing walls increases more rapidly than the difference in temperature, so that the aggregate loss, when the difference of temperature is divided between two cylinders, is less than when it all occurs in a single cylinder. Moreover, the heat imparted to the exhaust steam by the metal of the first cylinder is available for work in the second, and the low-pressure piston acts as a screen between the high temperature in the small cylinder and the low temperature in the condenser. It is still strenuously denied by many that greater economy can be secured with a compound engine than with a long-stroke single engine, using the same steam pressure. There are coasting steamers of similar size running regularly in the United States, using both types of engine, with, it is claimed, substantially the same results; but the boilers for the single engines are evidently the more economical, making an accurate comparison impossible. Strictly comparative experiments have, however, been made by Chief Engineer C. H. Loring, U.S.N., and the writer with engines of different kinds in the steamers of the United States Revenue Marine, and by the writer with some of those of the United States Coast Survey. The revenue steamers were of the same size, and the boilers very nearly identical. In one steamer was a compound engine with steam-jacketed cylinders; in another, a long-stroke, high-pressure condensing engine (cylinder not jacketed); in another an ordinary low-pressure engine (cylinder not jacketed); and in still another, a high-pressure condensing engine with a jacketed cylinder. The compound engine showed a saving of 12 to 16 per cent. compared with the best performance of either single engine when operated at the same steam pressure. It is believed that substantially the same differences will be found in all cases when equally good engines of both types are compared. The performance of a short-stroke compound engine may be equalled or even excelled by that of a long-stroke single engine, on account simply of the difference in clearance spaces and the superior efficiency of the steam-jacket in the latter case, but by making the compound cylinders in the same form they should still show an advantage. In practice, the economy of marine compound engines is greater than above mentioned, for the reason that the high steam pressure is better maintained with them by the engineers than when single cylinders are used with high rates of expansion, causing difficulties in management." Theoretically we know that the compound must be superior, and here we have a practical demonstration of the truth of the theory. By the way, "A. I. C. E.," who rushed into that "vacuum" in a violent hurry, has not condescended to notice my question on p. 374. I hope he did not injure himself.—J. B. C.

[32269.]—**Systematic Memory.**—Permit me to say that I entirely agree with the opinion that if as much labour is devoted to the effort to impress names and dates upon the memory they will be remembered when wanted as easily as any keywords formed by a system of mnemonics. If any system could be devised by which a man could remember a sermon or a speech, and write it out within an hour afterwards, it would of course be of great value, but to make any elaborate attempt to remember dates I consider as labour wasted. One refers to a list for them just as one refers to a table of square roots or logarithms. It would not be a difficult matter to remember a number of square roots or the areas and circumferences of circles, but for the sake of certainty it is always advisable to refer to the pocket-book. If the principles of any science, Boyle's law, Mariotte's law, Kepler's laws, &c., could be put into words easily remembered, it would be an advantage, to a certain extent, and to some people, but the careful student would always refer to his book if the work he was about was of importance.—S. M.

[32931.]—**American Dried Apples.**—I doubt very much whether the English climate will admit of apples being dried in the open air, as in the States A much better way has been adopted in California, and is known as the "Alden patent process." The apples are peeled, cored, and sliced as usual, and then stove-dried as quickly as possible by being exposed to a current of hot air, but not hot enough to cook them. Fruit dried on this plan cannot be told (when cooked) from the fresh article itself, requires very little sugar, is infinitely cleaner, and goes further than sun-dried fruit.—Backwoodsman.

[32980.]—**Leather Strapping for Chairs.**—Leather strapping is simply narrow braid put round the chairs to cover up the raw edge of leather left by the upholsterer and tacked on with brass studs. It is usually made with morocco leather, but is sometimes made of cheaper sorts.—W. H. W.

[33019.]—**The Spectroscope.**—In reply 33019, p. 425, "M. S." advised me to consult Proctor "On the Spectroscope," and Roscoe. I have now read both these books through, and find that there is not one syllable about the integrating spectroscope, or about different orders of spectra in either of them. It is a great pity that people answer questions on subjects of which they are so very ignorant.—Ignoramus.

[33029.]—**Electrotyping in 15 or 18-Carat Gold.**—"Os" did not make any mistake whatever, and he does know that "'Hydrochloric' will throw down the silver as chloride." He also knows that the cyanide of potassium used in making the bath will dissolve this chloride. I would suggest to the original querist that he should use two anodes—a large one of gold and a smaller one of silver—two wires being used for the purpose. Although a gilding bath is generally used hot, it is possible to obtain a deposit at the ordinary temperature. I have several times recommended Mr. R. H. Thomas's method of making a solution, and certainly consider it the best. I have repeated it several times lately, and thought it as well to give another. There is one thing to which I must take exception. You do not require a gold cathode; the end of the copper wire will answer the purpose, as while the current is passing the cyanide will not to any appreciable extent dissolve it. There is a good deal of information on these matters in back numbers, and I would certainly advise a reference to them.—Os.

[33067.]—**Tuning Forks.**—"S. M.," p. 451, sends a curious answer as to who was the inventor of tuning forks, by stating that a rev. gentleman possesses a fork once owned by Handel, and, therefore, Mr. Thunder, of 50 years ago, could not be the inventor. I rather expected to hear of a half dozen other forks with Handelian reputation, and how it is they have not some at the Royal Aquarium I don't know. But with respect to harpsichords, on which, individually, the "Messiah" was composed, I have seen more than I care to remember, belonging to both sexes, with and without keys and strings. In fact these memoranda are like Capt. Cook's club, everybody possesses one. I must, therefore, trouble our savants for more information, knowing, at the same time, that 50 years ago Mr. T. was an elderly man.—Fiddler.

[33111.]—**The Spider and the Fly.**—Whether spiders see or not is a moot point. Certainly, where sparrows breed spiders are very scarce. But I would wish to remark that, probably, spiders are fond of music, for I have often seen them come out during a performance, and retire when all is finished. These are long-legged fellows, living behind wainscots, and in corners of summer-houses. Fiddles and organs excite them most. Perhaps, though it's only the vibration that disturbs them; but they grow to an enormous size. I have known mice also come out of their holes and listen; but never a cat could abide a fiddle—it offends their dignity. Mice will breed in organs. Do they live on the wind, that they try to eat up the bellows?—Fiddler.

[33140.]—**Decimals (U.Q.).**—

$$\begin{array}{llr} +\frac{1}{5} = & & +\cdot 2 \\ -\frac{1}{3\cdot 5^3} = & \frac{1}{3 \times 5 \times 5 \times 5} = & -\cdot 00266667 \\ +\frac{1}{5\cdot 5^5} = & & +\cdot 000064 \\ -\frac{1}{7\cdot 5^7} = & & -\cdot 00000183 \\ \hline & \text{Sum of } + & \cdot 200064 \\ & \text{,,} \quad - & \cdot 0026685 \\ \hline & & \cdot 1973955 \\ & & 16 \\ \hline & & 3\cdot 158328 \\ \frac{4}{239} = & & 016736 \\ \hline & & 3\cdot 141592 \end{array}$$

This question is incorrectly printed; it should read thus:—

$$16 \times \left(\frac{1}{5} - \frac{1}{3 \times 5^3} + \frac{1}{5 \times 5^5} - \frac{1}{7 \times 5^7} \&c.\right) - \frac{4}{239}$$

—Peake.

[33149.]—**Coachmaking.**—The anathema that "Old Sub." hurls upon coachmakers in his reply on p. 401 is too well deserved; but I think it is more because of a scarcity of competent subscribers than from selfishness. The question that "E. B. F." asked through these columns was not in my branch of the trade, and the consequence is, that I know as little or perhaps less of the art of painting than he does. If "Old Sub." or any other subscriber is in a difficulty that I can remove, it will at any time give me pleasure.—Practical Wheeler.

[33151.]—**Drying Oils.**—What "S. L." says about the way in which oils dry is correct, but when he continues: "Boiling with litharge and other *substances facilitates the absorption* of oxygen by removing from the oil substances which would tend to keep it liquid," I cannot agree with him. How do "driers" remove these "substances?" The only way they can do so is by precipitation, which takes some time to effect. It follows, if "S. L.'s" view is the true one, that boiled oil should dry better after settling, but it does not do so. If there is any difference it is in favour of oil just boiled, and, further, the "foots" of boiled oil dry better than the oil itself. I believe that "driers" act through putting the oil into a more active state—that is, they impart to it an increased power of absorbing oxygen. Here let me ask: Is there a good work on drying oils in English?—Dandie Dinmont.

[33176.]—**Midland Lights.**—The light at the back of every train is a red one; and the light at the front of a train is white for a passenger, and green for a goods train. I do not know the arrangement with boards on the Midland; but the London and North Western Company, I think, employ a white oval board on the front of the engine in daylight for a passenger, and a diamond-shaped one for a goods train.—Novus Homo.

[33181.]—**Life of a Watch.**—In the *Gentleman's Magazine* for 1824 is an account of a sale, in London, of curious antiques, and among them is a silver watch that had been made 160 years, and "went well." I have a gold watch, 2in. across face, case, and all, that has gone very well since the year 1809 or 1810. So far as I know it has never been repaired; but has, of course, been cleaned and oiled. The name is engraved in it, but he was not the maker, and I do not know where it was made, nor who made it.—Furnace.

[33207.]—**Capital Investment.**—For £3 10s. 4d., line 7, under this heading, page 503, read £5 10s. 4d.—An Engineer.

[33207.]—**Capital Investment.**—Allow me to inform "An Engineer" that many building societies, under good management, are now paying 10 per cent. profit to shareholders. The employment of deposits is not, as he thinks, "therefore, somewhat speculative," but is, and must be, on the substantial security of houses and land. Building societies can, and do, charge borrowers only 6 per cent. per annum (estimated on balance due at beginning of each year), and yet pay 10 per cent. profit. "Mutual societies," for deposits from and loans to members, pay 7½ per cent. profit to investors, and charge borrowers only 5 per cent. net.—Jib.

[33207.]—**Capital Investment.**—"An Engineer" may pick up an idea or two from the following imaginary conversation. Mr. Penance Point: You once told me that you would give me some information relative to investing the £500 which my father left me. I have been told that consols and other first-class securities do not yield 4 per cent. per annum, but I cannot help thinking there may be some second-class securities that will answer my purpose, and return me 4½ per cent. at the least. As I am only 45 years old I do not think it desirable to sink my money in a life annuity, neither need I fear that if the second-class securities referred to should fluctuate to my disadvantage, either through civil commotions or war, that I should cry over spilt milk. I have been thinking that foreign loans might answer my purpose; Prussian—what do you think of that? Then there are colonial city loans and building societies, trading companies, such as discount-houses, offering excellent terms for money, which can be withdrawn at three months' notice. Answer: Well, let me see. You say you have £500 to invest, and you do not like "consols," which can be bought to-day at £95 10s. per £100 worth of stock, with the dividend due in January next. Owing to the stagnation of trade all kinds of good securities are at a high price now, including, of course, consols. I should not lend money to trading people offering high rate of interest; they may be over-sanguine—mistakes are often made in the best regulated offices. Foreign loans—excepting some European—we have had enough of; many families have been ruined within the last ten years by investing in them. If the war at the Cape is over, you might be quite safe in buying Cape of Good Hope £100 4½ per cent. bonds, p.c. £98, interest due 15th October next. Provided the Portuguese Government have ceased borrowing, you might be safe in buying that stock which will pay nearly 6 per cent. per annum, dividend January and July. Ask your broker—do not seek an advertising one—or banker or both, if these securities can be recommended to you. If the report is favourable, divide your capital—put £300 into Cape of Good Hope, and £200 into Portuguese bonds; by this arrangement your eggs will not be in one basket, and you may get 5 per cent. for your money. Thus:—

Capital Statement.

	£	s.	d.
3 bonds Cape of Good Hope Government 4½ per cent., price current, say, £98, 6 months' interest due October 15th ...	294	0	0
Broker's charges		15	0
	294	15	0
4 bonds Portuguese Government, 3 per cent., £100 each, nominal value; price current, say, £50 10s. Interest due January and July	202	0	0
Broker's charges	1	0	0
	1497	15	0

Interest Statement.

	£	s.	d.
12 months' interest on Cape bonds ...	13	10	0
12 ,, ,, ,, Portuguese bonds	12	0	0
Showing a clear 5 per cent. on £500 ...	25	10	0

—Penance Point.

[33235.]—**Telegraph Engineers.**—A telegraph engineer must be acquainted with practical electricity, be capable of remedying the defects of instruments, and of laying out new circuits, all which involves a good education to start with, and plenty of technical knowledge. I should say the best way to acquire the information would be apprenticeship to a telegraph engineer.—Nemo.

[33236.]—**Slide Rule.**—I beg to express my acknowledgments to those correspondents who answered my query on the slide-rule, especially A. A. Watkins, for his kind offer, but I have ordered Routledge's instructions, and therefore will not trouble him. I see by the examples worked by "Buttershaw" that it is possible to get the contents of round timber by using this particular rule, but the result would be very different from that given by the ordinary carpenter's rule, or by the measuring books. Thus, taking, say, 8ft. long and a quarter girth of 11in., the carpenter's rule would give as the content 6·75ft., while the engineer's rule would give about 8·60ft., so that while one would give the customary measure the other would give, approximately, the actual content.—Cotswold.

[33240.]—**Clear Gelatine, Rendering Insoluble.**—"Americus" cannot make gelatine insoluble, and at the same time keep it clear. All the salts formed by chromic acid colour it, though the bichromate is perhaps the best and cheapest to use."—J. M.

[33250.]—**High-pressure Horizontal Engine.**—I see one gentleman asks if cutting off the steam earlier would not be a more rational way out of the difficulty. Even supposing that the pressure attainable at the cylinder were only 14lb. it would require a cut-off of 1-11th! Referring to the diagrams on p. 478 it appears that there is a large amount of condensation or throttling in the steam pipe, causing a reduction in pressure from 28lb. in the boiler to about 12lb. in the cylinder. It is evident, too, that there is a large amount of "wire-drawing," as is to be expected. There also appears to be an absence of back pressure, which is rather remarkable, since, as "H. L." states, the exhaust steam is used for heating the feed. The necessary alterations must depend to a great extent on the design of the engine, whether to put in a new cylinder complete, or to bush the old one, and add new valves, and, perhaps, eccentrics. If the initial pressure in the cylinder cannot be increased above 14lb., then a 1½in. liner, with a valve arranged to cut off at ¼ stroke, will suffice. There may be a difficulty with the valve, as the amount of lap required will be great, and, probably, the port will not open sufficiently without increasing the stroke; and, with the increased stroke, the valve chest may not be long enough. Separate expansion valves would remedy this if they could be got in. "E. C. S." advises leaving the cylinder as it is, and a cut-off of one-third. But this would be still worse, not being practicable with a single valve, and certainly not with the same eccentric, and even then it would leave an excess of power. Of course the liner need not be of 3in. metal; ½in. will be ample, with facings to fit at each end, and, if ends are caulked, the annular space may be advantageously utilised as a steam jacket. I strongly suspect, however, that the cause of the large coal consumption must be looked for in the steam pipes as well as the engine, and, therefore, fear that the proposed alterations will not reduce it to 4lb. per I. H.-P., though, if the design is favourable, it may be quite possible. There is no doubt but that the better job would be to put in a new cylinder, and use higher grade of expansion and steam pressure. But would it not be nearly as cheap, and far the best, to dispose of the existing engine, and put down a smaller one? "E. C. S." states that "The best modern engines do not exceed 2lb. of coal per h.-p. per hour." He surely does not mean to imply that non-condensing engines, such as the one under discussion, are made to give such good results.—Novus Homo.

[33259.]—**Japanning Stove.**—Mr. Temple will find what he wants in No. 324.—Remus.

[33266.]—**Convertible Investments.**—"Greenfield" asks why people do not invest their surplus cash in land, instead of in foreign bonds. The answer is: They do, as he would find if he tried to buy any land. It is true that the sale of land is hampered by the law, but I don't know of any offered at a fair price that goes begging. In London just now some capitalists have found out that it pays to build model dwellings, and I believe they are ready to buy up all the suitable ground that is for sale. Seven per cent. on house property of that quality is not bad interest.—S. M.

[33268.]—**To Oculists.**—Does this querist really want telling that he should get medical advice at once? Very likely there is nothing the matter with the eye itself. I wonder how it is that the "cuca" hasn't been recommended in this case. "Advice gratis" is invariably obtained at its true value.—Not a Doctor.

[33275.]—**Dispersion of Sound.**—It is singular if no experiments have been made on this matter, for, if there is a dispersion of sound, it forms

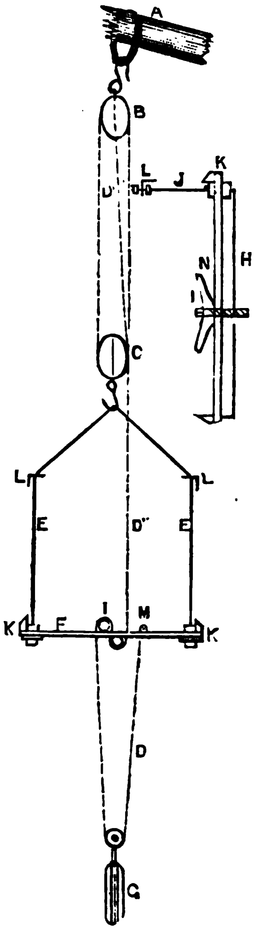
the most striking and beautiful analogies
sound and light. I do not remember, how-
seting with any closer reference to it than
ntained in Tyndall's "Sound," where, in
g of the ever-varying penetrating power of
t sounds, as proved in his experiments at the
Foreland, he says:—"Such experiments yield
nceptions as to the scattering of sound in the
here. No sound here employed is a simple
in every case the simple note is accompanied
rs, and the action of the atmosphere on these
t groups of waves has its optical analogue in
attering of the waves of the luminiferous
hich produce the various shades and colours
sky." Another somewhat similar point of
is found in the experiment of causing sound-
to impinge upon pads composed of squares of
&c., and measuring the absorption, reflection,
smission of the sound by the action on sensi-
ames. Tyndall says:—"A further step is
ken in the illustration of the analogy between
ad sound. Our pad acts chiefly by internal
on. The sound from the reed is a composite
ade up of partial sounds differing in pitch.
sounds be ejected from the pad in their
proportions, the pad is acoustically white;
return with their proportions altered, the
coustically coloured." I have no doubt Mr.
as read these quotations in the original; but,
aery is supposed to be personal, I give them
same.—C. W. HODGSON.

.]—**Organ Pipes.**—Take a lesson or two
voicer to prevent the woolliness of tone, and
t is meant by the 8ft. stopped not speaking
Do you mean the 8ft. stopped won't give the
ne? If so, give the dimensions of pipe, wind
, how much mouth is cut up, &c., and you
a reply.—E. G.

.]—**Preserving Moths, &c.**—The simplest
have heard of for preserving moths from
ks of mites is to put a globule of mercury,
of a pea, into each case. I cannot guarantee
acy of this method, but it is worth trying for
licity. "Mike" should refer to Wood's
ion British Moths," for information as to
of corrosive sublimate for keeping off mites,
G. K.

.]—**Hay Fever.**—I have read "Incog.'s"
to "F. W. S.'s" query with interest, as I
en myself a sufferer from hay fever for the
enty-nine years, ever since I was fourteen
age, and I must say I entirely differ from
o the cause of the complaint. The origin of
r, or hay asthma, is simply nothing more or
n the exhalations from flowering grasses,
ly *Oxycanthum odoratum*, or those cut and
during the process of hay-making. These
ous emanations are especially active during
of great solar heat and high winds; conse-
the patient suffers more or less, according to
perature of the air during hay-making time.
eather during that period be hot, the severer
ptoms will be. If the weather be then
, with a cool temperature, the symptoms
milder, but the attack protracted as the hay
more slowly proceeds. If none of these
ous grasses were grown, and if no hay was
hen there would be no hay fever whatever.
se these emanations do not affect every one.
ase the complaint is of hereditary origin—so,
, they act upon a peculiar nervous organisa-
he complaint generally commences about the
nd of May, with a slight sneezing, and an
al itching about the eyelids and eyes. These
ns are increased if the weather be hot and
ect takes much exercise in the country. If
ther be cool the severity of the attack does
ease till the latter end of June, when hay-
commences; then all the annoying symptoms
eir appearance in full vigour—violent sneez-
amed eyes, and spasmodic asthma, sometimes
anied by a most distressing cough, with pro-
pectoration of frothy mucus. A highly
state of the system is invariably present.
ay harvest progresses, and field after field
rass is mown down, dried, and stacked, so
mptoms gradually disappear, and the patient
cured. After the hay harvest is over, how-
the weather may be, none of the character-
nptoms of hay fever are manifested. That
r of the dried grasses is the special cause of
ction I am perfectly convinced. Only the
y when walking close to a field which had
n cleared of its hay, I was seized with
fits and inflamed eyes. In the winter I
ve asthma nor bronchitis, and suffer little
arrh. I attach little importance to the bac-
ory origin of the affection. The microscope
acteria on the mucous secretions, but not in
ntity; and, probably, a few bacteria are to
l in the secretions of the human body at all
en they are examined with adequate mag-
power. As to a remedy: the only effectual
moval to the sea-side, especially to a barren
ast where little hay grass is cultivated; and
ent should frequent the beach as much as
, particularly when the wind blows off the
f circumstances prevent the sufferer from
the sea-coast palliative remedies must be
ered. The bowels should be kept open with
aline purgatives, the fever kept down with
brifuges, and coloured spectacles will pro-
eyes from the glare of the sun, and their
ation will be relieved by the use of mild lotions of lead diacetate or zinc sulphate. I have not found glycerine or other remedies applied externally to the nostrils of much use, and of quinine I cannot speak personally. Smoking stramonium, or occasionally sucking an ipecacuanha lozenge, or drinking strong coffee, will mitigate the asthma. Attention should be paid to diet. Everything of a flatulent nature should be avoided, and stimulants be left off altogether, and the greatest care should be taken not to catch cold, by avoiding draughts and sudden chills, and, finally, the patient should refrain from going near hay-fields as much as possible.—C. F. TOOTAL.

[33397.]—**Hoist (U.Q.).**—The following has stood me in good stead, and by it I have carried out repairs and jobs where I could not get a ladder or anything but a flying stage. I prefer it, with my own management, to trusting to those who can't or won't do without their beer and 'bacca, and by whose mismanagement I have been left in a fix more than once:—A is a jib or scaffold pole off roof or bank over parapet upon a cross, with a bag of sand at the other end, or lashed to chimney stack; B and C, single-sheafed blocks, 5in. wood; D D D, fall of 1½in. bolt rope; E E, suspending rod, ¼in. iron; F, floor, 3 boards good yellow deal, 3ft. × 11in. × 1in.; G, dog weight; H, rider; I, cleat; J, pillars for angle iron frame, L; and K, fillets for nailing or screwing wirework or match-boarding to, to form a box or cage, and again fixed to angle iron at top of pillars. The fall has a loop, with thimble spliced in it, forming strop for block, B. The tail end is passed through C, up and through B, down and through floor under rider, H, up alongside of cleat, I, over cleat, down through floor, through pulley upon dog weight, up through floor, and a large knot made. By this arrangement I have raised myself upwards of 100 feet, taking tools and materials from 1½cwt. to 2cwt., and stopping anywhere I required. When you want to go up, pull at fall, D. The rope will slip over rider, H, and cleat, I, and the weight, G, will keep and take the fall up. But, in moving about upon the stage, it is apt to move in very dry weather; so, when wanting to be fixed at any place, take the fall off top of cleat, I, and pass around and under at N, and it will not move.—BEAVER.



[33413.]—**Hysteria.**—Go to Schwalbach (near to Wiesbaden), take a course of the waters and baths this year if you can, if not save your money and do it next. But, in the meantime, drop all fermented liquor. Take cold baths and plenty of exercise, and, above all things, keep your mind fully occupied. Try to forget that your body exists except as a case for your mind.—N. SIRCH.

[33445.]—**Determination of Blood to the Head.**—I hope this question will receive further notice. "Physiologist," p. 481, speaks against drinking and smoking with a perfect right, but he ought to write of the individual, and not of the community. Some people can drink a bottle of whiskey a week, and remain in good health, because they have a good re-action. I believe it would kill me, not that I am unhealthy, but not used to it. As for smoking, a cigar would upset me more than a pipe, and I have had some experience. A great deal depends upon the pipe being baked or burnt, porous or not. Determination of blood to the head means inflammation, and that causes pain somewhere—viz., the weak place. If our physiologists would inform of the condition of the blood in diseased persons, and how it is that heat will cure some, and cold cure others; same with acids *v.* alkalies, water *v.* electricity, and what is the proper medium condition of blood to insure freedom from pain, and thence to good health, they would benefit us very much indeed. Is pain a curative agent? I think this an important question.—FIDDLER.

[33453.]—**Explosive Force.**—The boiling point of water depends upon the pressure to which it is subjected, and in the case you mention the water would boil at, probably, 20° to 30° above its normal boiling point. The process of boiling would, however take place slowly, hence the internal pressure would be gradually raised, and, consequently, although the pressure in bottle would be sufficient to explode the bottle, still, under the conditions of gradual rise of pressure, the bottle would not burst. Now, on the application of cold water, two things take place—first, the outer surface of bottle suffers a considerable contraction, thus bringing about a strain similar to that in unannealed glass, then the cooling of the vapour inside bottle would cause an instant production of more vapour, and between these the bottle would burst.—W. J. LANCASTER.

[33462.]—**Harmony.**—It is quite possible to learn harmony without a master, and the best work for a beginner is Stainer's "Harmony," price 2s., to be had from any music-seller. After going through this carefully you might with advantage get Richter's larger treatise, price 7s. 6d. The first is published by Novello, and the second by Brewer.—C. J. LEAPER.

[33462.]—**Harmony.**—I should most strongly advise the querist to get a copy of a book entitled "Music," by H. C. Banister, Professor at the Royal Academy, price 5s. It gives in a handy form an outline of all the principal branches of music, including harmony in all its branches—method, rhythm, counterpoint, canon, fugue, a description of all the instruments in a full orchestra, and a copious glossary of musical terms. I have read many books on science in its various forms, but I never came across one better put together than this. —R. S.

[33462.]—**Harmony.**—If you get Bannister's "Music," published by Bell and Daldy, 5s., and follow out the advice given in the preface, and in the chapter commencing on p. 255, you can certainly learn harmony without a master. By all means commence at once in "dispersed" harmony, as this book teaches, and do not get into the slipshod way of writing in "close" harmony as taught in some of the cheaper works.—NE SUTOR.

[33462.]—**Harmony**—Can undoubtedly be learned without a master, with study and perseverance, and the help of a good treatise. It is a subject that has, in my opinion, been made unnecessarily difficult to the student by the way in which it has been treated in many works. I can recommend "Lessons in Harmony," which appeared in the ENGLISH MECHANIC Vol. XX., as affording an easy introduction to the science. If those lessons do not go far enough, then "Logier's System of the Science of Music, Harmony, and Practical Composition," published by T. Boosey and Co., will supply "Poor Musician's" wants admirably, if he likes to spare the necessary guinea for its purchase.—W. WALKER.

[33464.]—**Dirty Filter.**—I bought a guinea Lipscombe of a neighbour for 2s. Out of curiosity I broke it open. It consists of charcoal and grit. Never have a filter you cannot clean; they are worse than nothing. There is no reason, except in the interest of the manufacturer (which is obvious enough), why they should be fastened up with Portland cement. If any correspondent can tell you what will dissolve this, you can easily open the filter and recharge.—DANDIE DINMONT.

[33465.]—**Acoustics.**—1. Earnshaw, by mathematical analysis, found that sounds of great intensity should be propagated with a high velocity, and observation and experiment have confirmed this; but I am not aware that pitch alone has any influence on the velocity. 4. The elasticity of water is not less than that of air, but many times greater. Elasticity is a word of such various meanings that it is no wonder students are perplexed on such questions.—C. W. HODGSON.

[33465.]—**Acoustics.**—1. Theoretically all sounds should travel with the same velocity. As a rule a sound of low pitch will travel faster than a sound of high pitch, if its volume be sufficient. Thus there are many examples given, as the firing of cannon being heard before the order to fire, &c. 2. This follows from what I have said above the cause being that a wave some 20ft. long will leap over resistances that would destroy a 1 or 2ft. wave. Thus, as an example familiar to every one, the drum in a band can be heard long before any of the other instruments in the same band, and some time must always elapse for the band to approach before all the instruments may be heard at the same time. 3. The best length for a monochord string is 4ft. 4in.; this is a capital length to work with. Have it so arranged that a scale pan may hang at one end. 4. Tyndall is quite correct. One of the simplest laws in connection with acoustics is, "The velocity of sound is proportional to the square root of the elasticity, and inversely proportional to the square root of the density of the medium." You will find all these laws in my "Notes on Physics," of which I shall be happy to give you a copy if you will write to me. Now, by working out the relative elasticity and density of water compared with air, you would find that, on the assumption of equal densities, water would have 16 times the elasticity; hence $\sqrt{16} = 4$, which gives 4 times velocity in water.—W. J. LANCASTER.

[33472.]—**Herb Essences.**—I do not think that success will attend any effort to "distil" the essences named. Very good preparations may be composed in the following manner, and these will, I think, suit your correspondent:—Take a handful (vaguest of vague terms) of the herb, and infuse in a quart of boiling water for an hour. Evaporate this down gently to one-eighth its bulk, which is a quarter of a pint. If to be preserved, 20 to 25 per cent. of rectified spirit should be added. The infusion should then be put into a stoppered bottle, and labelled. One part of this infusion added to seven parts of water is equal to a like bulk of an infusion made with a handful of the herb and a quart of water.—T. P.

[33473.]—**Microphone and Phonoscope.**—The sounds produced in a microphone cannot be heard by a number of people at the same time. You may, however, have three or four telephones in the circuit, and have fronts made different to those used for ordinary speaking through. Thus, have a piece of brass tube some 6in. long and 3in. diameter, like the one used for the phonograph to go over the mouthpiece, the mouthpiece used having an aperture of 2in., leaving the ferrotype plate exposed nearly the whole of its surface. This will render the sounds audible to a dozen people with each telephone. The phonoscope may be made by an amateur in the following manner: Make a wooden speaking trumpet about 4 to 6in. long, with a mouthpiece 2¼in. in diameter, and having a flange at the other end about 3in. in diameter; cover this end with parchment glued on when damp, then across it glue a thin strip of silver or tinfoil at the back of the ring, and on one side, opposite to the foil side, have a brass spring with a platinum tip. This spring must be adjustable, so that its distance may be so arranged as to prevent the spark passing from platinum point to foil. Then, when in the circuit from an induction coil, it will be at once seen that by speaking into mouthpiece the membrane will vibrate, and contact made. I will, in a week or so, give fuller directions both of the phonoscope, phoneidoscope, thermomicrophone, and a new form of compound telephone I am now making experiments with.—W. J. LANCASTER.

[33475.]—**Telephonic.**—At present about the best instrument you can use is Bell's, well made. I have an improvement upon it, which makes it much better in several ways; but, not yet having finished all my experiments, I will wait a week or so before giving all details.—W. J. LANCASTER.

[33477.]—**Mercury.**—You should use less mercury, a smaller retort, and keep the whole of the retort tube as well hot. The temperature of the end of tube should be at least 700° F., or you will not distil well.—W. J. LANCASTER.

[33477.]—**Mercury.**—Use a smaller retort, the top covered with a hood of tin during the distillation. The reason the mercury runs back is that the dome of the retort being cool condenses the mercury (which has a very high boiling point) before it reaches the neck. By using a tin hood to keep the dome hot this is altogether avoided.—C. J. LEAPER.

[33480.]—**Sea-sickness.**—I have spent several years at sea, but never experienced this unpleasant sensation. I have met sailors of 20 years' standing who, upon going to the topgallant yard when the ship was rolling, would invariably throw out this unpleasant "signal of distress;" consequently, I consider some are so constituted as to never get used to the rolling and pitching of a ship labouring in a sea-way. On the other hand, some never experience sickness from this cause, and others get over it after being a few days at sea. I offer the following advice to "Would-be Sailor," having proved the value of it by conducting landsmen prone to sea-sickness through several hours' rough-and-tumble without seeing the shadow of a sign of the ailment upon their faces:—Start with as full a stomach as possible, take a small brandy every half hour, keep the mind occupied by cards or some other exciting amusement, make up a determination not to be sick, keep the idea from the mind, so as to avoid nervousness upon the subject, and then, if that will not answer, do the business quietly, and don't disturb your friends or steward, for it is your fate.—EILLIW SIVAD.

[33480.]—**Sea sickness.**—I am not aware of any direct preventive for sea-sickness. I have been many times out, but never suffered sickness but once, and this was in a 9 hours' passage. The water was terrible. and a good stiff gale was blowing, so that the situation was not a pleasant one, more especially as lightning flashes and peals of thunder helped to make bad matters worse. I quote this because I was with a gentleman who had been accustomed to the sea for 20 years, and had been sick only once or twice; he was sick on the passage I mention. Now, he told me that he had always found that a good meal prior to starting was the best possible preventive; brandy or brandy and soda he repudiated, and so do I. I have never been sick since adopting this plan.—W. J. LANCASTER.

[33480.]—**Sea-sickness.**—If you will try and breathe with the motion of the vessel—*i e.*, inspire as the vessel goes down, and expire as she comes up—you will never be troubled with sea-sickness. I believe all sailors and others gradually and unconsciously get into the habit of doing so, which prevents their suffering. It is very easy to get into the way of it. The reason is very plain. As you inspire, the diaphragm dividing the lungs from the stomach and intestines is pushed down; as you expire, it rises up. As it does this it takes the weight off the stomach and intestines. Now, when the vessel descends into the trough of the wave, it also has a tendency to take the weight off these parts, by, so to speak, pulling them away from the diaphragm, and that in a more sudden and irregular manner than happens in expiration. Therefore, if, instead of resisting the vessel's downward movement—as novices always do—you promptly allow yourself to go with it, and at the same time inspire, you keep the diaphragm down on the stomach, and so overcome that strong tendency to raise it suddenly. As she comes up you may expire, for then the diaphragm ascending, and taking the weight off the stomach, will do no harm, and the tendency of the vessel in coming up is to press the stomach up to the diaphragm. It is the fact of the weight being taken off the stomach and intestines that produces sea-sickness. In ordinary respiration the movement is too regular and gradual, and not sufficiently great, to do so. I always breathe with the vessel, and I never suffer from sea-sickness. I hope this is clear.—BRICKWALL.

[33480.]—**Sea-sickness.**—Three weeks ago I left Liverpool for Havre, on Monday, at 5 p.m., in the steamer British Queen. On Tuesday afternoon I began to feel unwell, and after tea was rather sick. Mr. Kemp, the chief engineer, seeing me, strongly urged me to drink a tumbler brimful of salt water, and a glass of fresh water an hour afterwards. The effect of the sea-water was wonderful; in 5min. I felt all right, and went down into the engine-room to thank my friend.—WALLASEY.

[33481.]—**Daniell's Battery.**—I much prefer Daniell's battery to any I have used. They are easily made, and tolerably economical. You can buy copper rolled very thin. Of this the outside cell should be made. The zinc for the porous cell should be cast in sand, and well hammered to harden it. You can make the copper cells either round or flat. Purchase the porous cells first, and you can then have the others made to fit—that is, about ¾in. larger each way. I like the cells flat, as they can be packed in a box, and occupy less space.—OS.

[33481.]—**Daniell's Battery.**—These cells are good, and require but little attention. Keep them clean, and they will work well. The copper, when done with, will sell as scrap for more than half first cost, and the zinc is so inexpensive as not to be worth a mention. The electromotive force is about 400 as compared to Grove's 900.—W. J. LANCASTER.

[33482.]—**Betts' Patent Capsules.**—The fixation of these capsules is a matter of practice in the art. If there is any method of affixing them with a string that method must suggest itself to your correspondent, whose reason in wishing for some other method I fail to comprehend. The practice necessary for an expert use of the machine is considerable, but when the art is acquired very creditable results in the appearance of the bottles will reward the user. The two necessary conditions for good capsuling are—previous practice and bottles with well-shaped necks. Large jars may be capsuled by affixing a cord with a movable ring to a fixed iron rod, placing the cord round the neck of the jar once, and cautiously pulling. But considerable skill is necessary in the use of this method, the adoption of which for smaller bottles would be an impossibity.—T. P.

[33482.]—**Betts's Patent Capsules.**—Instructions are hardly required for fastening these things, as you have only to put one on the bottle, and turn the cord tightly round the neck, and as close under lip as you can. You may, before applying the cord, compress the capsule with the finger and thumb, and if possible arrange it in the neatest manner.—OS.

[33485.]—**Bleaching Organ Keys.**—Rub them repeatedly with good spirits of wine in a flannel rag. That is the way I did my harmonium keys.—W. LOCKERBY.

[33485.]—**Bleaching Organ Keys.**—If "Pipe Metal" will take his keyboard out, and expose it to the rays of the sun he will succeed in bleaching his keys.—C. J. BONSER.

[33487.]—**Management of Birds.**—Procure "Natural History of Cage Birds," by J. M. Bechstein, M.D., price 3s. 6d., Groombridge and Sons, Paternoster-row.—H. A. WRIEDEN.

[33490.]—**Flexible Composition.**—The way I made my composition was by melting together glue and glycerine, which, when cool, was of a very elastic and tough nature. I cannot now remember the proportions used. Inclose the vessel containing the glue, &c., in another vessel containing water, or else the mixture will scorch.—AMERICUS.

[33491.]—**Spirit used by Glove Cleaners.**—This is common petroleum spirit or benzoline. If "Delta" would like to know how benzine collas and such like preparations are prepared, I can tell him. Procure some of the ordinary benzoline at about 1s. a gallon, put it into small glass bottles, cork it up, and label. If he wants to sell it, he should charge at the rate of about 12s. a gallon.—DANDIE DINMONT.

[33492.]—**Atmospheric v. Ordinary Burner.**—I am disposed to doubt the asserted fact that we "always" get an unpleasant smell from a Bunsen burner: furthermore, though the combustion may be "supposed" to be more perfect than in the case of an open flame, it does not follow that it really is so. The smell is usually produced when the flame is used to heat a vessel, and is, I think, caused by its being too close to the vessel. The inner part of the flame is thus prevented from obtaining air, while it contains enough to partially burn it and to produce low hydrocarbons. An ordinary flame in like conditions deposits soot and smells badly enough to suit any one. I cannot give the ratios of heat inquired for; and besides they depend upon the manner of application. There is, I think, little difference in actual total heats generated where both burners are good and both properly used.—SIGMA.

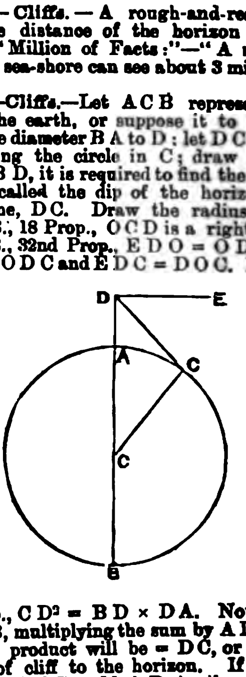
[33403.]—**Writer's Cramp.**—I would direct the attention of "Scrivener" to an ingenious invention of Holtzapffel's—viz., a "penholder for enfeebled hands." A description may probably be obtained by application at No. 64, Charing-cross. I think either Donkin or Mordan manufactured an elastic gold ring, by which the pen was braced to the forefinger, which was then employed without the thumb when writing. Perhaps the pen may be braced by two common elastic bands below the knuckle as a substitute.—N. S. HEINEKEN.

[33493.]—**Writer's Cramp.**—"R. P. G." is very peremptory, but is he quite sure that the querist has writer's cramp? I had what I was told was writer's cramp, and was proportionately alarmed—it was rheumatism. Let the inquirer get a flesh-brush, and brush his arm hard for ten minutes two or three times a day, from the knuckle of the first finger and thumb right up to the elbow; brush quickly and gently. Also, get one of the thick cork penholders to write with. Be sure that chair and desk are of right height, so that little pressure is on the wrist. Do hand and finger gymnastics by working the wrist up and down; by closing and extending the fingers sharply; by clenching the hand, &c. Keep the liver in order, and take cod-liver oil if you like. Bathe the hand over the wrist in salt and water; and I hope the uncomfortable sensation which alarms you will disappear.—N. SIRCH.

[33494.]—**Cliffs.**—An easy rule to get the distance of the horizon from any height is the following: The square root of the height in fathoms gives the distance of the horizon in leagues. Apply this rule to the question, and you get 32·4 miles as an answer, or 32 miles and 3 furlongs nearly.—B. RILEY.

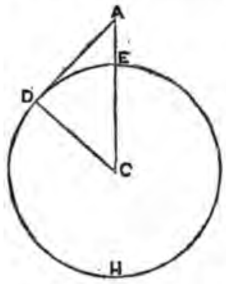
[33404.]—**Cliffs.**—A rough-and-ready way of finding the distance of the horizon is given in Phillips's "Million of Facts:"—"A man 5ft. 6in. high on the sea-shore can see about 3 miles distant.'—YENDIS.

[33494.]—**Cliffs.**—Let A C B represent a great circle of the earth, or suppose it to be a sphere. Produce the diameter B A to D: let D C be a straight line touching the circle in C; draw D E perpendicular to B D, it is required to find the angle E D C (which is called the dip of the horizon) and the straight line, D C. Draw the radius, O C; then, Euc. 3rd B., 18 Prop., O C D is a right angle, and Euc. 1st B., 32nd Prop., E D O = O D C + D O C. Take away O D C and E D C = D O C. But Euc. 3rd



B., 36 Prop., $CD^2 = BD \times DA$. Now, by adding A D to A B, multiplying the sum by A D, the square root of the product will be = D C, or the distance from top of cliff to the horizon. If "E. B. F." wants to find O D, add A D to the radius, A O. Then, D O : D C :: *r* : sin. D O C, or sin. E D C. Or O D : O C :: *r* : cos. D O C or cos. E D C. When A D is very small, a very near approximation to the true results may be found as follows:—Take B A and O A, instead of B D and O D, and the arc, A C instead of D C. Now, by putting n = the feet in A D, and since one mile equals 5,280 feet, D C = $\sqrt{(BA \times AD)} = \sqrt{(7{,}912 \times 5{,}280 \times n)}$; or in miles $DC = \frac{\sqrt{(7{,}912 \times 5{,}280 \times n)}}{5{,}280} = \frac{\sqrt{(7{,}912 \times n)}}{5{,}280}$ $= \sqrt{\frac{3n}{2}}$ nearly. Hence the rule for finding D C, or istance of the horizon, from a given height the earth's surface. To D A in feet add its he square root of the sum will give the distance horizon in miles. Thus, √ (700 × 350) = iles. To this should be added one-fourteenth lf for refraction, making the distance to the m from the top of cliff 34·7 miles. N.B.—I not included in this calculation the height of 3. F."—Bernard McGuire, Liverpool.

04.]—Cliffs.—Let A E represent the height of liffs = 700 feet; D H E the earth. Then, g E C or D C, the earth's radius, at 4,000 miles,



$: 4{,}000 + \frac{700}{5{,}184}$. Now, by Euc. 1, 47, A D, the ce of the horizon $= \sqrt{A\,C^2 - D\,C^2} =$

$$\sqrt{\left(4{,}000\ \frac{700}{5{,}184}\right)^2 - 4{,}000^2} = 33\tfrac{1}{2} \text{ miles.}$$

Sprague.

ip in Horizon" has also sent a similar reply.]

04.]—Honey Dew—Aphides.—The feathery s of white mentioned by "R. P. G." in his r to this query are the Aphides themselves us Lanigerus), and not merely produced by They are very beautiful when looked at gh an ordinary magnifying glass, and are on on apple trees and crabs, on which they ce the large misshapen knobs so often seen on I have also often seen them on the young s of the beech, but do not remember having een them on the larch. I have, however, often d what might be described as "small feathery s of white" on larch trees, and which, I think, aused by a sort of efflorescent exudation of the r turpentine, which also takes place sometimes Scotch fir and other pines, though in a rather crystalline form. I have seen a great deal of s year on young Scotch fir. Chas. Robinson e able easily to tell which it is, if either. If phides, they will, if crushed, stain like cochi- as "R. P. G." says; if an exudation of sap, will smell and taste very strongly of turpen- and be very sticky. Perhaps he would let your rs know the result of a further examination of .—G. J. H.

507.]—Midland Engines.—"R. H. G.," I dare an get a photograph of the G.N. bogie engine ssrs. Taylor and Son, photographers, Sepul- gate, Doncaster. I have seen them in his shop ow. I have not seen any of the Midland engines. on Horse.

508.]—Violin.—You can give them a dose of fin—a very good insecticide—or you might bake violin in a moderate oven, and repair glue frac- afterwards.—Fiddler.

509.]—Photographic.—If "D. Strathearn" vs the directions given, he will have what he res. In my previous reply for "grammes" "grains."—Os.

512.]—Magnetic Engine.—Of course it would ite possible to do what is inquired about, using amo-electric machine giving a current equal to furnished by the battery able to work the e; also, of course, it would be only a plaything, g that the power required to drive the dynamo- ric machine would be several times greater than required to drive the magnetic engine by hand; he medical machines referred to would be quite ss; nor can any descriptions be given without fuller information as to what is wanted.— A.

513.]—Purgative for Dogs.—If the quantities ribed are not large, they may be well mixed up linseed meal, and mixed with the food. If ' will let me know the quantities prescribed, I be able to give him better information.—T. P.

515.]—Defective Speech.—If "Penance t" will advertise his address I shall be happy to him in the way of obtaining what his friend res, gratis of course.—Os.

516.]—Mildew.—Mildew is invariably caused apes and roses, and many other plants, by a m lowering of the temperature, accompanied by ecess of moisture in the atmosphere. If in a house giving air too soon in the morning, and much at any time, and shutting up too late in fternoon, will cause mildew to appear on all s that are subject to it. Sulphur, used in us ways, is the only remedy known and used by culturists. It may be applied by apparatus ally designed for the purpose in the form of rs of sulphur; or with a tin box with a per- ed lid, a pepper-box, dusting the plants freely, ially on the affected parts; or boil together equal parts, by weight, of lime (caustic) and sulphur; syringe with the liquor. If in a greenhouse sprinkle all about on the pipes or flues (but not near enough to the fire end of a flue to set fire to the sulphur), so that the fumes may be given off by the heating apparatus, or by the sun's rays. The querist does not say whether his affected plants are outside or not. But mildew in glass structures may always be prevented by paying attention to ventilation, avoiding draughts, and keeping an equable temperature; and when the weather is wet and cold at this period of the year the least bit of fire of a night will keep away mildew.—Americus.

[33517.]—**Pianoforte Tuning.**—Hamilton's "Art of Tuning," price 1s., to be had from any music-seller.—C. J. Leaper.

[33517.]—**Pianoforte Tuning.**—Hamilton's "Art of Tuning the Pianoforte" (Cocks), 1s., contains information on temperament, practical instructions, and useful advice on care of the instrument generally.—J. N. D., Tuxford.

[33519.]—**Civil Service Examinations, &c.**—"Xit" will find full particulars of every branch of the Civil Service in Johnston's "Guide to the Civil Service," price 3s. 6d., which he may obtain from Longmans, Green, and Co., Paternoster-row, London. "Xit" does not state what particular branch of the Civil Service he requires particulars of, but I believe if he applies to the above firm they will supply him with the questions given at any recent examinations for a few pence. If he will state particulars I shall be glad to afford him any information I can on the subject.—Micawber.

[33519.]—**Civil Service Examinations.**—Johnson's "Civil Service Guide," to be had from Longmans. The Civil Service Commissioners publish their last year's papers yearly, in a volume which may be had from Eyre and Spottiswoode.—C. J. Leaper.

[33520.]—**Bronzing Plaster Ornaments.**—Obtain from some colour store a bottle of Japan gold size, a rather broad camel's-hair brush, and the desired quantity and shade of bronze powder. Then, with an ordinary pig-bristle brush give the article a coat of the Japan size to fill up the pores. When quite dry give another coat. Let it stand until it becomes "slightly sticky" (not too wet or else it will drown the bronze). Then dip your camel's-hair brush into the bronze, and carefully brush it over the article until completely covered, taking care to hold the work over a sheet of paper to save all the surplus bronze. The bronze is about 2s. 6d. to 3s. an ounce, but a ¼oz. goes a very great way. Some friends of mine after the above operation cover over with mastic varnish, but I myself prefer to see them without. Of course, if they are likely to be handled, the varnish will preserve them.—Derby.

[33521.]—**Cracked Gong.**—Drill a small hole, say ⅛in., at extreme inmost end of crack, and then run a saw up the crack. This method of procedure will restore the clearness of its sounding, and will not weaken it.—Ram Chand Biswar.

[33523.]—**Isle of Man.**—1. The Isle of Man is a very beautiful place to live in, but to give a general description would occupy too much space. "A Handy Man" should get Brown's "Guide," 1s., and he will get full particulars—to be got at Brown and Sons, printers, Douglas, Isle of Man. 2. The climate is exceedingly temperate; the winters are very mild. Frost is scarcely ever seen more than ½in. thick in the middle of winter. There certainly has been no skating on it for the last ten years to my knowledge. 3. A man (single) can live well on £50 per annum. Very respectable board and lodgings in a good district of Douglas can be had for 12s. per week.—W. Lockerby.

[33524.]—**Photography.**—The method which I have adopted, and which invariably insures success with regard to separating photographs from their mounts, is to lay the photo on its face, keep the back constantly wet by the application of water with a camel-hair brush, and then scrape off with a rather blunt penknife the mount from the photograph (not, it is to be observed, the photo from the mount). The thickness of the cardboard mount may be reduced by half at once if sufficiently soaked.—W. P. M.

[33524.]—**Photographs.**—Instead of removing the picture from the card, try taking the card from the picture. Soak well in cold water, and remove outside layer of card, soak again, and remove another layer, and so on.—Os.

[33529.]—**Tank.**—Having excavated the earth to the required size—say 13ft. × 7ft. × 7ft.—cover the bottom 6in. thick with concrete, which must be composed of 6 parts of gravel and sand, or broken bricks, to 1 part of Portland cement. When set, carry up the walls with concrete blocks. To make these blocks, make an oak mould 6in. × 6in. × 12in., and fill with concrete, and well ram. If done quickly they will require no cementing, and I warrant a 6in. wall built as described, will be stronger than a 9in. brick and mortar wall, and considerably cheaper. It would be improved by putting a few inches of clay puddle behind each course of blocks. Take care no stones are put in that will not pass through a ring 2in. in diameter. You may just cement over the face to give it a finished appearance.—A.— C. E.

[33535.]—**Geometry.**—(1.)

Angle A D B = angle A C D + angle D A C (1 – 32)
= angle A C D + D A B (constr.);
∴ angle A D B > angle D A B (asc. 7)
and side B A > side B D (1 – 17)
Similarly, C A > C D.

FIG. 2

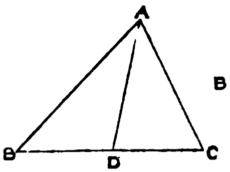
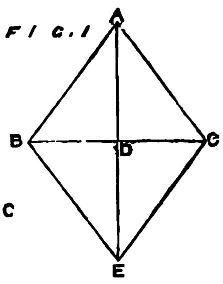


FIG. 1



(2.) Produce A D to E, making
D E = D A (1 – 2).
Then ∴ B D = D C (hyp.)
D E = D A (constr.)
and angle B D E = angle A D C (1 – 15);
∴ Base B E = base A C (1 – 4);
but A B + B E > A E (1 – 20)
that is, > 2 A D;
∴ A B + B C > 2 A D.

W. Morshead.

[33535.]—**Geometry.**—Because B A C has been bisected by A D, the angle, B A D = C A D. Because side B D has been produced to C, the angle, A D C, is greater than B A D—that is, C A D (16 I.); ∴ C A is greater than C D. Similarly, because side C D is produced to B, A D B is greater than D A C—that is B A D. 2nd question: Let A B C be the triangle, bisect base B C in D and join A D. Produce A D to E, making D F = A D. Join B E. Then (by the 16th I.) B E = A C, and since by the 20th I. any two sides are greater than the third, A B, B E, or A B, A C are greater than A E—that is, twice A D.—F. H de R.

["Peake," "B. R." and "Archimedes" have also answered this query.]

[33540.]—**Vegetable Tar.**—This is, no doubt, what is usually named "Stockholm tar," it being derived from pine trees. Trinidad pitch is called a mineral product, and the term "vegetable" is used to distinguish the "Stockholm" from coal tar or the mineral varieties.—Sigma.

[33541.]—**Worm-Eaten Harmonium Case.**—Try paraffin oil, and if that does not stop the ravages of the worms, a solution of corrosive sublimate.—Nemo.

[33543.]—**Nocturnes and Harmonies.**—These are fanciful names applied to certain pictures, or rather studies, for which it is probably somewhat difficult to find a name. Their meaning may, perhaps, be understood by the artist and by the select few who profess to appreciate this style of art, but to outsiders is somewhat vague.—Dædalus.

[33544.]—**Spring Brass.**—If "S. K." will hammer his brass on an anvil (which ought to be smooth, and his hammer face flat), he will find by that process he will be enabled to set his pieces of brass to the spring that he requires. The brass should be hammered lightly—not heavy blows—or he will draw it too thin, and perhaps cause it to crack.—I.

[33544.]—**Spring Brass.**—You can only make brass "springy" by hammering or rolling. You should use "hard rolled brass."—C. T.

[33544.]—**Spring Brass.**—Hammering or rolling will make brass very hard and "springy." Of course, if it is heated or annealed it will become soft again.—Os.

[33544.]—**Spring Brass.**—By hammering it all over on a smooth anvil, but the most satisfactory method is to purchase your sheet brass for this purpose "hard rolled," not the ordinary soft do.—A., Liverpool.

[33546.]—**Watercresses.**—They can be grown quite easily in ground kept constantly moist, either from seed or by inserting cuttings, such as the growing ends of good watercress. I have myself a fine bed getting up in this way, the waste water from a tap led away to it. Of course it would be a little more difficult in boxes; and they should be deep enough to hold sufficient moist soil.—Sigma.

[33546.]—**Watercresses.**—They are of no use unless you can run a stream of water through your boxes. They are raised from seed.—C. T.

[33548.]—**Multiplication.**—The question of "Erasmus" is surely a very extraordinary one. He asks whether it is correct to say that ½ × ½ = ¼, and, if so—*i.e.*, if it be correct—whether it would not be better to employ some other term than multiplication. Why, in the name of common sense, ought we to employ another term, if the one in use be correct? And that it is literally so admits of easy demonstration. Multiplication consists in repeating any number as often as unity is repeated in the multiplier—thus: 12 × 2 = 24, and 12 × 1 = 12; therefore, 12 × ½ = 6, *i.e.*, 12 taken ½ times. In like manner, 1 × 2 = 2, 1 × 1 = 1, and 1 × ½ = ½; or, substituting, a fraction for unity, ½ × 2 = 1, ½ × 1 = ½, and ½ × ½ = ¼.—A. E. S.

[33550.]—**Books on Food Analysis.**—The best book "A. E. S." can procure is "Food and its

Adulterations," by A. H. Hassall, published by Longman and Co. I believe the price is 17s. 6d.—H. G.

[33553.]—**Astronomical Books.**—I have a copy of "Herschel on the Telescope," published by Adam and Charles Black, Edinburgh, 1861; therefore, unless it is out of print, your bookseller should be able to get it from them. Should it be out of print, your bookseller could advertise for a copy. They do this free of charge.—Brickwall.

[33554.]—**Battery Power.**—In my reply, page 507, line 8, the word "collect" should be "select."—Would-be Inventor.

[33556.]—**Chemistry.**—Thorpe's "Non-Metals" would be a very suitable book for "Amateur;" he may also study with advantage Roscoe's "Lessons in Elementary Chemistry."—H. G.

[33556.]—**Chemistry.**—As it is not advisable to pin one's faith to any man's sleeve, you had better get both the books named—Wilson's "Inorganic Chemistry," new edition (W. and R. Chambers) and Thorpe's ditto, 2 vols. (W. Collins and Co.) Begin with Wilson's, and then go through it again with the help, subject by subject, of Thorpe's. Wilson's describes most of the typical experiments, so that you can follow them without a teacher, but Thorpe's is much fuller and the matter more condensed. Together they will give you a "thorough knowledge," as far as they go, which is quite far enough to last a "Beginner" a long time, if he is a conscientious worker.—Daghbert.

[33556.]—**Chemistry.**—I strongly advise "Amateur" to procure Wilson's "Inorganic Chemistry," and, for practical work, "Harcourt and Maden." I myself have used them, and find them all I could wish.—Hawks.

[33557.]—**Geological.**—Procure "Tabular View of Characteristic British Fossils," and "British Tertiary Fossils" (Stanford), mounted, 6s. each. What can you expect in "two or three general rules" to help you in so wide a field? The Palæontographical Society's publications contain 1,300 plates of fossils (see advt. on p. 1 of cover). Nicholson's "Manual of Palæontology" is excellent, but the price is 15s.—J. N. D., Tuxford.

[33561.]—**Colouring Gold.**—I have not had an opportunity of trying the following recipes, and I forget now where I obtained them—perhaps from the English Mechanic. They will be used in the same manner as ordinary gold colouring:—For yellow gold, saltpetre 6 parts, sulphate of zinc 1, sulphate of iron 2, alum 1 part. For green gold, saltpetre 11·2, acetate copper 11·2, sal-ammoniac 11·2, roche alum 11·4. I should try equal parts of these, as I hardly think a little alum more or less would make much difference. The compound usually sold for "roche alum" is common alum coloured with Venetian or other red earth. For red gold, sal-ammoniac, sulphate of copper, alum, and borax, equal parts of each. The saltpetre should be of the best kind—small dry crystals. If these cannot be obtained, sal-prunel should be used, as it is unliable to adulteration. If you do not succeed write again.—Os.

[33561.]—**Colouring Gold.**—The various colours are produced by making the parts of different alloys, of which the following are a few:—Green: Fine gold, 1oz.; fine silver, 6dwt. 16grs. Another green gold is composed of fine gold, 5dwt.; fine silver, 1dwt. 12grs. Red gold: Fine gold, 5dwt.; Swedish copper, 2dwt. 12grs. Another red gold: Fine gold, 5dwt.; Swedish copper, 1dwt. 6grs. The solders used with these alloys are usually composed of 1dwt. of the alloy and 6grs. of fine silver. Platinum is used for grey or white flowers, and fine silver or gold for yellow. Articles made from the above are coloured by the usual wet method.—W. G. H. A.

[33563.]—**Rash.**—The rash described is heat rash. I frequently have it in hot weather. Sulphur soap relieves it a little, but the remedy is change of diet, exercise, and saline drinks.—S. M.

[33565.]—**Induction Coil.**—It is a pity that cotton-covered primary has been used, as it is a serious drawback in a large coil, and the economy is very bad, as the small difference of cost is so slight in proportion to the whole cost. From what the querist says, I should think there is a leakage in the condenser. Test this by making it part of the circuit of a galvanometer first. There may be leakage, however, under the tensions of working with a coil, which would not be manifested with the small force of a cell. Such a coil would require large cells—at least, quarts. The size required in any case is proportioned to the resistance of the coil and to the current needed to fully charge its core with magnetism.—Sigma.

[33567.]—**Ancient Literature.**—I have among my cuttings what E. Sprague inquires for, excepting the first, which appears to have escaped my notice. The numbers of the *Daily Telegraph* in which the Chaldean translations appeared were:—Dec. 9, 16, 26, 1872; Jan. 4, 9, May 14, 21, June 25, July 7, 28, Aug. 5, 19, Sept. 8, 20, Oct. 29, 1873; July 8, 17, 1874; March 4, 1875. If E. S. lives in London, I should advise him to attend the Guildhall Library, which is open from 10 a.m. to 9 p.m., where he can read Smith's and Layard's books, Max Müller, &c.—Chas. Bentley.

[33571.]—**Communication Between Two Shops.**—Decidedly the best way of communication would be by means of a speaking-tube, with a whistle at each end to be inserted when speaking is not being carried on. If a telephone were used there would also have to be a battery and some kind of alarm, both of which would be expensive.—T. A. Garrett.

[33571.]—**Communication between Two Shops.**—It would be rather difficult to say which would be cheapest in your case. The speaking-tube could not get out of order with ordinary wear and tear, while telephones might require adjusting occasionally.—Os.

[33575.]—**Measuring Casks.**—You cannot tell the contents of a cask by merely "dipping" it. It is necesssry to measure the inside diameter at centre, do. at head, also the length of the cask. Thus do the excise gaugers, and should the cask be oval measurements are taken both ways, and the mean taken as the diameter. When a cask is leaving the bonded warehouse the "wet dip" is taken and marked thereon, and when received the party so receiving is supposed to dip again to see that no tampering with it has occurred on the road.—A., Liverpool.

[33575.]—**Measuring Casks.**—Had "U. F." given dimensions of cask I have no doubt he would have received more definite replies to his query than he may expect to see under the present conditions. From the variety in the form of casks he must be able to infer that no general rule can be given to answer every shape, and a very high authority on gauging has very truly remarked that two casks may have equal head diameters, equal bung diameters, and equal lengths, and yet their contents may be very unequal. If "U. F." possesses a fair knowledge of mensuration, of superficies, and of solids he can approximately calculate the contents of almost any form of vessel in cubic inches, and having found the number of cubic inches the vessel contains, he has only to divide the sum by 277·274, or multiply the sum by ·0036065—the result in either case will give the number of imperial gallons the vessel contains. The following "general rule," by Doctor Hutton, may be of some service to "U. F.:"—"Add into one sum 39 times the square of the bung diameter, 25 times the square of the head diameter, and 26 times the product of the two diameters, then multiply the sum by the length, and the product again by ·00031⅓ for the content in gallons.—Bernard McGuire, Liverpool.

[33585.]—**Bath for Electro-Plating Solution.**—I should think a large earthenware foot-bath would suit your purpose.—Os.

[33586.]—**North Pole of Magnets.**—In England that pole of a magnet which turns towards the north is called the north pole; but in France the pole which points to the north is called the south pole, for that magnetic pole of the earth which is nearest the north terrestrial pole is called the north magnetic pole, and, as unlike magnetisms attract each other, this pole attracts south poles; therefore, the pole which turns to the north is really the south pole of the magnet. In English books on electricity the north pole of a magnet is said to turn to the left, if a current is supposed to enter at a man's feet while he is looking towards the magnet. If this is applied to the case in question it will be easy to see in what direction the current should flow.—T. A. Garrett.

[33588.]—**Annealed Cast Iron.**—Your question is vague, though I opine the following will suffice as an answer thereto:—The description of iron used for producing malleable castings is that known as mottled pig. The castings are annealed for the purpose of malleableising them by subjecting them to a particular heat in an annealing furnace for a few days (the castings having been previously packed in iron boxes prepared for the purpose), and allowed to gradually cool, the result being the production of a casting equivalent in strength and ductility to that of a very good quality of wrought iron.—Bartlett.

[33589.]—**Bismuth for Plumbers.**—This will be ordinary metallic bismuth.—Os.

[33592.]—**Esquire.**—Perhaps the following, taken from *Chambers' Encylopædia*, will answer "Roy's" question. After describing the position and duties of the knight of chivalry, the article continues:—"Though the title of esquire has now come to be given without discrimination to all persons above the rank of a tradesman or shopkeeper, the following seem to be those whose claim to it stands on the ground either of legal right or of long-established courtesy:—1. All the untitled sons of noblemen; 2. The eldest sons of knights and baronets; 3. The sons of the younger sons of dukes and marquises, and their eldest sons. All these are esquires by birth. Then there are esquires by profession, whose rank does not descend to their children; and esquires by office—*e g.*, justices of the peace—who enjoy the title only during their tenure of office. To the former class belong officers in the army and navy, barristers and doctors of law, and doctors of medicine, but not surgeons." Nothing whatever is said about being a freeholder. There is no necessity, I think, to add anything to the above extract.—C. Lark.

[33592.]—**Esquire.**—Blackstone says:—"Esquires appear to be:—1. The eldest sons of knights, and their eldest sons in perpetual succession; 2. The eldest sons of younger sons of peers, and their eldest sons in like perpetual succession; 3. Esquires created by the king's letters patent or other investiture, and their eldest sons; 4. Esquires by virtue of their office, as justices of the peace, and others who bear any office of trust under the Crown. To these may be added the esquires of Knights of the Bath, each of whom constitutes three at his installation; and all foreign—nay, Irish peers—for not only these, but the eldest sons of peers of Great Britain, though frequently titular lords, are only esquires in the law, and must be so named in all legal proceedings; and, from long custom, we may add also barristers, for in one instance the Court of Common Pleas refused to hear an affidavit read because a barrister named in it was not called an esquire." It is usual also to give the title of esquire to gentlemen in the professions generally, and to all in independent circumstances.—I. F. Ballard.

UNANSWERED QUERIES.

The numbers and titles of queries which remain unanswered for five weeks are inserted in this list, and if still unanswered are repeated four weeks afterwards. We trust our readers will look over the list, and send what information they can for the benefit of their fellow-contributors.

Since our last "Peake" has replied to 33140; "Beaver," 33397.

32963. Polar Bands, p. 276.
32965. Author Wanted, 276.
32971. Chestnut or Oak, 276.
32977. Indelible Ink, 276.
32978. Wheel-cutting Machine, 276.
32981. Electric Bells, 276.
32983. Spherical Aberration of Object Glasses, 276.
32991. Kiln Blast, 276.
32997. Spinning Wheel, 277.
33003. Selenium Plate, 277.
33009. Bisulphide of Carbon Test, 277.
33011. Buffs, 277.
33012. Brickmaking, 277.
33014. Ouncil, 277.

33231. Bagpipes, p. 379.
33251. Parallel Motion, 379.
33252. Induction Coil, 379.
33263. L. C. and D. R. Engines, 379.
33264. Centre of Gravity, 379.
33265. Punching Machine, 379.
33276. Organ Stops, 380.
33281. Lathe Castings, 380.

QUERIES.

[33593.]—**Rotary Pump.**—Will some of our mechanical correspondents kindly give a simple sketch of the two cams as now used in rotary pumps?—Hydraulic.

[33594.]—**Lathe Crank.**—On large work it takes two of us to work the treadle. I am advised to alter my crank so as to have two treadles. What advantage shall we gain?—Saladin.

[33595.]—**Leyden Jars.**—I have two Leyden jars; size, 2 quarts. I cannot get either of them to retain the electricity. Thinking the tinfoil was bad I took it off and re-covered one of the jars. It is not improved. Can any one tell me what is the matter with them? They are fitted with brass ball and rod complete, and the lid is insulated from the glass by cork. I connect the outer coating with the ground by a brass chain.—John-o'-Groat.

[33596.]—**Powdered Wood Charcoal.**—I use this article largely, and pay a high price for it. Recently information has been given me that the vendors mix coal dust and other foreign matter with it; in fact I am led to believe that the minor portion is only the real article. I shall be very thankful if any of your readers could inform me how I can detect such deception?—W. Foster.

[33597.]—**Australia or New Zealand?**—Would any of "ours" kindly enlighten me, a civil engineer, on the following points, as I am desirous of going either to Australia or New Zealand, and I do not mind turning architect, or even builder, on an emergency? 1st. Which is best, Australia or New Zealand, and which part of either? 2nd. What capital would be required to start with? Any other information will be very acceptable.—A. C. E.

[33598.]—**Three-Cylinder Engines.**—Thanking sincerely your two correspondents respecting my queries as to three-cylinder engines, you must excuse me asking "Draughtsman" a few more questions respecting them, if he would be kind enough to reply to them. 1st. Is the theory of single-acting engines right if only the practical part was right? 2nd. Suppose that a really efficient valve motion was applied to three-cylinder engines, such as have three vertical pistons acting on a three-throw crank, the valve motions to be so as to cut off at any part of the stroke, would a three-cylinder engine then be as economical as an ordinary double-acting one, with the double advantage of never having either knock or thump on the bearings. 3rd. Is it a necessity that these engines have a great amount of back pressure on the pistons, or is it a matter that cannot be avoided, owing to the pistons acting as their own valves? A reply from "Draughtsman," with the questions numerically as they are will oblige—A Mechanic.

[33599.]—**Rubber Stamps.**—Will some of the numerous readers of "ours" kindly inform me through this medium the process of making the well-known rubber stamp?—H. F. J.

[33600.]—**Expansion.**—Will any one give a simple method of converting an engine working non-expansive into one to cut off a ½ stroke?—Steam.

[33601.]—**Haydn.**—How many Haydns were there of that name and celebrated as musicians? Has the family benefited by their genius?—Fiddler.

[33602.]—**Mildewed Album.**—I have a new photo album which shows signs of mildew, though kept in a warm dry room, bound in morocco leather. Could any of "ours" suggest a remedy?—W. A. R.

33603.]—**Straight Toes.**—The ball joints of my at toes are quite stiff and refuse to bend, consequently y give me great pain when walking. The joints are abnormally large. I shall feel grateful if any of your respondents can give me a cure for the above. Am 18 rs of age and enjoy good health.—C. L.

33604.]—**Theta Delphini.**—How is the invisibility this star to be accounted for? It is given as of the rth magnitude in Proctor's smaller atlas, and, while a was perfectly distinct, not a trace of Theta was to be a on the remarkably clear night of July 24th. It is mentioned as variable by Webb or Proctor.—Twenty urs.

33605.]—**Brickmaking.**—1. Could any of the readers the English Mechanic inform me of the advantage, if r, arising from the use of Hoffman kilns over the inary kilns (oblong) with side fires? 2. What means ld be used to prevent the edges of the bricks as they ne from the pug, becoming curled and rough? The pug se was made by Clayton. 3. I experience great loss in wear and tear of the belting which drives the rollers. ald any one suggest a practical substitute? Would in-gearing be better? If so, how should it be attached? e names of some makers would be acceptable. Any ts or other information would be thankfully received —A Constant Reader.

33606.]—**Blacking Ironwork.**—Will one of your bscribers kindly inform a country blacksmith how ges for church doors, and other wrought ironwork of at kind are blackened? I have heard it is done some- w with linseed oil, and should like to know how.— ith, &c.

[33607.]—**Pedigree.**—Can any one help me towards iting broken links of a long pedigree? I have a mass information from Herald's College, and many office cords, registers, churches, &c., &c., but shall be grate- l for hints from those who have had experience in these bours. What probable and possible fields can be arched, and what in general is the amount of fees?— hn M. Bacon.

[33608.]—**Collodion Varnish.**—Will some fellow- ader kindly inform me of the best way of preparing tton for making a thick, hard, tough varnish, which ll stick firmly to glass, and give a smooth hard surface ith colours, yet retain elasticity; and also if there is y other ingredient such as gelatine that can be com- ned with the cotton to help to give the above required operties? I am told that there is a French preparation ssessing the above properties, which may be known to me of the readers of the Mechanic.—An Apprentice.

[33609.]—**Perspiration.**—I am much inconvenienced om this, even if I walk a moderate distance, not only in t weather, but also in cold. I am a light weight st. 12lb.), having lost 10lb. in the last year. My occupa- n has been an outdoor one, not working with my own nds, but overlooking others, and have been pretty much y own master. I live regularly and take good food and stimulants except a couple of glasses of beer per day. y age is 21 years. I will feel obliged to any of your rrespondents who have been inconvenienced in the same y by giving me some advice as to the above.—Bor- rer.

[33610.]—**Aquarium Cement.**—I have tried several, my experiments have proved futile; the best I have ad is composed of 1 gill of plaster of Paris, 1 gill of harge, 1 gill white sand, ½ gill powdered resin; it was xed into a paste as thick as putty, with boiled oil and yers. It did not set hard as I required it, so tried it thout the dryers, and found it set very fairly when re was only a thin coating required, but when I laid it lf an inch thick it would not set at all. I shall esteem a favour if you can tell me the reason the above receipt s not set, and inform me of any other that will.— ardenburg.

[33611.]—**Chemical Food.**—Would "Incog." or D. rathbearn kindly give me the prescription of chemical d or syrup of the phosphates of iron, lime, potash, and a, as prepared from the "Formula of Parrish of Phila- lphia?" Is it published in the pharmacopæias, and ich?—W. W. B.

[33612.]—**Photographic.**—Will some reader give me w hints on re-touching up negatives, also what letter- ncil I ought to use?—Woolwich.

[33613.]—**Tea.**—Will some of our kind friends describe e best way of making tea by steam for large numbers in untry places where water cannot be boiled in the dinary way?—Basso.

[33614.]—**Plaster of Paris.**—Will any kind reader form me what sort of moulds are used for moulding aster of Paris figures?—Cement.

[33615.]—**Disease in Fowls.**—Can any one of our aders tell me about the cause of the following disease in wls and its remedy? They seem to have fits, when they row their heads back, and fall on the ground and seem ing to die. After awhile they get better, till it comes on ain. I have two suffering now in this way, and adually getting weaker.—M. W. G.

[33616.]—**Operetta.**—Can any one recommend a good mic opera in one act, suitable for a drawing-room, for ree or four persons—say, a bass, a tenor, and one or two pranos? I know of Metzler's series, but there are none here which will do. For a larger number than that amed above, the "Crimson Scarf," in that series, is a ry clever and pretty production, which can be recom- ended.—R. S.

[33617.]—**Turkey Red.**—I shall be much obliged if y of "ours" can inform me how the colour is taken out f Turkey red in making banners with mottoes on them. want some liquid that, when printed on the stuff with ooden type, will leave a white letter on a red ground ithout burning the material.—Wallasey.

[33618.]—**Legal.**—Will one of your legal contributors indly give his opinion of the following? I took some uilding land on a long lease 13 years ago, with covenants or annual rent, and building within four years. The ssor reserved right of re-entry for breach of covenant. le, however, was aware the take was rather speculative, nd by word of mouth he said he shouldn't re-enter for reach of building covenant. The time for building according to lease expired nine years ago, and the lessor as continued to receive his rent with a full knowledge hat no building was done. Just now he has sold out his nterest, and the buyer is talking about re-entering for breach of a covenant nine years before he bought. My idea is that if a lessor permits a covenant to be broken, and he continues to receive rents so long after the breach, he by that conduct assents to the non-observance, and waives his right of entry. An exactly similar case, in an action for ejectment, recently came before a county court judge, when he decided "that receipt of rent, with knowledge of a broken covenant, was a waiver of that covenant, and the right thus lost could not be transmitted." The before named buyer says he has the opinion of three lawyers that he can re-enter for that breach, and also that if I fail to pay the rent he can sue upon my other property (if he chooses) in lieu of entry. I have always thought that when re-entry was stipulated for breach of covenant, the lessor had no other resource but said entry. Should be glad of a reply to both points.—Robert Langton.

[33619.]—**Gramme Machine.**—Could any electricians give me full particulars for the construction of the Gramme machine as used for electric lighting, giving size of wire and quantity, also explaining contact-breaker, commutator?—Arthur Bethell.

[33620.]—**Microscopic.**—I have been fortunate enough to secure a good specimen of Dytiscus marginalis, the forelegs of which I should like to mount in balsam without pressure, so as to show the suckers unaltered. If some correspondent would give me directions how to proceed, describing the operation, step by step (as I am only a novice), and also give instructions for preliminary treatment, I should be much obliged. A few hints also on the preparation of the outer skin of onion to show raphides *in situ* would also be very acceptable. In the many attempts which I have made I have always failed to make the balsam "take" except in small and isolated patches. I have proceeded according to the textbooks—viz., dried the skin soaked in turpentine (also benzole) for weeks, and then mounted in the balsam. Perhaps some of "ours" would kindly assist me.—Dytiscus.

[33621.]—**Artists' Canvas.**—Would any reader inform me how the canvas that is sold for artists, prepared by Winsor and Newton, Rowney, and others, is done to be made so flat and smooth? Is it rolled, or gone over with heavy hot irons?—Artist using Quantity.

[33622.]—**Wheel Gearing.**—Will any of your correspondents inform me through your columns of a first-class mechanical work on wheel gearing, with detailed instructions as to finding exact required diameter for any given pitch and number of teeth, and how to construct correct drawings of various gear-wheels on the most approved principles and proportions? If some one able to do it would contribute a series of papers on this subject, like those of Mr. Travis on bee-keeping, or those of Mr. Davies on the pianoforte, I am sure many readers would be thankful.—A Country Subscriber.

[33623.]—**Dido.**—Can any one tell me how it can be proved what relation Dido was to Jezebel (daughter of Ethbaal, King of Phœnicia), as I should be glad of any information on that subject?—Hawks.

[33624.]—**Designing.**—Will any correspondent give a few hints as to what is required in designing for fabrics, such as width, colouring materials used, &c., also where and how best to dispose of them? What is a ruled-paper draughtsman?—B. W. Lane.

[33625.]—**Boat Building.**—I purpose building a boat 13ft. long, 3½ft. wide, sharp at both ends, perfectly flat bottom, centre board 3ft. by 2ft., which, when down, will project 2ft. 3in. below bottom of boat. I intend rigging her with a small sprit and foresail. Will any reader of the English Mechanic kindly tell me would such a boat sail on a wind in a small canal? I want a boat that will sail over flooded bogs, where the water is very shallow in parts, and will also be able to sail close in deeper water when centre board is down. Should the centre board be forward or abaft of amidships? I am thinking of building her myself, and purpose putting three sections of templates which will be permanent, bending sides round these, and nailing bottom on afterwards. Would this plan succeed? Any hints will greatly oblige.—W. A. R.

[33626.]—**Bichromate Cell.**—Will some contributor to the English Mechanic be kind enough to explain fully the chemical action which occurs in a bichromate cell, and to adapt his answer as far as possible to readers not acquainted with the forms of chemical notation.—H. S.

[33627.]—**Musical.**—If "Ne Sutor" or any of your other musical correspondents would give me a little advice on the following subject I shall feel exceedingly obliged:—I am at present serving my apprenticeship to the bookselling trade in a Scottish town, but as I have an impetuous desire to enter the musical profession I have decided on giving up the former occupation at the expiry of my apprenticeship in April of next year. Now, by securing a situation in some music warehouse in London could I earn enough wages to carry me through a course of organ and violin instruction, together with all the branches connected with the theory of music; and, if so, how am I to obtain the necessary instruction, seeing that I could gain only the evenings for study? Also how can I best occupy my time till the end of my apprenticeship, what branches of the subject had I better pursue, and what books are supposed to be the best? An answer will greatly oblige.—Amor Musicæ.

[33628.]—**Diving.**—I should like the opinions of some of your correspondents as to the reason why the hands are usually placed before the head in diving. I incline to the opinion that it is done in order to more easily assume the required position—viz., the head downwards one; and because when the arms are raised the upper part of the body presents from above a much more favourable form for entering the water than is presented by the head and shoulders in their normal position, and that another reason why it should be done is that the head is thereby defended from any obstacle that might be concealed in the water. On the other hand it is said that it is done because the hands, entering the water first, cleave the water and open a way for the head and shoulders to enter, and that unless the hands were so placed the head would be severely injured by concussion with the water in diving from any height. The question arose upon the incident related in Mrs. Brassey's book, "The Voyage in the Sunbeam," of her having seen the natives of one of the South Sea Islands dive from a height of 100 feet. Which theory is correct?—Law Student.

[33629.]—**The Atomic Weight of Uranium.**—In the ninth edition of "Fownes' Chemistry" uranium is said to be 60, subsequent editions give it as 120, and in the latest edition it is given as 240! Can Hugh Clements or any other contributor kindly explain the reasons for these changes? I have seen a recent and very profound study of fluorescence by Prof. Morton, of America, who gives a very extended list of uranium compounds, regarding the atomic weight as 60, having prepared many of them to insure purity. Uranium is peculiar, and in some respects only comparable with cobaltium; hence I give the three alternatives in regard to the two leading forms of chlorous (a) and chloric (b) combination:—

	60		120		240
(a)	UCl	...	UCl^2	...	UCl^4
(b)	U^2Cl^3	...	U^2Cl^6	...	U^2Cl^{12}

—Enquirer.

[33630.]—**Block Ice.**—I shall be obliged if any of your correspondents could recommend me a machine for making block ice. I want to make about one-quarter to one-half a hundredweight daily for home consumption. I have tried most of the advertised machines that require freezing powders, but find that if they get the least damp they become useless.—Wanderer.

[33631.]—**Gilding Glass.**—Would any kind reader favour me with an answer to the following questions that I could rely upon?—I thoroughly understand the gilding, but cannot imagine why the gold assumes irregularity of burnish. I use the size hot, and the hot water process; but still it does not look satisfactory where there is opposite light upon it. I have noticed upon the common glasses that are used in grocers and chemists' shops the burnish being all over alike, and without any perceivable marks. Is it because I burnish it with wool previous to applying hot size or water, or when burnished? How must I take out these marks to make it appear as even as a looking-glass?—Berkshire Typo.

[33632.]—**Electricity.**—Will Mr. Lancaster kindly give the promised information (see letter 33173)? I think he must have forgotten it.—C. Engineer.

[33633.]—**Entomological.**—In a pool of stagnant water I observed small red insects, from the size of a large pin's head to a small pea, moving with considerable rapidity; they have six legs, which are fringed with hairs, but have no appearance of any head. Can any reader inform me what they are?—T. S.

[33634.]—**Lightning Rod.**—Being about to put up a lightning rod to our dwelling, will any of our readers acquainted with the subject inform me if I can attach to it an electrometer to indicate during a thunderstorm the immediate presence of electricity?—W. H.

[33635.]—**Rivet-making Machine.**—Will any of our readers kindly inform me respecting a rivet-making machine, on the principle of those that make belt rivets, to make iron rivets ⅜in. thick from hot iron, and up to 2½in. long?—W. H.

[33636.]—**L. and N.W. Engines.**—Could "Egeria" or "Itzaex" tell me what has become of the Helvellyn, 890, as I see in the list "Egeria" gives of the coupled engines that the Sir Hardman Earle is 890; also what has become of the Dædalus 896 and the President 1,007. Whose design were 890, 896, and 1,007 built from, and are there any more of the same design? What is the number of the Precursor, and has she a cab, and what other engine is it like? I saw an engine some time ago which I think was a 7ft. or 6ft. 6in. single—the name was either Panthus or Panther. Could "Egeria" or "Itzaex" tell me what the name and also the number is, as I did not see the latter? Some one wanted to know the date of the Egeria 1,436, and as I know it I will give it—it is July, 1865. As "Egeria" says 868, 869, and 870 are in the sheds at Rugby, does he know if 869 (Llewellyn) is out yet? I know 868 and 870 are out, as I have seen them, and I see they both have the arms on them, as also the Hercules, which I had not seen with the arms when I asked before which had them. Thanks to "Egeria," "Itzaex," and "W. J. S." for the list of engines with them on.—Tamerlane.

[33637.]—**Models of Ironclads.**—I wish to make a model of one or two of our ironclads, also of the Devastation. Could any one tell me where I could get any drawings or plan or sketch to work from? Have there been any published in any of our illustrated papers or magazines? All I require is the dimensions and outside lines to work from.—Model Maker.

[33638.]—**Whiting and Lime-wash.**—Will some of our readers kindly tell me how to prepare whiting as applied to the ceiling of rooms? Also how to prepare a good lime-wash, for in and outdoor work, that will stand through rains and frost without shelling off as we so often see it?—W. H. Ke.

[33639.]—**Spectacles.**—Can any of our readers assist me in the following matter? I am suffering from a chronic weakness of sight, which has increased to such an extent that I cannot read or write without the aid of spectacles, and only for a few minutes at a time with any spectacles I have yet been able to obtain. I have several pairs, and have tried others, and with some I can see moderately well for about half an hour, when a smarting or twitching pain, followed by dimness of sight, compels me to abandon my task. I have consulted several physicians; and an eminent oculist, whom I have lately been under, after repeated examinations, ordered me a pair of 8in. focus double convex glasses, but with no different result from that I have experienced with others. Can any one suggest the most suitable kind of glasses for my case, or recommend any course of treatment likely to be effectual? I am a mechanic and have had to give up my employment in consequence of this growing weakness of sight.—Optic.

[33640.]—**Cabbages.**—Would "Saul Rymea" or any other of "ours" enlighten me as to why cabbages which I have grown will not be induced, with or without tying up, to form "heads," but persist in scattering their leaves in all directions; and thus also with cauliflowers. Is it for want of sufficient earthing up? Ought they to receive more than one dose? How long ought the runners of vegetable marrow plants (in the open air) be allowed to run before nipping, and will they bear without being artificially fertilised?—A., Liverpool.

[33641.]—**Portable Equatorial.**—The writer has a 4·3in. O.G., 6ft. 4in. focus, in a brass tube, with rack and pinion focussing motion, well mounted on a strong, portable, tripod stand, each leg trussed in the shape of the letter A, attached to a strong cast-iron circular plate, 8in.

diameter, turned and surfaced. Would some of your talented astronomical contributors kindly supply the best and most simple mode of mounting for a portable equatorial, with ready and easy mode of adjustment? Probably our Editor would oblige his subscribers with an illustration and dimensions, size of hour and declination circles, &c. Lat. 50° 43′.—Athelstan.

[33642.]—**Harmonium.**—Can any one say if American reeds have been put on the harmonium soundboard, and how they were fastened down, and what was the result? Can any one say if it is possible to buy French reeds in such a state that they shall be in perfect tune when put in instrument, also American reeds?—W. Clark.

[33643.]—**Harmonium.**—To Mr. W. H. Davies.—Please answer through our Mechanic how to put the cloth in the holes of an harmonium rail for stickers to pass through from key to the action under. I saw one in this way some time back; they were never known to stick in damp weather. It was a French made instrument.—W. Clark.

[33644.]—**Bleaching Oil.**—Would any of your correspondents kindly inform me of a cheap process for bleaching fish oils? I have tried several modes, but the result has been unsatisfactory, the large quantity of soapy deposit causing too great waste of oil.—B. F. O.

[33645.]—**Boat Building.**—I, like many others, am anxious to build a boat, but want the method of getting the lines. Can any competent person give us a more simple method than that of R. Cooper (14569) in the E. M. of July 12th, which to me is very confusing? It would be very convenient if terms used in boat building could be explained, and that whoever gives the information should reside somewhat nearer to the British Isles than Canada, in order that we may correspond more frequently if necessary. I wish to build a boat, 14ft. long by 3ft. 6in. wide, to carry two persons, but I shall be thankful for the dimensions of any sized boat to scale.—G. H. A.

[33646.]—**Cutaneous Eruptions.**—Can any of your numerous readers kindly advise me what to use internally or externally to get rid of an eruption of the skin? It first appears as red spots, which afterwards become white and scaly. There is no pain or itching at all. It is worse in cold weather.—X. O. X.

[33647.]—**A Rat Hunting a Rabbit.**—On Monday evening, 15th of July, I saw a half-grown rabbit run up a lane, and a moment or two afterwards a large brown rat came out of the hedge and followed the rabbit in the same manner as a weasel or stoat, with its nose to the ground, picking up the scent and following the rabbit's track with great accuracy, turning when the rabbit turned, and otherwise. I paused to see the result, but some men were at the head of the lane watching the animals, and turned the rabbit back towards me, spoiling the sport. They all said the rat had hold of the rabbit, and that their attention was directed to it by its cry. It was now, having been unable to hold it, trying to catch it again, and from its determined manner it would have, no doubt, succeeded. I should be glad to hear if any of your readers are acquainted with this habit of the rat.—Thos. Cridland.

[33648.]—**Flute.**—Will "G. A. P." kindly say what are the passages, or at least some of them, which can be played so much easier on the "Carte" flute than on the old kind?—An Amateur Flautist.

[33649.]—**Drilling up Staff and Pinions for New Pivot.**—If "Seconds' Practical Watchmaker," or any of our readers who are watch jobbers, will answer the query which appeared in "ours" some time ago, as to a good method to drill up staffs and pinions for new pivot, will greatly oblige many young hands who have only seen one method.—Young Sub.

[33650.]—**Willow Boxes.**—Do any of your correspondents know of a machine for making willow pill boxes by steam power?—H. L.

[33651.]—**Yeomanry Cavalry.**—What are the qualifications necessary to enter as trooper in the yeomanry? What should I have to find, and what would the regiment supply?—Young Sub.

[33652.]—**Means of Determining Temperature of Iron Cylinder.**—Will Mr. Lancaster, or any other reader, please kindly inform me the readiest way of determining the temperature of a cylinder of iron (outside)? The thermometer will not serve me. I should prefer a list of gums, wax, or other bodies that liquify at no fixed heats, and by the application of which to the side of the cylinder I can arrive at a reliable temperature.—C. J. Bonser.

[33653.]—**Repairing a Vice.**—Would a mere amateur, with an ordinary slide rest, be likely to succeed in turning a screw and box-nut for a vice? If so, a few hints from a practical hand would be most thankfully received. The great difficulty I anticipate is turning the internal square thread of the nut. My present mode of turning screws is by chasing.—Haddy.

[33654.]—**Pressure.**—Is not the pressure equal in every part of a locomotive boiler? In other words would not a gauge connected with the bottom of the fire-box indicate the same pressure as one in connection with the dome?—W. Wilson.

[33655.]—**Pickers.**—Will any of your readers inform me the best way to fasten loom pickers to picking-strap? I have used a small bolt through legs of picker, and find it wears out much sooner than part where the shuttle strikes. Have also tried thongs, but they break very quickly.—S. V. M.

[33656.]—**Rowing.**—I shall esteem any information as to the course of training, &c., I should have to take to get well up in above?—M. R. C.

[33657.]—**Bees.**—I have three nests of bees in the walls of my house. One has taken possession of the hollow space around a window between the linings and the brickwork. Can any fellow-reader of "ours" tell me how to destroy them without injuring the honey; for if I [illegible] them with sulphur until they are dead I am told [illegible] would have a sulphurous taste? Also what [illegible] to the rafters of the roof and other [illegible] taking up their abode again in [illegible] of their propensities is [illegible] a lodgment in a place [illegible] nest is destroyed?—A. F.

[illegible] **Harp.**—Can any reader inform [illegible] the pillar of the harp, and act as support for music? I mean something that I may read from, as I find it very disadvantageous to place the copy on a table, or anywhere not being close to the instrument. If any one would favour me with instructions to make one I should be obliged.—Harp Econ.

[33659.]—**Chlorhydric.**—Will some brother-reader give me information on this subject? What is the formula and preparation of it?—H. Y. J.

[33660.]—**Ink Stains on Furniture.**—Will some friend say how to remove them from polished mahogany table?—H. Y. J.

[33661.]—**Institution or Home for a Dumb Child.**—Can any reader kindly give me the address of any institution where a poor child of ten who cannot talk can be educated and taken care of? She can hear perfectly well and utter a few sounds. Any information will oblige—X.

[33662.]—**Injectors for Steam Boiler.**—I have a small boiler which I want to feed with an injector. I cannot get one suitable, and wish to make it, but, not thoroughly understanding the internal arrangement, I should be much obliged by any reader assisting me with a description or sketch. Will they work on a small scale?—J. C., Nottingham.

[33663.]—**Etching on Copper.**—Among the many readers of this valuable journal are there any who would give me instructions in the above? I may say, as an artist, I can draw or paint any conceivable subject, and wish to do as many of the old masters have done—that is, etch them upon copper, not as a pecuniary advantage, but having a wish to do so for pastime and amusement. If any one could give me the required information, or when and what books are published on the subject, would be pleased to know, and would gladly render any assistance to my brother-readers in return for their kindness.—V. Le Peintre.

[33664.]—**The Phonograph.**—To Mr. Shelford Bidwell.—Would Mr. Shelford Bidwell kindly tell me in what manner the point should be made to act upon the ferrotype diaphragm when only that one diaphragm is used? I believe it ought not to be fixed in the centre of the plate, as when two diaphragms are used. A spring, I think, is necessary. I am still quite unsuccessful with my phonograph, having hitherto used two diaphragms. Could the paper diaphragm also be used alone, both as a receiver and transmitter?—M. Williams.

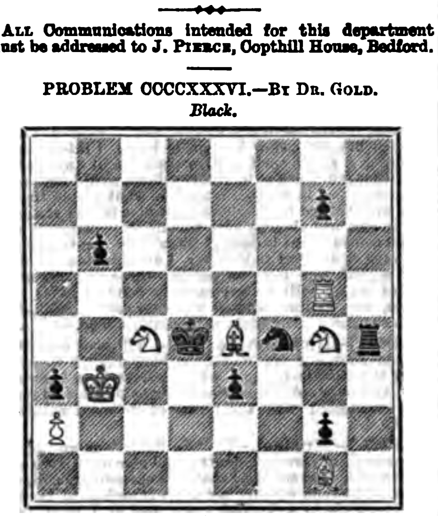
[33665.]—**Size and Weight of Anchor.**—I am anxious to ascertain the proper size and weight of an anchor (ordinary shape), to hold a centre board sailing boat in the Thames at Reading (6ft. beam, 14ft. long), also size of chain cable for same. The weight of boat, including ballast, &c., is about 5cwt. If any of your correspondents can give the above information I shall be much obliged.—X. Y. Z.

CHESS.

All Communications intended for this department must be addressed to J. Pierce, Copthill House, Bedford.

PROBLEM CCCCXXXVI.—By Dr. Gold.

Black.



White.

White to play and mate in four moves.

Solution to 434.

White.	*Black.*
1. Q to Q Kt 6.	1. B takes Q (a).
2. B to K Kt 3 (ch).	2. K to Q 5.
3. P mates.	
	(a) 1. K to K B 5.
2. Q takes B (ch).	2. K moves.
3. Q or P mates.	

Notices to Correspondents.

F. C. C.—Thanks for your clever problem, but we never insert sui-mates.

H. F. L. M.—We shall be glad to receive another batch of problems.

A New Insect Pest.—*Psyche*, the organ of the Cambridge Entomological Club, notes the recent introduction into the United States of a weevil, which devours the foliage of many beautiful plants, and suggests to florists who have been troubled by it, that it will be for their advantage to search, at this time of the year, in the flower pots and in all waste soil about their hot-houses for the larvæ and pupæ of those pests. The larvæ, which feed upon rootlets, are now pupating, and the destruction of every individual prevents the laying of a large number of eggs during the coming season.

ANSWERS TO CORRESPONDE

*** *All communications should be addressed to t*
of the English Mechanic, 31, *Tavistock-str*
Garden, W.C.

HINTS TO CORRESPONDENTS.

1. Write on one side of the paper only, and
ings for illustrations on separate pieces of pape
titles to queries, and when answering querie
numbers as well as the titles of the queries to
replies refer. 3. No charge is made for inserti
queries, or replies. 4. Commercial letters, or q
replies are not inserted. 5. No question asking
tion or scientific information is answered th
post. 6. Letters sent to correspondents, unde
the Editor, are not forwarded; and the names
spondents are not given to inquirers.

The following are the initials, &c., of letters
to Tuesday evening, July 30, and unacknowle
where:—

P. S. Looker.—S. W. Waud.—Geo. Pearson.-
Stamper.—A. Clarkson.—H. Greenwood.—J.
—A. and J. Dobbie.—W. Stanley.—Rev. T. W
W. Watson and Son.—J. T. Johnson.—Capt
Kaye.—Lyons.—Glass-shade.—Judge.—Thos.
S. V.—T. B.—A Brassworker of Brum.—John
Strathearn.—J. Symes.—Shire.—J. M. S.-
A. B. M.—F. C. B. B.—Economical.—Hugh C
Magnetism.—W. N. M.—Plomi Almoni.—B.-
—G. H. Button.—J. Clark, jun.—Archimedes.
Mechanic.—Young Tele.—Galatea.—S. D. K
Jewsbury.—Saxon.

A. H. S. (The only intelligible form in which
figuration of Saturn's satellites could be gi
monthly Astronomical Notes would be that o
of their positions for a stated hour on each da
from the fact, then, that these must necessar
a wholly inordinate space in our columns, "
could scarcely ask us to go to the very conside
of engraving them. He should obtain Nos. 2,
and 2,207 of the *Astronomische Nachrichten.*)
bosch. (Glue can be made insoluble by the a
bichromate of potash and exposure to light;
use it to glue pieces of wood together, how
expose it to light? Use marine glue. Lub
screw with a mixture of tallow and bla
Historian. (Write to the journal named.
(About 1,600 cubic feet will lift 1cwt.; to an
questions definitely the height of both baro
thermometer must be known. You can
required calculation from the round num
given.)—Cotswold. (He probably would, b
request can only be inserted as an advertis
J. S. Humpidge. (We are well supplied with
but should be glad to see any specimens of th
J. H. Cross. (Sketch and description are al
prehensible.)—Enquirer. (Do you think i
that we can make out or our engraver p
"sketches" sent with your letter?)—Old S
out of print.)—Holy Bitter. (Obsolete as
medicine, principally on account of the nause
of the aloes, which is ill-concealed by the arom
to disguise it. It is equal as a purgative to
cine you mention—superior perhaps to the po
parations, or rather supposed preparations
drug—which really have not a particle of it i
John Pennycook. (We do not know the p
book, but have forwarded your letter to the p
—A. E. I. (You cannot make it on a small
manufactured by an elaborate trade process.
Stott. (We cannot help you; the best way
to advertise in some of the papers which
among the Upper Ten thousand—or are supp
so.)—F. W. (Do not attempt such ridiculou
jokes. One unfortunate victim lost the si
eye not long since, thanks to inconsiderat
friend.)—Novice at Sea. (So many degr
sail from the pole to the equator, so many y
"to depress the pole," because it become
lower in the horizon.)—Antiquarian. (Ge
"Glossary of Gothic Architecture," and s
the *Building News*. The terms that confu
simply different names for the same ar
styles.)—Puzzled. (Of course it is a difficult
cases a very formidable one—but the obviou
overcoming it is by pumping. We see no
likely to be gained by your proposal, whi
would be impracticable in nine instances
One of the worst cases of the kind was met w
the construction of the Box tunnel. From
1837, to July, 1838, the works were susp
water having completely gained the master
pump. A second pump of 50 h.p. was subst
soon rendered resumption of work possible.)-
(The specific gravity of cast brass is 8·3
(There is nothing at all new in its composit
simply a yellow metal, consisting of 90·7
copper, and 8·33 of zinc, covered with a very
of gold by rolling. The amount of gold v
1·03 to 0·03 per cent., according to the pri
for the sham jewellery manufactured from t
—Foscari. (The word "Garth"—usually m
plans of mediæval buildings—simply mean
sure;" it may possibly have been derived
Persian "gird" or "gard"—an inclosed city o
F. R. J. (The income tax has fluctuated
since 1866, when it stood at 4d. in the pound
it was raised to 5d., in 1868 to 6d., in 1869 it
to 4d., in 1871 it was raised to 6d., in 1872 it
to 2d., in 1874 it was raised to 3d., and in 18
the pound.)

Acoustics and the Ear.—It has been
that Prof. M'Kendrick, as president of the
gical section at the meeting of the Britis
Association in Bath, will give an addre
recent progress of acoustics, more espe
regards the mechanism of the ear.

English Mechanic
AND
D OF SCIENCE AND ART.

FRIDAY, AUGUST 9, 1878.

ARTICLES.

E ECLIPSE OF THE SUN.

clipse of 1878, if we may judge
n the meagre details that have
us, promises to give rise to a con-
amount of discussion. It appears
he phenomena witnessed were in
spects different to those seen in
different, in fact, that a wonderful
ust have taken place in our great
since that date. It is, however,
ssible that some of the effects
been seen to greater advantage, and
with a nearer approximation to
by means either of new instru-
recent improvements in old ones.
have full details, speculation as to
e of the phenomena would be out
because practically of little value,
must, therefore, content ourselves
ief record of what has been trans-
y the cable. As usual, the mes-
slightly "mixed," but a few points
tly clear and unmistakable. First,
e has been satisfactorily observed
station in America, and although
re few, they were fortunately in
here the atmosphere is usually
l on this occasion the weather was
ould be desired. Drawing a line
nt the path of the shadow over the
narrow "belt of totality," as we
it, passes from the north-western
North America, down the Pacific
Continent, and curves off through
. The time was favourable, and
rge body of skilled observers,
and European, were ready to
the features of this grandest of
henomena. The most important
nnection with this eclipse is, that
a was markedly different from the
ces presented in 1869, 1870, and
hydrogen was faint, and generally
as was the case in 1874. The
ope shows that the light of the
onsists largely of a line in the
t of the spectrum, nearly coinci-
Kirchhoff's 1474, or the "iron
or some time it was supposed that
t was composed mainly of iron
ut that supposition, which, it must
ssed, was not very probable, was
by Prof. Young, who, by means
grating spectroscope, found that
al line is not identical with that
to be due to iron. It is doubted
he corona can be vapour at all,
omets have been known to pass
t without any visible effect upon
y light bodies, and it has been
l that the corona is composed of
ude of minute discrete particles,
g nothing so much as a dust-cloud,
intensely hot from its proximity
. The dust particles are supposed
o be kept away from the sun by a
force—a supposition acknowledged
ciful, but which is not altogether
le. From the telegrams received
that Mr. Ranyard has been able
n the theory of Prof. Young; and
radial polarisation observed in
been confirmed by Prof. Holden.
wcomb and his party made a care-
h for dark lines in the corona,
l none, and Prof. Young also tele-
hat at Denver no lines were observed in the ultra-violet. Prof. Draper, who used a Rutherford "grating," two inches square, ruled with over 17,000 lines to the inch, and Mr. Lockyer, who employed a small grating and an ordinary pocket camera, both obtained photographs of the corona, and obtained a continuous spectrum, while, in ordinary spectroscopes, the bright lines usually seen were altogether absent. Mr. Lockyer did not see any rings, and it is probable, therefore, that the substance which gives rise to the continuous spectrum is not that which produces any of the lines. The corona was small, of a pearly lustre, and the indications of definite structure were limited to two portions. As seen at Wyoming, the corona was markedly different from the phenomena observed in 1869, '70, and '71, and will probably be considered to demonstrate the changeableness of flickering lights reflected through clouds of metallic vapours, or the variability and instability of the sun's light when reflected though thousands of miles of its outer atmosphere. We have said enough to show that the eclipse of 1878 will afford the substance for many doubtless valuable papers, and some interesting discussion, at the meetings of the Royal Astronomical Society; and it is certain the next opportunity will be readily seized upon for the purpose of making further observations. It is noteworthy, however, that some of the cablegrams, as they are called, tell us of the discovery of an intra-mercurial planet—Watson's Vulcan—the R.A. of which is given as 8h. 26m., and N. declination 18°. There was, however, no chromosphere to speak of, and the only prominence was like the "horn" of 1868, but very dim. Mr. Edison's tasimeter was brought into work, being connected to a Thomson galvanometer, the index of which was put at zero. The telescope carrying the tasimeter was pointed several degrees from the sun, with the result that the instrument indicated heat in the corona—the point of light leaving the scale rapidly when the corona was brought upon the fine slit protecting the micro-tasimeter. Every facility has been afforded the observers by the United States Government and the railway companies, and the full reports we may expect to receive will doubtless add much to our knowledge of the sun, or at least point out better methods of observing eclipses.

NEW YORK ELEVATED RAILROAD.

THE indictment has been preferred against the New York Elevated Railroad, and it is now on its public trial. Some of the doctors, or we may say the medical world of the Empire City, have produced a tremendous bill against it, and, on the other hand, Mr. Edison has been employed to inquire into and to determine the cause of the noises complained of in Sixth-avenue. New York, it will be remembered, is built upon an island much longer than it is broad, and the business parts of the city may be said to be situated at one end. The majority of the populace are obliged to live a considerable distance from their labours, and it is, therefore, a matter of much importance to them that there should be no hindrance to the utilisation of any means of obtaining rapid transport from one part of the city to another. For this reason the New Yorkers tolerated the existence of tramways in their streets, although the rails were a source of great annoyance to the drivers of private carriages and tradesmen's carts. The tramway system, which is, perhaps, better developed there than in any other city in the world, has been voted too slow, and, in spite of some opposition, an elevated railway has been erected. We should, more properly speaking, say that elevated railroads have been erected, for there are separate companies. We have long been familiar with elevated railroads in London, and are well acquainted with the advantages, as well as the fumes, of underground roads, but we have nothing like the elevated railroads of New York, which are carried on girders supported by posts through the main streets of the city. About 140 doctors, residing in the streets through which the Metropolitan (Elevated) Railroad passes, have memorialised the Grand Jury of New York to indict the road as a nuisance, or to compel something to be done to abate the rumbling and noise of the passing trains. It may be assumed that the noise of trains passing on such a road as that employed for the purpose in New York is excessive; for it exceeds anything of the kind with which we are acquainted. The engineers adopted methods of erecting ironwork with which they were familiar, and having taken no steps to deaden the effects of vibration, the result may be readily imagined. The greater portion of the road consists of lattice work, with numerous rods of iron, about 8ft. long, which are set into vibration whenever a train passes. The result is a sound resembling that which would be produced by a number of gigantic, but untuned, Æolian harps. The petitioning doctors declare that it disturbs all mental processes, and interrupts all common conversation near the line of the route, during the continuous passage of the trains; but they spoil their case by attributing to the railway the promotion of diseases with which it cannot have anything to do. It may produce perverted mental action, but to say that perverted moral action is promoted by the noise of the railway is surely rather the outcome of perverted imagination than of sober sense. Cerebral exhaustion, hysteria, paralysis, meningitis, and decay of nutrition are among the terrible maladies which, according to these New York doctors, must be largely promoted among the population exposed to the influence of the railway, while, to some, the alternative will be deafness, dementia, or death. One might have thought that the "alternative" would have been to remove from the district; but no, the residents in the neighbourhood are to have meningitis or paralysis, or, as an alternative deafness or dementia. The grand jury was happily composed of men possessing common sense; who, after investigating the matter, and finding that the officers of the road were doing all they could to remedy the nuisance, declined to be alarmed by the gloomy predictions of the doctors, and refused to indict the line as a nuisance.

Although there is no reason to fear the results predicted by the doctors, there is ample reason for demanding that if anything can be done to decrease the noise it should be done, and the proprietors of the line have taken a wise course in requesting Mr. Edison to examine into the cause. That gentleman has already set to work in a systematic manner, and has employed a modification of Scott's phonautograph for analysing the character of the various sounds, records of which he has taken during about a hundred journeys on the line. He intends subsequently to employ the phonograph, and in a fortnight will have "an accurate chart of every sound that is now loose in Sixth-avenue." Then he will divide the "comprehensive noise" of the road into a hundred parts, and say, specifically, so many parts of the noise arise from this, so many from that, and so many from the other; and then the engineers will be left to find a remedy, which Mr. Edison thinks will present no difficulty. Seeing, however, that the engineers made the railway in such a manner that it was sure to make a terrible din, it may ultimately be found necessary to call in some one else to teach the officials how to deaden sound—Mr.

Edison apparently does not intend to attempt it. The whole affair is one system of large strings, which are put into vibration every time a train passes; and, as the trains follow one another at intervals of about two minutes, the din can be better imagined than described. There are forty iron rods, 8ft. long, between each set of posts, which, with their connecting girders, themselves assist in maintaining the vibration when once started. The sleepers being of pine are, says Mr. Edison, unable to hold the bolts, and so the rails at numerous places have sprung from their position. In some places the hand can be placed between the rail and the ties. This looseness of the permanent way creats other sounds—the perpetual banging of the wheels on the loose rails, and the deep murmurs of the strings, producing effects that are anything but agreeable. Steps have, however, been taken to deaden the sound by placing pieces of tarred felt beneath the ties, where they rest on the iron structure; washers of rubber have been placed between the heads of the bolts and the iron rail, as well as between the heads of the rails; and blocks of timber have been wedged between the rails and the huge balk of wood that serves as a guard rail. In another part, felt has been placed under the wooden sleepers, and between the rail and the guard, whilst a thick curtain of the same material has been passed under the iron beams and tacked to the guard rail at each side of the line. The actual road has thus been muffled, and the noise has been considerably reduced; but, as Mr. Edison has been consulted, the engineers will probably await the issue of his report before carrying out any comprehensive scheme over the whole line. Since the road was opened, about 35,000 passengers have been carried daily, at least, so it is stated; but much of the crowding is probably due to the novelty of the new method of conveyance. The car-drivers on the tracks running beneath the railway complain that steam is frequently blown off just as the train passes over a car, that live coals fall on the horses, and that sometimes heavy coupling-irons have fallen from the line and injured persons underneath. Those are much more serious charges than the probability of acquiring hysteria or developing a "decay of nutrition," but the New York engineers will show anything but the cuteness with which they are credited if they cannot devise some means of reducing the noise and preventing the fall of water, cinders, and coupling-irons, without shutting out the daylight from the street below. The experience thus gained in connection with the New York Elevated Railroad will be useful to other engineers, for there has been some inclination to push the question on, both in London and some provincial towns, where quick transit from one part to another is becoming more and more a necessity of the times.

ELECTRO-MAGNETIC ROTATION OF LIQUIDS AND PROJECTION OF THE PHENOMENA.

(M. Bertin, in *Journal de Physique.*)

THE art of projection must be about as old as instruction in experimental physics. P. Kircher projected the images of the magic lantern. Newton projected the solar spectrum, but that is nearly all that one sees figuring in the plates of Abbé Nollet's "Physique." This was not enough; as physics developed the phenomena studied became more complicated and more difficult to project, and it is only in recent years that the art of projection has come abreast of all the requirements of our public lectures. It would be an injustice not to say that M. Soleil, senior, has been the initiator of this great progress.

To project, light is needed—plenty of light. Formerly there was only the sun, and it was not always to be had. The Carcel lamp was insufficient; the gas-burner was not much more powerful, and projections without the sun were nearly impossible. Foucault, therefore, did an immense public service when, taking up the old experiment of Davy, he substituted for the unwholesome mercurial carbons of the English physicist crayons of retort carbon, thus making possible the use of the electric light. When later he devised the regulator, which gives fixity to the luminous point, it may be said with truth that he was really the inventor of the electric lamp.

But this so powerful luminous source requires a battery of at least fifty elements, or a magneto-electric machine. On this account it is reserved for large scientific establishments. Happily, it may be replaced in most cases by the Drummond lamp, which, since the substitution of ordinary coal gas for hydrogen, has become very convenient and inexpensive to use.

It is regretable that the intensities of the various luminous sources used by physicists have never been systematically compared. Pictet has told us that the Carcel lamp is equal to seven candles. The moderator lamp, large model, is nearly in the same case, though it burns a little more oil (46gr. instead of 42gr.) According to Pictet a gas-burner, with glass chimney, has the same intensity, but on forcing the flame this intensity may be raised one-half. I have also found that the Drummond lamp was equal to nearly 15 Carcels, but that this intensity might be raised to 24 by forcing the oxygen jet, so as to render the flame noisy—a circumstance, however, which is to be avoided. On the other hand, the "Alliance" magneto-electric machines are warranted to furnish a light equal to 250 Carcels, so that the Drummond lamp is equal to only the seventeenth part of the electric lamp. Lastly, I find, in the *Bulletin de la Société d'Encouragement* for 1845, that, according to M. Fizeau, the photographic power of the electric lamp of mean intensity must be nearly a fourth of that of the sun. In absence of direct experiments suppose it is the same for the light, and we may draw up the following table of intensities of different luminous sources:—

Star candle (5 to the pound)	$\frac{1}{7}$
Carcel lamp of Pictet, or moderator lamp, large model	1
Gas-burner with glass chimney, ordinary flame	1
Gas-burner with glass chimney, forced flame	1½
Drummond light, regulated to the ordinary state	15
Drummond light, regulated to the noisy state	24
Electric light of *Alliance* machines ...	250
Solar light	1,000

The experiments we have to describe were made with the Drummond light. Though its intensity represents only 6 per cent. of that of the electric lamp, it is still sufficient for projection, even in a hall which still remains sufficiently lighted for one to be able to write easily.

At first objects were projected which were in a vertical plane, but many phenomena occur in a horizontal plane, and it is desirable to project them too. Such is the deflection of the galvanometer by M. Duboscq, exhibited to the Société de Physique, on 7th Jan., 1876—an apparatus which he had made in 1866, and which perfectly fulfilled this object. He then projected various phenomena of optics, magnetism, and electricity, a galvanometer of great sensibility, and more recently M. Arago's phenomena of magnetism in motion, and the mercurial waves of the brothers Weber. As he was in search of phenomena to project, I indicated to him the electro-magnetic rotations of liquids. It seems to me they are still little known—certainly less than they deserve to be. I believe, therefore, it will be useful here to present shortly the theory of them, along with a description.

Only one method has been used hitherto in lectures on physics for showing the electro-dynamic or electro-magnetic rotation of currents. It consists in taking for movable current a copper wire capable of turning about its middle part. The electricity which traverses this conductor being solicited to move perpendicularly to the wire, and not being able to escape, since it is insulated, carries the wire with it in its movement. But it may be asked what would happen if the electricity could move in all directions on a conducting surface—if, *e.g.*, the wire were replaced by a vessel, a small inverted cauldron of copper, capable of turning on a point at its middle? It seems that the electricity must obey the impulsion it receives, and move on the conducting surface, leaving the vessel unmoved. But it is not so; the vessel turns with the same facility as the linear conductor. The electricity, then, must experience from the conductor a certain resistance which does not allow it to move without involving it in its movement, and accordingly one cannot see why liquids might not turn as well as solid bodies.

It was, no doubt, considerations of this kind which determined Sir Humphrey Davy, in 1823, to produce electro-magnetic rotation of mercury. He succeeded perfectly in it by passing a strong current through mercury by two wires perpendicular to the surface, and placing the liquid between the opposite poles of two strong magnets. The mercury began to turn in contrary directions about the two wires.

It may be asked if mercury is a liquid well chosen to demonstrate electro-magnetic rotations. The motor force being due to the resistance of the conductor, it is desirable to increase this resistance; on the other hand, the accelerating force being in inverse ratio of the mass to be moved, it is desirable to diminish this mass. From both points of view, aqueous solutions are more suitable than mercury, since they are at once more resistant and less dense. The experiment of Davy, then, may be easily repeated with acidulated water, and the following is how we have succeeded in projecting it:—The Drummond lamp sends a bundle of rays, rendered slightly convergent, upon the inclined glass of the Duboscq apparatus. This bundle is sent vertically to the illuminating lens which is placed horizontally over the glass. It then passes through a hollow electro-magnet, and traverses the glass bottom of a vessel placed on the electro-magnet, to arrive at the projection-bar and the total-reflection prism, which sends it to the screen. In the vessel is placed some acidulated water ($\frac{1}{40}$ sulphuric acid and $\frac{1}{40}$ nitric acid). The current of two Bunsen elements is passed into it by means of two platinum wires curved back vertically and immersed in the water, and at one-third of the diameter of the vessel from the sides. The direction of the current can be changed at will with a commutator. If the electro-magnet is excited by a second battery of four elements, the liquid is seen to turn in opposite directions round the two electrodes; its rotation is rendered very apparent by means of a little lycopodium sprinkled on the surface.

But Davy's experiment is a complicated case. Phenomena much more simple will be observed on placing the liquid (acidulated water or sulphate of copper) in an annular vessel. The apparatus which I have made known * for repeating these experiments is open to varied combinations. Most of the effects may be projected by placing on the illuminating lens of the Duboscq apparatus an annular vessel, with glass bottom and sides of copper, in which the liquid is placed; this is decomposed with a battery of four elements. A cylindrical magnet may be introduced by the end into the central ring so that the liquid will be sometimes under the magnet, sometimes between the two poles. The rotation takes place with great rapidity, and it is rendered visible by means of lycopodium powder strewed on the liquid.

These phenomena are easily explained. Suppose that the magnet has its austral pole downwards, and at first above the liquid, and let us remember that this pole drives the current to the right of it. If the liquid be traversed by a centrifugal current, it is necessary that it take a left rotation; if by a centripetal, the rotation will be right, or in the direction of the hands of a watch; the change of direction is easily worked with a commutator. If the magnet have descended, so that its lower pole is under the liquid, the action of this pole will change in sign, and that of the upper pole will ange; but, from being discordant, it come concordant with that of the other The liquid will then be seen to turn in osite direction to that previously, but ore rapidity. Since the rotation of the changes sign with the position of the , it should be *nil* in certain cases; if it rved attentively it will be seen that this when the extremity of the magnet is a elow the liquid. The neutral point of gnet is, therefore, very near its extremity, nearer than the pole determined by ib's rule.

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* "Annales de Chimie et de Physique," 4th Series, t. xvi., p. 206.

he course of my earlier researches on -magnetic rotation of liquids I have d to perceive that the interior action of w magnet and that of a hollow bobbin, ed in the same manner, act in opposite ons—*i.e.*, the introduction of a hollow e into a hollow bobbin diminishes the this bobbin exercises in its interior. a Rive having contested this law, I have ew experiments in order to establish it.* periment is also easy to project.

on the illuminating lens of the Duboscq us an arrangement formed of a hollow containing an iron core, also hollow. In erior is an annular vessel containing ted water, sprinkled with lycopodium. ommunications are made so that it is send the current of a battery (of four ts) at once into the electro-magnet and e vessel. Whenever the current passes, uid turns, at first weakly; but its rotareases considerably if the iron core is d. It diminishes again on the core being d, and if the dimensions be suitable, it sently stop.

are the three fundamental experiments electro-magnetic rotation of liquids, and e seen with what facility they can be ed by means of the Duboscq apparatus.

author concludes by remarking on oints of theory raised by the experi-]

ORGAN: A COMPREHENSIVE ATISE ON ITS MANUFACTURE, CURAL, AND LODGMENT.†

By John Watson Warman,

ssociate of the College of Organists, London.

I.—GENERAL TREATMENT IN MANUFACTURE.

and. It will be seen that the use of inch is strongly discountenanced by . An exception may be allowed Gas Engine is used, as the Cranked then necessary may be utilised. By ng with simple Handle, on the Band Engine shaft being disconnected the lower will at once be furnished, pro of course, the resistance be not too great to size of Feeders; if only designed for ncy it will be sufficient to make the long enough for two men to stand side at; if otherwise, two or more separate shafts must be used, or power Cog employed.

OMPARISON OF THE VARIOUS MACHINES. s the most practical way to indicate the lection of a Motor in all cases will be by each kind of Organ, and with it a suitlower; this I have accordingly done, and it may safely be relied on.

For a Small Organ chiefly for practise. t very permissible.

a Larger Organ (say over 9 Stops Sounde), chiefly for practice. Gas, if much Water, if little used.

a Small Chamber or Drawing-room used not very frequently. Hand, t, or Water.

a Large Chamber or Drawing-room used not very frequently. Hand, Gas, er.

a Large Chamber or Drawing-room used frequently. Hand or Gas.

a Church or other ordinary place of ip. Gas, if daily service. If weekly serbecomes a question between outlay and ience for gas, cost, and reliability of water supply, and cost and usefulness of blowist. If Organ large enough to demand two of latter, and first outlay can be borne, and the motor properly housed and inaudible, better use Gas. The cleaning and attention necessary, however, must not be forgotten, and the cost of this will be a palpable item.

For a Cathedral. Gas *decidedly*, Steam in *no* case.

For Concert Org. Steam, if already possessed or required for other purposes. Otherwise Gas, unless not often used; then may use Water, provided the necessary conditions (*see* 20, q.) can be secured.

n. The above assumes for Water a pressure of not less than 25lb., demanding a fall of, say, 65ft.

For Precise Structure and Arrangement see end of last week's article, p. 516.

*** TABLE OF POWERS.

o. I will now give a Table showing the amount of Horse-power necessary with Organs of given size; at the same time it must be confessed this is a matter of great difficulty, and the figures are put forward with consider able diffidence; I have, however, spared no pains to make them of real use. One great confusion arises from the ambiguous nature of the term Horse-power. Thus the Albert Hall Organ, about 111 Sound.-Stops, is said to possess Steam Engines giving an aggregate of 21 H.P.; while, as a fact, the large Organ (of 68 Registers Sounding-size) erected for Mr. T. Spratt, at his residence in Vassall-road, S.W., had at first but a ½ H.P. Hugon attached, and yet a very large portion of the Organ could be used. It is true the former Instrument is very heavily winded, and has besides a great number of powerful Pneumatic motors; but still, allowing for this, the discrepancy is excessive.

p. The Horse-powers following are all real—that is, *indicated*, if necessary.

"Otto and Langen." Crossley, Maker.		"Duncan." Forrester, Maker.	Actual H.P.	Maximum Sounding Size Permissible.
Intermittent.	*Silent.*			
Not made ...	—	Made (Bore of Pipe ½in)	One-seventh	10 Sounding Stops
Not made ...	—	Not made	One-quarter	15 " "
Not made ...	—	Made (Bore 1in.)	One-third	21 " "
Made ...	—	Made (Bore 1½in.)	Half	30 " "
Made ...	Made	Made (Bore 2in.)	One	50 " "
Not made ...	—	Made (Bore 3in.)	One and three-quarters.	65 " "
Made ...	—	Not made	Two	70 " "
Made ...	—	Not made	Three	90 " "
— ...	Made	—	Three and a-half	—
— ...	Made	—	Seven	—

q. *See* exact method of calulating Sounding-size. (15, v and 16 g.)

r. It must be understood that the above are in all cases supposed to be running at Full power or thereabouts; the Gas with 30 *Explosions* per minute, and the Water with 30 *Strokes* per minute, and at pressure of 40lb. per inch.

s. It is necessary to add that the last-mentioned strength can in no way be relied on as procurable, but that 30lb. may be considered as claimable; when as much as this, or, at all events, say 25lb., cannot be guaranteed, Water may be considered for Bellows-blowing absolutely out of question.

t. It must be understood that the foregoing Table is constructed as assuming that the Bellows will be of size as laid down in Bellows Table (*see* 15, v.), and with all proper allowance of Pneumatics, and it will be seen that the ratio of H.P. to number of Registers increases rapidly to allow for latter. Thus a 30 Stop Organ may often be without Pneumatic, but a 50 Stop Instrument would be sure to have *at least* one; therefore 10 sq. feet extra is enjoined. A 70 Stop Organ will be *certain* to have a great deal of Pneumatic actuation; therefore, instead of being a little over 1 Horse (the ratio from 30 Stops), it is of 2 Horse.

u. With regard to Manual Power it will, I think, be quite safe to reckon on mean or strong youth as one-third of a horse, and allow Blowing Handles accordingly. Thus, 21 Stops Sound.-size and under may have one Handle, and so on—only that it may be laid down that, where there is no Pneumatic, one Bellows Handle, with an adult blowist, will supply a Sounding-size of 25 Stops, but no more. Thus 30 Stops Sounding-size *must* have Two Handles, and 50 will have Three.

v. Remember that the Table is, throughout, at *Minimum* of Power, and where funds are ample (even with 40lb. pressure if using Water), it will be safer to allow a little more. Thus, the Melbourne Town Hall Organ, by Hill, which had a Sounding-size of only 78 Registers, required, as a fact, 12 men to blow comfortably; it is true that Instrument was exceptionally copiously winded. The Organ is now driven by three of Joy's Patent Hydraulics, but what is their exact power I do not know.

**** BOOKS ON THE ORGAN.

See Writers.

**** BORROWING: All Methods.

(*Construe with* Soundboards.)

w. By this is meant the making of one Pipe serve for two Stops, by whatever particular method that service is accomplished. It is as well first to remark that, as the Pipe must under all such circumstances retain its character of tone in both cases, and will not, or at least ought not, to receive any accession of volume when either or both Stops are drawn, it will be manifest that the plan of Borrowing is in itself, and, as it were fundamentally, a makeshift; nevertheless, as will be presently shown, it may, with due care and judgment exercised in the Extent, Method, and particular Portions treated, be not only effective, but really valuable.

x. Borrowing may be divided broadly into two orders—viz., Auxiliary and Primary. The former is where some *non-essential* portion of a Stop or Clavier is so furnished; as in the grooving into Stopt Diap. of a Ten C Dulc., or a Swell man. acting below Gam. G on the Choir or a portion of Great. The latter is where some *essential* portion or the *whole* of a Stop or Clavier is thus obtained, as in example given a little on (*see* also 127, e.). Both methods will be now considered, as in the first laying out of an Organ it will be obviously necessary to know and make provision for all the Borrowings; both Room, Size of Soundboard, Structure, and Size of Bellows (*see* 15, r.) being involved.

*** ADVISABILITY.

y. Although the legitimacy of a moderate Borrowing, with proper precautions, may be almost *assumed*, yet, as it is the object of this work to convey as much information as is practically possible, the reasons for considering Borrowing as advisable—under proper regulations—will be here touched on.

z. We first take Auxiliary Borrowing The most usual purpose for which this is employed is the completion of some Register that stops short at some little distance from bottom, generally at Ten C, though sometimes Gamut G, and occasionally Ten F or Fid. G; this latter can, however, only be strictly regarded as Primary Borrowing.

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* m. de Chim. et de Phys.," 4th Series, t. xvi., p. 70.

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[22, a.] The perfect legitimacy and effectiveness of this treatment a very few words will demonstrate: we will suppose an average Great Manual of, say, 10 Stops. The Open Diap. will, of course, as a rule, go through (*see*, however, *Dep.* of Specifications); its Pipes will be valuable for Front, for supplying Principal of Pedale, for asserting the dignity of the Great Man. throughout, &c. The Stopt Diap. or Clarabella will always also go through; a soft Bass throughout is *necessary*, and the Covered wood so admirably thickens the Open Diap., and this, too, at a moderate cost. But now, if there be a second Open 8ft. Stop, circumstances are widely different: first, supposing Augmentation of Treble to be necessary, the stopping at Ten C does certainly, to a certain extent, assist this; secondly, a certain amount of *attenuation* downwards undoubtedly renders the Manual more fit for supplementing the Pedale (*see Dep.* of Specifi.); thirdly, independent Pedale Stops are far preferable to completion of all Manual Stops, and when one must be sacrificed it should undoubtedly be the latter (*see Deport. idem*). The Pipes are large and expensive (Dulciana is charged by some Pipe-makers as much as Open Diap.); when procured there is a difficulty in placing them; they are very often not wanted in front, and, if they are, great care is required in arranging so that the difference of scale be not detrimental to the Design; and when all is done there is danger of robbing the groove of the Soundboard.

b. It will be manifest that in such a case as this the completion by grooving into the *Bass* of some other Register is very valuable; the second Open Stop being obviously of great value in the *Treble*. If a Dulciana it is delightful with Flute or other combinations—if a Viol d'Amour it makes an excellent Solo Stop, &c., &c.; but it will be evident that if the *sounds* cease at Ten C the usefulness of the Register will be much restricted, if not seriously injured. Now, the old way of meeting the difficulty was by cutting—at such a point as to continue the incomplete Register—the Slider of some stop appropriate for such continuation, generally the Stopt Diapason; but this method has these very serious disadvantages: 1. It increases the labour of the player, for he has an additional Knob to look after. 2. The Slider is increased in breadth. 3. It is weakened. 4. The labour of cutting the Slider is involved, besides that of the additional Draw-action, (the additional work of Grooving, if Borrowing be adopted, is, as a rule, much less than these two *combined*). 5. A fetter is involved in setting out the Soundboard, for there must at the point of junction be a certain amount of space or *land* between the holes (*see Dep.* of Soundboard).

(*To be continued.*)

HOW TO MAKE A PIANOFORTE.—IV.

THE fall and back-piece are ¾in. thick, and project sufficiently beyond the cheek to allow of the edges being rounded; the front of the fall thus answering as a lift. The flap, B, Fig. 1, will be hinged far enough back to give it the appearance of a panel, especially if the bottom of the lock-board is moulded as seen in diagram. It will also greatly improve the appearance if the back-piece is mounted with a 2in. ogee moulding, which may be shaped in 1in. walnut, backed with pine. The top and bottom doors, C and D, Fig. 1, are simple framework, dowelled or tenoned together, the bottom door being fitted between false styles, E, to facilitate its passage between the truss legs, and is panelled with ⅛in. walnut The top door is carried to inside the ends, which will look better if thickened at the front to match the cheeks; it also can be finished with panel and sconces, as in diagram, or with a fret and silk, according to taste. It forms a very effective swell if the panels of both doors are divided longitudinally, and hinged so as to open and close with pedal action. The top is a 1in. board projecting about ½in. all round to allow a thumb moulding. The legs most suitable to the style of case are either plain, bracket, or *pillar, and drop, as shown in Fig.* 2, either resting on a 2in. square-fronted shoe. The case work is now complete. The next task will be fitting the action, or as it is termed "finishing." For this purpose it will be necessary for the operator to provide himself with a set of 16in. keys to match the size of key-bottom; they may be bought at from 38s. to £3, according to quality, and also a set of action or "small" work. This will consist of a set each of hoppers, levers, stickers, dampers (Collard's), and hammers, together with a hammer rail, and a socket rail, for the damper wires to work in, costing altogether about £2 2s. A check action would cost very little more, but would require considerably greater care in putting together—but, as it is, if properly regulated, a very great improvement both to tone and touch. A simple and at the same time very effective check action will be described further on. In finishing, the keys are first prepared; a line ruled across them from 5½in. behind the centre pin of the two outside A's will show the position of the front of the hopper mortice. To make sure of keeping the mortice in the centre it will be advisable to gauge from each side, the morticing being done with a ⅛in. chisel. Two other lines will also be necessary to guide the boring for the touch leads, the first about 1in. in front of the hopper mortice, the other as near the end of the key as practicable. They will be bored with a ⅜in.

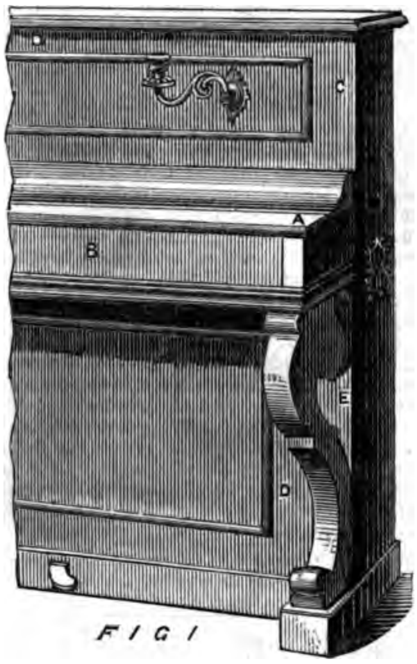


FIG 1

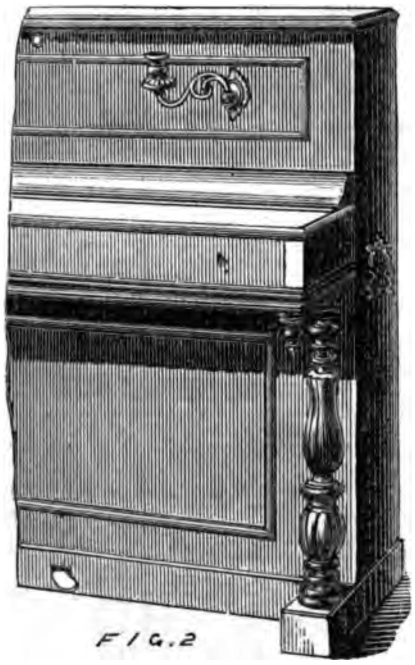


FIG. 2

centre-bit (the hole being about 1-16in. la
melted lead can then be poured in,
must be punched when cool, to make
the hole tightly, as otherwise it would ra
The key-frame can then be clothed; a
centre cloth of firm texture, about ⅛in. dia
is required for the centre pins. This n
shaped with a gun-punch for the front pins
3 to 5 slips of ordinary baize will be nec
for each row of key-pins; or, if prefer
set of key baizes may be bought, read
fixing, at the cost of a mere trifle, fro
small work makers. At the back rail, f
key to fall on, are put 2 slips of baize, the
edge being protected by a groove made
ceive them. The keys are now read
easing. This will require a small flat
rat-tail file for the square and round
These holes must be filed till the key
gently drop to its place without pressure

W. H. Dav

GRINDING CUTTING TOOLS.

THE grinding and sharpening of tools
an important item in the accounts
manufactory, which, if not actually ente
the books, is nevertheless a matter o
sideration. Improved methods of perfo
the operations have been introduced, an
the employment of machine tools it is n
and perhaps necessary that machinery
be employed to grind the cutters. An
recent inventions of this kind we notic
of M. F. G. Kreutzberger, of Paris, pa
in this country by Mr. J. H. Johnson.
lates chiefly to a method of grinding
dentated cutters, as for example boring
rimers, &c., and to the construction of a s
machine for the purpose. Many ma
have been constructed with a view to fac
the operation of grinding or sharpenin
they are incapable of accommodating
selves to all the combinations of shape
outlines of the teeth of which this class o
offers such numerous and varied exa
Attempts have, however, been made to
duce mechanical appliances for effectin
combined objects, but the principle o
struction having been defective and
accessory apparatus wanting in complet
the results obtained have been unsatisfa
which has prevented the general adopt
such appliances. This invention, then,
its object rendering machines for grind
sharpening rotatory, dentatory, or se
cutters, applicable to all cases which car
in practice; and this object is attained
by improvements in the mode of grind
sharpening, and by the combination wi
machine of an apparatus which the in
designates a metal hand, which enabl
cutters to be presented at an angle by
of a system of movable axes, each havi
independent rotary motion, so as to
conical cutters to be applied to the
according to the angle of the cones;
with oblique teeth, according to the ob
of the teeth; cutters with helical teeth,
ing to the pitch of the helix; and cutter
curved teeth, according to the mean ce
the particular geometrical or irregular
The machine consists of a table, having
thereon two supports or brackets carryi
axis on which is mounted one end of an o
ing or adjustable frame, the opposite ext
of which is provided with a steel slee
which the spindle carrying the grin
works. This spindle is provided at o
tremity with a pulley which receiv
motion from another pulley mounted
transverse shaft driven by any suitable
mover.

The frame, which is balanced in its p
parallel to its axis, when moved for adju
or otherwise, slides, in describing an a
circle, against a support fixed upon the
and when brought into the most suitabl
tion for effecting the grinding or shar
which it is desired to perform, is secure
bolt passing through the support and th
of the frame, and tightened by a nut.
upper part of the support is jointed a
provided with a counterweight and con
to the frame by a rod so as to enable
procating up-and-down motion to be im

to the latter, and to bring it to any required position in which it may be fixed to the support by means of the bolt and nut. Or after loosening the nut, the frame may be moved as required in order to cause the grindstone to follow the shape of the cutters to be sharpened. A compound slide-rest is provided for the facility of adjusting the position of the cutter, and of moving it longitudinally during the operation of grinding or sharpening. That portion of the slide-rest which gives the longitudinal motion is provided with a bracket or support capable of rotating on a vertical axis, and carrying at its upper part a split socket, to which is pivoted a split sleeve inclosing a spindle fitted at one end with a crank handle. The split sleeve is free to turn in the socket on the support, and may be placed at any required angle, and the spindle is capable of rotating in the split sleeve, the two being retained in position by a set screw. The other extremity of the spindle is provided with a split head through which is passed a rod having a lever arm which carries the cutters to be sharpened. This lever arm is capable of being raised or lowered at will, and of sliding backwards or forwards in the split head on the spindle in which it is retained by a screw.

The cutter which is placed on a small mandrel fixed by screws to the lever arm is capable of turning freely upon a smooth part provided at the extremity of the mandrel.

FIG. 1

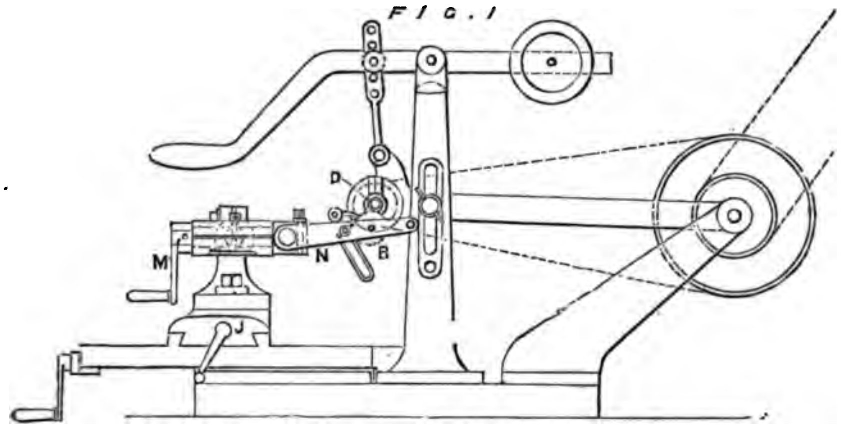


FIG. 2

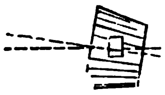


FIG. 3

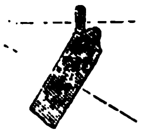


FIG. 4

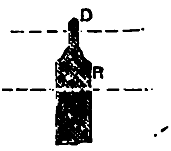
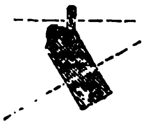


FIG. 5



The lever arm also carries a small pawl which is capable of assuming different positions and of engaging in the teeth of the cutter so as to divide the teeth properly. The cutter may thus be brought with facility under the action of the grindstone, whatever may be its dimensions or shape, or the inclination of its teeth, and the generating line of the tooth may always be brought parallel to the direction of the motion of the slide which effects the displacement of the cutter during the operation of sharpening. In order to sharpen cutters having a non-perforated stem, which consequently cannot be mounted on the mandrel or cutter-holder described, it is proposed to employ a holder constructed in the following manner:—It is composed of three parts, one of which (provided with a V-shaped notch) is jointed to a second part and secured thereto by a screw, whilst the third part consists of a spring fixed upon the second part and placed with its extremity, which is slightly concave, immediately above the V notch in the first part. A small eccentric centre is provided which supports the centre of the cutter to be sharpened, whilst the stem of the latter lies in the V notch in the holder, where it is adjusted on its true centre. This arrangement is applicable to the sharpening of rimers and all tools which are not perforated at the centre.

The sharpening or grinding action takes place in a direction at right angles to the cutting edge—that is to say, every part of the grinding disc or stone acts successively on the edge of the tooth, whilst the cutter moves longitudinally so as to present every portion of the tooth in succession to the action of the disc or stone. In the case of conical cutters with straight teeth, during the sharpening process the generating line of the cone is placed horizontally, and the grinding disc acts in the same direction and in the same manner as when operating on a cylindrical cutter.

The drawing, Fig. 1, is an elevation of the machine; Fig. 2 shows the position of disc, D, and cutter, R, when the latter is conical with inclined teeth; Figs. 3, 4, 5 show different positions assumed during the process of grinding by a dentated rotating cutter with curved teeth. The cutter is first placed on the holder on the lever arm, N, and the screw that holds the spindle in the split sleeve is loosened, when by means of the crank handle, M, rotary motion is imparted to the spindle, and consequently to the cutter, R. It will be observed that the apparatus carrying the cutters is composed of a number of parts which enable the cutter to be brought with facility under the action of the grindstone, whatever may be its dimensions or shape, or the inclination of its teeth, and that the generating line of the tooth may always be brought parallel to the direction of the motion of the carrier, J, which, as before described, effects the displacement of the cutter longitudinally during the operation of grinding or sharpening.

NEW COLOURING MATTERS.

THE well-known German company of aniline makers have recently obtained a patent in this country for the production of new colouring matters for dyeing and printing. The invention consists first in the production of green colouring matters by the action of benzotrichloride on aromatic tertiary amines in the presence of metallic chlorides, such as chloride of zinc, cadmium, tin, mercury, iron, &c.; secondly, in the production of yellow-orange and red colouring matters by the action of benzotrichloride on phenols, all colouring matters produced in such manner being suitable for dyeing and printing. Under the name "benzotrichloride" is to be understood the substance to which chemists give the formula $C_6H_5CCl_3$, having an average boiling point of 215° C., which is obtained by treating the vapours of toluol, or chloride of benzyl, with chlorine.

Production of green colouring matters by the action of benzotrichloride on aromatic tertiary amines:—All so-called aromatic tertiary monamines, of which bimethyl-aniline (bimethylphenylamine) and methyldiphenylamine are typical compounds, yield by the action of benzotrichloride, in presence of metallic chlorides, green colouring matters, which dye in shades similar to methyl-green, although they are not identical with them, and also differ in their resistance to higher temperatures. The presence of metallic chlorides is not absolutely necessary for the production of smaller quantities of colouring matter, as benzotrichloride and the amines alone, if heated together, already yield a green colouration, but for the production on a manufacturing scale, and for a perfect conversion, the addition of chloride is needed. In producing the colouring matter from bimethyl aniline 3 parts of bimethylaniline, 2 parts of benzotrichloride, and 1½ part of dry chloride of zinc are heated in an enamelled vessel for 3 hours to 110° C., under constant stirring. The product obtained is treated by direct steam to distil all volatile substances over; the residue is then extracted by boiling water. From the filtered solution the colouring matter is precipitated by sodic chloride. The colouring matter thus obtained may be used dissolved in water or spirit directly for dyeing and printing. By the same process methyldiphenylamine is equally converted into a green colouring matter. In working on a large scale it is advantageous to moderate the very energetic action by adding powdered or liquid substances, like sand, salt, or hydrocarbons, that serve to dilute without having any chemical action.

Production of yellow, orange, and red colouring matters by the action of benzotrichloride on phenols:—All so-called phenols, of which phenol naphthol and resorcine may be considered as typical compounds, if heated with benzotrichloride are converted into yellow colouring matters, of which the compounds derived from phenol or naphthol are very similar in their chemical properties to amine, whilst the compound derived from resorcin forms a substance very similar to fluorescein, yielding with bromine, in the same way as fluorescein, orange and red coloured products of substitution. In producing the latter compound on a manufacturing scale, 6 parts of resorcin and 5 parts of benzotrichloride are heated in an enamelled vessel for several hours at a temperature from 100° to 120° C. The product of the reaction is extracted by means of boiling water, and forms a substance similar to fluorescein, insoluble in water, soluble in spirit or alkali. The solution in alkali diluted with water shows also fluorescein, and dyes wool and silk, under addition of acids or alum, yellow. If this product, suspended in glacial acetic acid, is treated with a solution of bromine in the same solvent, and then treated with an excess of water, a brominated product is obtained which is soluble in alkali with a red colour, and which can be purified in the well-known process used for eosine, and yields a colouring matter of similar properties.

Benzotrichloride has been exclusively mentioned above as the re-agent, but it is to be particularly noted that instead of benzotrichloride also the corresponding bromine compound, or mixtures of both, may be used, and that also, instead of the metallic chlorides mentioned above, other metallic compounds may be applied to accelerate the reaction.

Of the tertiary aromatic bases, yielding the characteristic reaction with benzotrichloride, only those have been mentioned above that are at present actually commercially produced, as bimethyle-aniline and methylediphenylamine, and also of the phenols only phenol, naphthol, and resorcin have been mentioned as being now available to manufacturing chemists; but it is to be distinctly understood that the present invention includes as well the use of the corresponding ethylated bases as well as the homologues of phenol and the isomeric compounds of resorcin, as they all yield colouring matter with benzotrichloride. The proportions given may be varied within considerable limits.

THE "TRIPLEX" OR "HESPERUS STAR" LAMP.

THE "Triplex" or "Hesperus Star" Lamp, just brought out by Messrs. Jones and Willis, of Euston-road, London, and Temple-row, Birmingham, will certainly find favour with all in search of a lamp which gives an exceedingly good light at an economical cost. The lamp has three wicks, arranged, after quite a novel fashion, in a triangular form—each wick, however, being supplied with a separate elevating screw. The three flames are quite distinct, but the combined light is the most brilliant we have yet seen. The illuminating power is asserted to be equal to 45 sperm candles, as demonstrated by Professor Pepper. It is thus the most powerful lamp yet brought before the public. The consumption of oil is 1 pint in 5 hours, being very small in proportion to the great amount of light given. For domestic use, as a table lamp, it has also another great advantage—viz., the heat only rises 1° per hour in a room of 1,500 cubic feet. The experiment establishing this fact was, we are assured by the makers, tried in July, when the temperature was 75° in the shade. We believe the manufacturers, who are well known as ecclesiastical art metal-workers, were induced to devote their attention to this matter, in the first instance, on account of the difficulty in obtaining a sufficiently powerful paraffin lamp for churches and other buildings where gas could not be used. One great saving in such cases with the "Triplex" is, that it requires fewer fittings than any other lamp—for instance, four triplex lamps would give nearly as much light as eight duplex lamps; therefore a 4 arm pendant could be substituted for one of 8-arms fitted with duplex lamps, thus saving the cost of the four additional arms, and the trouble of attending to eight lamps instead of four.

HOW TO USE A FILE.*

By Joshua Rose, M.E.

THE excellence of a piece of work operated upon by a file is only limited by the skilfulness of the operator, because a file can be made of any required form and size, and the quantity of metal it will cut away and the location of the same may be varied at will; hence it is evident that it is possible to perform with the file every cutting operation assignable to steel tools.

The legitimate use of the file may be classed under four headings: 1. The removal of surplus metal. 2. To correct errors in the truth of work that has been operated upon by such machine tools as the planer and shaper. 3. The production of small intricate or irregular forms. 4. To fit work together more accurately than can be done by the use of other tools. With reference to the first, the domain of the file has of late years been greatly circumscribed by the introduction of special machines which will finish small work sufficiently accurate to render subsequent filing unnecessary. As a correcting process, however, filing still maintains a pre-eminent position from the fact that no other tool can be so delicately or minutely applied, and it is found that work produced by special or other machine tools, though sufficiently true for ordinary purposes, yet require correction in all cases where the utmost attainable exactitude and smoothness are required. One of the main reasons for this is to be found in the fact that work to be operated upon in special machines requires to be held or clamped firmly, and as a result is almost inevitably sprung. Another reason is that in filing, the work, unclamped and therefore unsprung, may be tried to its place or to gauge, &c., and any detectable error remedied. On large work this is especially the case, and for this reason the file is almost the only finishing tool. In the production of small, intricate, or irregular forms, the file is either used to originate a cutter or tool to be used in a machine tool, or if but few of the pieces are required, it is applied direct to get out the work, machine tools being employed to rough the work out somewhat near to the required shape.

It is always desirable that the surface to be filed should lie horizontally level, and for ordinary work the face to be filed should be about the same height as the operator's elbow. If the work is large and requires a long reach, it is better to be lower, while if it is very small, so that but little pressure is required upon the file, it may be placed higher, so as to render less stooping necessary, and the eye may be able to add its scrutiny to the sense of feeling of the hand, upon which principally successful practice depends. When the work is level with the elbow, the first joint of the arm is in a line with the force required to push the file, which places less strain upon the arm. This is of great consequence in filing chipped surfaces or removing a quantity of metal.

The teeth of a file are unequal in height, and as the file warps in hardening, it is evident that, even supposing the operator to move the file in a straight line, the surface filed would not be straight; hence files to be used upon flat surfaces should be thickest in the middle, and thinner at each end of their lengths. This gives to the surface of the teeth tops a curve or sweep in the length of the file, so that if it should warp slightly in the hardening process, the effect is to merely lesson the sweep on one side and increase it on the other. This is of but little consequence, because by altering the height of the respective ends of the file to the work, any part of the file may be brought into contact with the work, and its action located to any required part of the work. If the file is moved in a straight line it will file flat so long as the surface is curved; but if the file is hollow in its length, it cannot under any circumstances file a flat surface, and one of the greatest objections to recut files is that the original curve is not maintained. The most expert mechanic, however, cannot move a file in a straight line, and the curve of the file is usually about sufficient to compensate for the variation of the stroke from a horizontal plane. The level of the teeth across the file may either be flat or slightly rounding, but in no case should it be hollow, for in that case the two file edges would cut two grooves.

For convex surfaces a flat file is usually employed, but for concave surfaces the file must be given a convexity greater than the concavity of the work, so that any desired part of the file may be brought into contact with the work, notwithstanding a slight irregularity in the curve of the file. A round file should always be a trifle smaller in diameter than the hole it is to be used upon, and before inserting it in the hole the eye should be cast along the length of the file while the latter is revolved slowly in the fingers. By this means we may select the curve in the length of the file, and bring it to bear upon the work so as to avoid filing the edges away.

If we closely examine a flat, square, or half round file, we shall find that the cutting edge of the teeth does not come fully up at the corner; hence neither of them will file a clean corner, but leave it slightly round. To remedy this defect the only plan is to grind away the edge of the flat or one side of the square file, making it smooth, or at least so that the teeth points will meet the corner. Care should be taken to select the worst side of the file to grind away, and this will be the side hollowest in its length. Sometimes a smooth half round file is used to square out a corner, in which case the smoother the file the better.

Safe edge files are those which have one edge left without teeth, so that it will not cut, the object being to enable that edge to be moved against a flange or projection of the work without cutting it. As a rule, however, it will be found that cutting the teeth on one side, throws a burr over the edge, and it is necessary, unless in very fine piles, to pass the safe edge over the grindstone to make it absolutely safe.

In using parallel files for keyways, it is often necessary to finish with the end of the file only, so as to take any roundness in the keyway surface. It is to be especially noted that by giving the file a slight lateral motion at each forward stroke, and reversing the direction of that motion, so that the file marks cross, there will be less liability for the file to pin, and the file will cut more freely, but with a lateral motion, from right to left the file cuts cleanest. This is because the deepest serrations forming the file teeth are diagonal and nearest to the end of the file on the left-hand side, hence with a motion from right to left there is a partial draw-filing motion. For finishing, very light strokes should be taken, the cross-filing being done with smooth files before the draw-filing is begun, and to prevent pinning, a frequent application of chalk should be given to the file teeth.

CHANGES IN THE MOON.*

By Richard A. Proctor.

THE moon, with her multitudinous craters, has been a favourite subject of study since first the telescope was invented; and yet, perhaps, there are few lines of astronomical research which have been less profitably pursued. There are not many students of astronomy at this moment who would venture to express a confident opinion either as to the moon's present condition or as to her past history, and those who would are those who know least about the subject. It is easy to speak of the moon as a dead world, and very likely she is in a sense dead; but if the statement is intended to imply that she resembled our own earth when she was a living world, it is probably altogether erroneous. It is difficult, when we study the moon through a telescope of considerable power, to believe that the moon ever resembled the earth in being clothed with vegetation, in having seas, lakes, and rivers, in being enveloped by an atmosphere like our own, or in bearing on her surface many races of living creatures. If we consider the future of our own earth again, we find it very difficult to believe that she will ever be like the moon. Even if our atmosphere were in some way rendered as rare as that of the moon, if the seas and oceans now existing on her surface were withdrawn into her interior, if not only all forms of vegetation were destroyed, but all the masses of vegetable matter now existing on the earth were in some way removed, she would yet present, from the moon's distance, an aspect entirely different from that which the moon presents to us. Unless appearances are altogether deceptive, the present surface of the moon is in great part the surface with which she was originally formed. In many places molten matter has poured forth from the interior, and covered the original surface. Moreover, unquestionably the original condition of that surface has been entirely changed In several regions it has been broken as though burst by explosive action, though doubtless the real process by which such changes were wrought was a process of contraction, the crust closing in upon the nucleus. In other regions we see multitudinous corrugations, where the semi-plastic crust has shrivelled up, so to speak, upon the contracted nucleus. In some places mighty slopes can be seen, as in the Sea of Serenity (really a great plain) the whole surface of which (extending over many hundred thousands of square miles) slopes gently downwards on either side of a sort of ridge-line, which divides that great plain into two nearly equal parts. But the most characteristic feature is the existence of enormous numbers of craters over the greater part of the moon's surface, which presents an appearance closely resembling that which would be shown by a pool of deep and rather tenacious mud into which hundreds of stones had been thrown. A theory of the origin of this appearance is discussed by me in the August number of the *Belgravia Magazine*. Parts of the earth's surface may at one time have resembled these different parts of the moon's surface, when first a solid crust was formed, hundreds of millions of years ago. But there is scarcely a single terrestrial region where the action of air and water has not removed all traces of the original surface. In some places the crust has not only been covered repeatedly with deposits of different kinds, but each successive deposit has been cut through by running water, or beaten away by the long-continued action of sea-waves, or in other ways denuded, until not the faintest idea of the former aspect even of any single deposit, far less of the original crust, can be formed from a mere study of the present surface.

It would be unsafe, however, to assume that the moon has greatly changed since the time when she was passing through the same stage of planetary life as our own earth. It may be that when first formed, or rather when first her crust was solidified, the moon was in nearly the same general condition as at present. We are apt to assume rather too confidently that, if a planet is not now the abode of life, it must once have been so, or will one day become such. Our limited range of view does not enable us to perceive any purpose which a planet can possibly subserve, except to support living creatures; but in reality there may be other purposes far more important for which a planet is fitted, apart always from the possibility that the idea itself of purpose belongs only to our limited conceptions of the meaning of the universe. If creatures living on a fruit could reason about that fruit, we can imagine that they would be apt to regard the support of creatures like themselves as the one purpose which such fruits could by any possibility fulfil. A higher race of creatures might still regard the fruit as only intended to serve for food in some way or other. Yet quite possibly far other purposes might be fulfilled by the fruit. For instance, to name only one, it might, by falling to the earth, give birth to a noble tree, whose wood might be fashioned into articles of far more importance to man than the mere nourishment which the food could afford him.

Now the moon is not merely a satellite of the earth. She is a planet, circling around the sun as the earth and the other planets do, large enough to support more living creatures than exist on the entire continent of Asia, and in many respects an important member of the solar system. But quite possibly she never has been, and certainly it seems unlikely that she ever will be, the abode of living creatures. Yet, quite apart from the useful light she affords us, from her action in producing tides, and from other services she renders to us, it may well be that, even as a planet, she may have other work to do than to support life—work which, with all our science, we may be at present no better able to conceive than an insect could conceive the value of wood for building houses or ships. And possibly, on the other hand, it may accord quite as well with the plan of the universe that planets should occasionally be wasted, as that seeds which fall on desert places should be wasted.

I have been led to make these remarks by noting the anxious care with which some modern telescopists are searching for signs of change in the moon, with the express object of proving that she is not yet a dead world. There is one spot, the floor of Plato, a crater some sixty mile sin diameter, which they have scrutinised with exceptional care. And some among them are satisfied that, as day progresses on this crater-floor, the surface darkens, as though some form of vegetation spread over it, or some chemical change took place. Others, however, have been hardhearted enough to assert that the supposed darkening is only an effect of contrast. Then, again, Schmidt, of Athens, who has given the best part of his life to the study of the moon, announced eleven years ago that a crater called Linnæus, or Linné, had recently disappeared from view; and as this crater was certainly five or six miles in diameter, and probably deep, when Mädler made his map of the moon, it seemed as though some mighty volcanic disturbance had taken place, by which either the crater had been filled up or its lofty walls had been thrown down. Here again some were cruel enough to point out that Schröter, an older observer than Mädler, had seen the crater precisely as it now appears, whence it was to be inferred that no change had taken place. And now Dr. Klein, of Köln, informs us that near the centre of the moon's disc a new crater, two or three miles in diameter, has formed where none formerly existed. But in photographs of the moon taken more than thirteen years ago signs of this crater can be traced, which prevent us from regarding it as a new formation, though not necessarily precluding the idea that a change of some sort may have taken place. The evidence for and against change is too voluminous for these columns, and I would refer the reader curious in such matters to the pages of the August number of the *Contemporary Review*, where I have considered this case and others at some length. It certainly suggests singular ideas to conceive that the vast surface of the moon, some fifteen millions of square miles in extent, is a scene of absolute silence and desolation. But it must be confessed that the evidence of change is not satisfactory, while evidence of such systematic changes as we associate with the existence of life seems wanting altogether.

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* *From the Scientific American.*

* From the *Echo*.

THE APPLICATION OF PHOTOGRAPHY TO THE PRODUCTION OF PRINTING SURFACES AND PICTURES IN PIGMENT.—III.[*]

By Thomas Bolas, Esq., F.C.S.

Line Engraving on Metal Plates.

WE now go back to the first photographic process discovered—that is to say, the first process which gave photographic representations which could be exposed to light without destruction—the bitumen process of the hard-working and patient Niépce. This investigator noticed that the residue left on the drying of certain varnishes became insoluble by exposure to light. About the year 1814 he covered metal plates with a bituminous varnish, exposed them in the camera obscura, and after exposure he subjected them to the action of similar solvents to those originally employed in making the varnish. Under these circumstances those parts of the film which had been exposed to strong light refused to dissolve, while the unexposed parts dissolved, a negative image being thus formed on the metal plate. To convert this negative image into a positive, those parts of the metal which were uncovered by bituminous matter were darkened by the vapour of iodine, and the bitumen was then removed by the use of a more powerful solvent. By the application of a suitable acid to the bitumen pictures on metal the bare parts were dissolved away, and engraved plates were obtained. Here is a specimen of bitumen or mineral pitch—a substance which is found in most quarters of the world. Let us powder a little, and pour benzole on it; you see that it dissolves quite easily, and the solution runs freely through this paper filter. You see that the solution is about as thick as collodion, or perhaps, rather thinner. Now, here is a carefully cleaned copper plate, such as the engravers use, and you see that I am going to clamp it down on to this turn-table. The next step is to flood the plate with bitumen solution, and then to make the table revolve quickly. Now it has revolved a few seconds, and I think the film will be dry. Here it is; I hand it round, so that you can judge for yourselves as to the advantages of this method of coating the plate. I know of no other method by which such a uniform and compact film of bitumen can be obtained. After coating it is well to put the plate aside for twelve hours, in order that the film may become harder. It is then necessary to dust it over with French chalk, to remove stickiness; and, after this, it is placed behind a transparency, and exposed to light. The time of this exposure may vary from twenty minutes to two days.

Here is a plate which has had the requisite exposure, and the next matter is to dissolve away that portion of the bitumen which has not been made insoluble by the action of light. Now, benzole is too energetic a solvent for my purpose, and oil of turpentine is not sufficiently active; but, by mixing these together, you can get any degree of solvent power which you may require. I will get Mr. Barker to treat this plate with the solvents. You see that he commences by flooding the plate with oil of turpentine, and, as this has not sufficient action, he pours it off, and adds a little benzole; this begins to produce an effect, and enables him to judge as to the amount of benzole which he may safely add to the oil of turpentine. He has added this quantity, and has now washed away all the soluble bitumen from the plate, which is next thoroughly rinsed with water to remove the oil of turpentine. You see how extremely sharp and well-defined the lines are. I next place the plate in nitric acid, so as to etch the lines where the metal is bare; and while the etching is in progress I will get Mr. Barker to dissolve away the soluble bitumen from this glass plate, when we shall find remaining the bituminous reproduction of a page of letterpress, which I can show you by means of the lantern. Our first plate is now sufficiently etched, and when I have cleared off all the bitumen, by rubbing with a rag and benzole, the plate will be ready for the printer. It is now clean, and I will hand it round for you to examine.

Mr. Barker has now the bitumen image on the glass plate, ready for the lantern; the image is now on the screen, and you see how sharp and well defined the lines are; I take the plate out, and if you examine it, you will notice that the letters are raised on the glass—they being, as you know, formed of insoluble bitumen. If we wish to etch the glass, it is merely necessary to expose it to the action of hydrofluoric acid, as I do now.

So much for the line-engraving process of Niépce; but before you go I want to show you that very perfect half-tone transparency pictures may be produced by means of bitumen. Here are some pieces of sheet gelatine, and some pieces of talc, which have been varnished on one side with bituminous varnish. I hold two of these, one being on talc and the other on gelatine, over against the lime-light, and you merely see even films of bitumen, but no image. There is, however, in each case a picture of insoluble bitumen imbedded in the films, and I will get Mr. Barker to dissolve away the soluble portions, so as to lay bare this hidden image. He will use a mixture of oil of turpentine and benzole as a solvent.

Supposing that the varnished side of the talc or gelatine is placed in contact with the negative, and the light is allowed to shine through it, those parts of the bitumen film which are under the perfectly transparent parts of the negative, become insoluble, let us say, all through. Now, those parts of the film which are under less transparent parts of the negative, do not become insoluble all through, but a skin of insoluble bitumen is formed on the surface of the bitumen film, this skin varying in thickness according to the amount of light which has given rise to it. Put a varnished and exposed gelatine sheet of this kind into the solvents, and note the effect. When the film is made insoluble all through, it resists the action and remains on the talc; but where only a skin of insoluble bitumen exists on the surface of the film, the solvents loosen and dissolve the bitumen from underneath this skin, and away it floats. Now you can understand why the bitumen process, in its ordinary form, is only adapted for the reproduction of subjects in extreme black and white, such as line engravings or letterpress. Now, if we wish to preserve the half-tone picture intact, we must expose through the transparent medium (talc or gelatine) so as to insure every part of the insoluble image, whatever its thickness, being in contact with the transparent support. Those prints which Mr. Barker is developing were done in this way, the talc or gelatine being placed in contact with the negative. The small thickness of talc or gelatine does not render the image notably unsharp. It was only during the last week that I thought of making bitumen transparencies by this method of printing against the back of the film, so I have not had time to make many examples. Mr. Barker has now finished the washing away of the soluble bitumen from those which he took in hand some minutes ago, and as I exhibit them on the screen you will see how perfectly all the gradations of half-tone are represented. You quite understand that a picture of this kind is solid, the gradations of light and shade being due to a greater or less thickness of bitumen, and that the essential points in producing them are to varnish a thin, transparent medium with bitumen, to expose to light through this medium, and then to dissolve away that portion of the bitumen which has not been acted on by light. The ordinary black varnish sold for backing glass positives will answer very well, and so will some samples of Brunswick black. Here is a transparency which was made with ordinary Brunswick black; remember, however, that some samples of Brunswick black are now sensitive to light, these being probably made with coal pitch.

I think that by the method which I have just indicated very fine lantern slides may be produced, as there is an entire absence of texture or granularity, and it is probable that the bitumen pictures may be stained or toned without difficulty. As I told you before, I only recently thought of this method, and perhaps some of you will experiment with it.

On the table are some plates and specimens illustrating the process of engraving on bitumenised plates, and you will specially notice the great clearness and sharpness of the lines produced by this method. Messrs. Leitch and Co. have kindly lent me some of their photo-engraved plates, which you will examine with much interest. These copper plates have been covered with a thin film of iron, by the electrolytic method, and as the film of iron is extremely thin, it does not in any way interfere with the printing qualities of the plates. When the surface of a plate begins to wear a little, and the impressions show signs of deterioration, the plate is sent back to Messrs. Leitch and Co.'s factory, where the film of iron is dissolved off by means of dilute sulphuric acid, leaving the copper plate as good as ever. The film of iron, although so thin as not to injure the printing qualities of the plate, is nevertheless sufficiently thick to protect the copper from injury in printing. The plate having been freed from the first worn-out film of iron, is once more coated with a layer of iron, and is again ready for use. When the second film of iron is nearly worn away, and the printer approaches near to the true surface of the copper plate, the iron is again dissolved away, and a new coating of iron is put on. According to this system, one really prints rather from a cast of the plate than from the original plate, and new casts are made as required.

Here are some admirable specimens of photographic engraving by Mr. Dallas, a gentleman who is always to the fore in matters connected with photo-mechanical printing.[*]

Before you go I wish to call your attention to a very simple and expeditious way of making engraved plates from line subjects. Here is a photo-lithographic transfer made from a positive instead of from a negative, as is usually the case. You see that the ground is black, and the lines are white; in fact, by far the greater part of its surface is black. I now lay it on a zinc plate, and pass it through the press. Now, what will be the result? I will tell you beforehand. So much of the paper being covered with printing ink, and so little being white, moist, and gelatinous, the transfer will slide over the zinc plate, and we shall merely get a smear. Here it is. I have here another transfer similar to the last, excepting that white patches are introduced on it wherever they can be introduced without falling foul of the picture. This is done by painting on the transparency with Brunswick black. On putting this transfer down on a zinc plate you see that it adheres properly, and we have a perfect image on the metal. As the white patches are now done with, I varnish them over, and you see that the zinc is covered everywhere except where the lines of the engraving are bare. The covering on the zinc is now made denser by inking and dusting with resin, as I explained in the last lecture, and the plate is then etched by dilute nitric acid. Here is a plate all ready inked and dusted; I place it in this dish of nitric acid, and allow it to remain a few minutes. I now clean off the ink, and you see the lines are engraved on the zinc plate. The plate may now be printed from in the copper-plate press, or, as zinc is not a convenient metal for deep plate-printing, it may be reproduced by the electrotype process.

THE COMPOSITION AND WORKING OF ALLOYS.—II.[†]

Bronze Alloys.

A BRONZE in imitation of gold may be made of 45·5 parts copper, 3·5 parts tin and 1 part zinc—50 parts. Bronze metals are generally cast of an alloy of 50 parts copper and 2·8 parts tin. This alloy is very hard. A softer bronze for medals than the above is composed 46 parts copper and 4 parts tin. Ancient bronze nails were made of 40 parts copper to 1 part tin, and were very flexible. Soft bronze is composed of 18lb. copper to 2lb. tin. Hard bronze is composed of 20lb. copper to 5lb. tin. The ancient bronze mirrors are said to have contained 16 parts copper to from 7 to 8 parts tin. At the time of Louis XIV. of France, a period when the art of casting statues was much cultivated in France, statues were cast of an alloy of 30·6 parts copper, 0·11 parts tin, 2 parts zinc, and 0·6 parts lead. The statue of Louis XV. is cast of 82·4 parts copper, 10 3 parts zinc, 4 parts tin, and 3·2 parts lead. The bronze of the ancient Greeks consisted chiefly of copper and tin, but was frequently alloyed with arsenic, zinc, gold, silver, and lead. All their shields and weapons of war were made of bronze, as well as coin, nails, kitchen utensils, &c. All the ancient nations seem to have understood the art of tempering bronze and copper, and the ancient Mexicans understood the art of converting bronze into edged instruments in a high degree, but the art of tempering and hardening bronze and copper has been lost to modern nations; but as we understand the working of iron better than the ancients, and have steel, an alloy of iron and carbon, which the ancients did not have, we do not miss this art much.

Bell-metal Alloys.

One hundred and forty-four pounds copper, 53lb. tin, and 3lb. iron, are said to make a superior bell. Iron, copper and tin do not unite well, if each is added separately to the other, but if tin-plate scraps are melted in a crucible together with tin, and then this tin and iron alloy added to the molten copper, it will unite readily. Another alloy that is highly recommended is composed of 53·5 parts copper, 6 11 parts tin, 2·13 parts lead, and 3 9 parts tin. This alloy has a good, sonorous sound, even if the mould is not thoroughly dry. House bells are made of 4lb. tin to 16lb. copper. Soft musical bells are made of 3lb. tin to 16lb. copper. Common bell-metal consists of 50lb. copper to 15 or 20lb. tin. The silver bells of Rouen, France, consist of 40lb. copper, 5lb. tin, 3lb. zinc, and 2lb. lead. Too much tin causes bell-metal to be brittle. The gongs or cymbals and tam-tams of the Chinese are composed of 40lb. copper to 10lb. tin. To give these musical instruments their proper tone, they are plunged in cold water while hot, after being cast; cooling in water deprives the metal of almost all its sound. It is tempered and very slowly cooled, which imparts to it that peculiarly powerful sound. If bell-metal is suddenly cooled, it becomes less dense and hard, and is increased in malleability; but the tone of the metal is decidedly impaired, and bells ought never to be cast in damp moulds. When bells are cooled suddenly they should be reheated and tempered by cooling slowly.

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[*] Being the Cantor Lectures delivered before the Society of Arts.

[*] After the lecture, Mr. Dallas informed me that he has been in the habit of coating the surface of his plates with iron, as described above.—T. B.

[†] From a series of articles by Mr. E. Kirk, published in the Iron Age.

Type Metal.

Six parts lead and 2 parts antimony form a very hard and brittle alloy used for small type. Eight parts lead and two parts antimony form a softer alloy that is used for larger type. Ten parts lead and 2 parts antimony form an alloy that is still softer, and is used for medium-sized type. Fourteen parts lead and 2 parts antimony form an alloy that is softer than any of the above alloys, and is used for the largest-sized type. A small amount of tin is sometimes added to the above mixtures, and some typefounders add 1 or 2 per cent. of copper. Both of these metals improve the quality of the type, when used in small quantities. Forty parts lead, 8 parts antimony, and 2 parts tin form an alloy that is used for stereotype plates. Six parts lead and 2 parts tin form a coarse solder, used by plumbers. This alloy melts at about 500° Fah. Two parts lead and 4 parts tin form the fine solder used by tinners. It melts at about 350° Fah.

Lead Alloys.

Ninety-four parts lead and 6 parts antimony form an alloy that may be rolled into sheets, and is a little harder than pure lead. This alloy is much used for sheathing for ships. Twenty-four parts lead and 4 parts antimony form an alloy that is used in place of Babbitt metal for filing small boxes and bearings. Twenty parts lead and 4 parts antimony form an alloy that is a little softer than the above, and is used for the same purpose. Either of these may be hardened by the addition of more antimony; but care must be taken not to use too much antimony, for it will cause the alloy to lose its fluidity, and it cannot be run into the boxes. All alloys of lead and antimony are rendered more fluid by melting them under a covering of oil. Five parts lead and 5 parts tin make a beautiful white alloy, used for organ pipes. The mottled or crystalline appearance, so much admired in the pipe, is caused by using an abundance of tin. One hundred parts lead and 2 parts arsenic form an alloy from which drop shot is made. Eighteen parts lead, 4 parts antimony, and 1 part bismuth form an alloy that expands on cooling. This alloy is much used for metallic patterns for snap mouldings.

Spelter-solder Alloys.

A good solder for copper and iron is composed of 3 parts zinc and 4 parts copper. A softer solder that is used for ordinary brass-work is composed of equal parts of zinc and copper. A very hard but fusible solder is composed of 2 parts zinc and 1 part copper. This solder is so hard and brittle that it can be easily crumbled in a mortar when cold. The two first solders are first alloyed and cast into ingots. The ingots are allowed to cool in the mould and then reheated nearly to redness upon a charcoal fire, and are broken up on the anvil, or in a mortar, into a finely granulated state, for use.

Hard-solder Alloys.

The following metals and alloys are usually used as solder in the art of hard soldering:—Fine or pure gold rolled or beaten into sheets, and into shreds or small pieces, is used as the solder for soldering chemical vessels made of platinum. Silver solder is composed of 4 parts silver and 2 parts yellow brass. Yellow brass is much used for hard soldering. The brass is used in this solder, so that the operator can tell when the solder is fused by seeing the blue blaze caused by the burning of the zinc. This solder is either rolled into thin sheets and cut into small bits for use, or is granulated while hot. The gold solder, the composition of which is given under the head of gold alloys, is rolled into thin sheets and used for soldering gold alloys. Gold soldering is generally done with the blowpipe, as the work is seldom large enough to require the brazier's hearth. Pure copper, in shreds, is sometimes used for soldering iron. Spelter solders, granulated while hot, are used for soldering iron, copper, brass, gun metal, German silver, and sometimes for gold and silver alloys. As a cheap substitute for silver solder the white or *button solders are commonly* employed for the white *alloys, such as German silver, gun metal, &c.* The flux most generally used in hard soldering is borax. In fact there is very little hard soldering done without the aid of this flux. It is generally granulated, and used in the dry state for large or heavy work, and for small work it is generally used in solution with water.

Soft-solder Alloys.

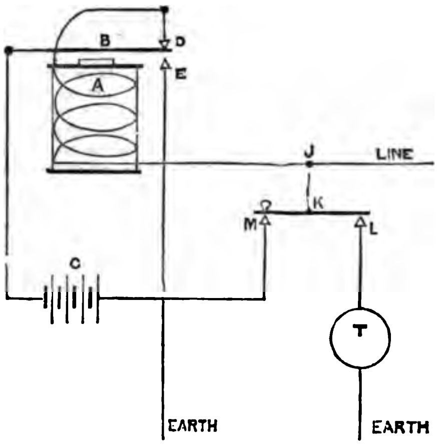
The soft solder used by plumbers, called sealed solder, is composed of 2 parts tin and 4 parts lead. This solder melts at 450° Fah. The common solder used by tinsmiths is composed of 4 parts tin and 2 parts lead. This solder melts at 350° Fah. The bismuth solder is composed of 7 parts bismuth, 5 parts lead, and 3 parts tin. This solder melts at about 225° Fah. All the tin and lead solders become more fusible the more tin they contain. Thus 1 part tin and 10 parts lead melt at about 550° Fah.; while 6 parts tin and 1 part lead melt at about 375° Fah.; and all the tin, lead, and bismuth solders become more fusible the more lead and bismuth they contain. The fluxes used in soft soldering are borax, sal-ammonia, chloride of zinc, common resin, Venice turpentine, tallow, and sweet oil. Those most commonly used for ordinary work are common resin and chloride of zinc.

Babitt Anti-friction Metal.

This metal is made of 1 part copper, 3 parts tin, 2 parts antimony, and 3 parts more tin are added after the composition is in the molten state. This composition is called hardening, and when the metal is used for filling boxes, 2 parts tin are used to 1 of hardening. The above alloy constitutes the best anti-attrition metal in use, but on account of its expense it is very little used. The anti-attrition metals commonly used are principally composed of lead, antimony, and a little tin, but they are not nearly so good as the above.

A NEW FORM OF TELEPHONE CALL.

SINCE the introduction of the telephone a number of devices have been employed as the means of calling the attention at the distant station, the telephone itself not being sufficiently loud to be heard unless it is held close to the ear.



The first form of call instrument used was a magneto-induction arrangement, brought over to this country by Professor Bell with the telephone; it was the one then in general use in America.

In using this instrument for calling a switch had to be moved into position, and the handle of the instrument turned. The handle acted upon a small magneto-induction machine, and so generated a current of high tension electricity, which, passing out to line, rang a polarised electric bell at the station called at the other end of the line. One of the objections to this form of call was that persons using the telephone were very apt to omit to leave their switches in the proper position, so causing delay. To obviate this difficulty, as well as the objection to using high-tension electricity, the Indiarubber and Telegraph Works Company, Silvertown, introduced an automatic switch and electric bell worked by a battery; the switch was so constructed that the weight of the telephone, when in its place, always held the switch in its proper position for calling, and when taken out for speaking, the switch, having no longer the weight of the telephone on it, sprang into the necessary position for speaking through the telephone. This form of switch was also applied to the magneto calls already mentioned, as objection had been made by some persons to using a battery.

Utilising the weight of the telephone for actuating the switch has since been applied to a variety of different forms of calls.

To still facilitate the use of the telephone, and do away entirely with the switch, M. Niaudet, manager of M. Breguet's works in Paris, constructed a modified form of telephone, in singing into which, or otherwise causing the telephone diaphragm to vibrate violently, the diaphragm caused intermittent contacts to be made between a battery and the line for such time as the push on the telephone was held down. The intermittent current caused a sufficiently loud noise to be given out by the receiving telephone.

This plan of using intermittent battery current as a call with the telephone has also been made use of by Mr. E. Conrad Cooke. In his arrangement, by turning a handle a succession of contacts are made mechanically between the line and battery, the effect of call being the same as in M. Niaudet's instrument.

Mr. Edison, in America, has also designed two or three ingenious arrangements for telephone calls. In one of these the receiving telephone is made use of for calling attention. Upon the diaphragm one end of a light lever, pivoted at its centre, is made to rest. On the diaphragm being thrown into vibration by an intermittent battery current from the sending station, the end of the lever resting on the diaphragm receives a succession of blows, causing it to rebound, and so, it is stated, increase the sound. The telephone, when not in use for speaking, is held in a suitable stand, so that the end of the lever is resting on the diaphragm.

In order to further simplify the telephone call, Mr. A. Le Neve Foster, of the Silvertown Telegraph Works, has now perfected an intermittent battery call, which entirely does away with the switch, also the necessity of singing into the telephone, as with M. Niaudet's call. or turning a handle, as is the case with that of Mr. Cooke.

The battery and call are contained in a small box about 6in. square. On the ordinary telephone is arranged a button, which, on being pressed, causes, for such time as it is held down, an intermittent current from the battery to flow out to line, and so acting on the receiving telephone call attention.

The call contained in the battery-box consists of a simple make and break arrangement somewhat similar to that used in causing the hammer of an ordinary electric bell to tremble. The connection with the battery and line is so arranged that by pressing the button on the telephone, the electro-magnet of the call is worked on short circuit, whilst at the same time, the whole strength of the battery is intermittently brought into connection with the line, completing the circuit through the receiving telephone, and so causing a sound to be emitted.

By reference to the accompanying diagram, the manner in which this has been carried out will be more readily understood. In this A is the electro-magnet of the call instrument, in front of the pole of which is placed an armature, B, such as is used for ordinary electric bells; one end of the armature is connected to one pole of the battery, the other end being free to vibrate between the contact stops, E D, the contact, E, is connected direct to earth, whilst D is joined to one end of the coil of the electro-magnet, A, the other end of the coil being in connection with the line and key, K, at J. The key, K, when at rest, makes contact with L, to which is connected one terminal of the telephone (or telephones, where two are used), the other telephone terminal going to earth in the usual manner. The remaining contact, M, of the key is joined to the remaining pole of the battery.

Now, in order to call the attention of the distant station, on depressing the key at M, connection is made between the battery and line, whilst the connection at L is broken, so that the telephone, T, at the sending station is now cut out altogether; but in doing this, one end of the electro-magnet coil is brought into connection with one pole of the battery, the other end being already joined to the other pole through the contact, D, and armature, B. The local circuit being thus completed through the coil of the electro-magnet, A, it now attracts the armature, B, so severing connection at D, and making it with E; but, in touching E, one side of the battery is put to earth, and as the other pole is already (by the key) connected to the line, the battery circuit will now be completed through the line and telephones at the receiving station.

It will be readily understood that, in severing the connection at D, the magnet, A, is no longer acted on by the battery; so that the armature, B, is released, a spring causing it to fly back to the contact, D; and thus, for such time as the key is depressed, a series of intermittent currents are sent through the line—these currents throwing the diaphragm of the telephone into violent vibrations, so causing a sufficiently loud sound, for ordinary purposes, to be emitted at the receiving station. This sound is far less disagreeable to the ear than the incessant clatter of an electric bell. At the same time, the whole arrangement is so simple that there is nothing at all liable to get out of order. In practice, in place of the key, K, an ordinary back contact push is used; this can either be arranged on the telephone, or separate, as thought most convenient. The call is also so made that it can be readily screwed to an ordinary battery-box. In place of the contact stop, E, the armature, in practice, is made to strike the core of the electro-magnet, which in this case is therefore joined to earth.

THE LAURENT SACCHAROMETER.

AN improved form of saccharometer called the Laurent is stated by *La Nature* to give more accurate indications than can usually be obtained. Fig. 1 represents the apparatus in longitudinal section, and the other figures give the appearance of the disc in different positions of the polariser and analyser. The illuminator, consisting of an intense yellow flame, is placed at a definite and constant distance from the instrument. B is a diaphragm containing a solution of bichromate of potash to absorb the violet and blue rays of the flame, while allowing the useful yellow rays to pass. P is a bi-refracting prism, in which the second image is diverged to one side and intercepted by diaphragms. D is a diaphragm carrying parallel to the axis a thin plate of quartz, the thickness of which is one-half wave for the yellow rays. This plate is fixed and covers only half the diaphragm. E is another diaphragm; N, the analysing Nicol; H, the objective; O, concave eye-piece. The system, O H N, is mounted on an alidade, which turns on the disc, C, around the axis, O E. T is the tube containing the solution to be tested. C is a graduated disc having one or two divisions; one especially for sugar, the other in half degrees of the circle, for any rotary substances. L is a lens for reading the scale, and M is a mirror to reflect light from the burner on the divisions, and thus obviate the use of any additional light. The new optical disposition consists in the polarising system, which is composed of two distinct parts—the bi-refracting prism, P, which turns, and the diaphragm, D, which, with its half plate of quartz, is fixed. In Fig. 2 this diaphragm is represented enlarged, as it is seen on looking into the instrument. The left half is covered by a quartz plate, the axis of which is also parallel to the line of separation, O A, and the right half being open allows of the passage without deviation of the polarised light from the polariser, P, Fig. 1. The plane of polarisation is, say, parallel to O A. If this is fixed and the analyser, N, is turned, there will be a progressive passage from total extinction to maximum illumination, and the two halves of the disc will always remain equal to each other in intensity, exactly as if the quartz plate did not exist. The plate being always fixed, let the polariser be turned so that the principal section comes at O B, making with the axis, O A, any angle, a. Let a vibration occur in the plane represented by O B. This vibration, represented in length by O B, may be decomposed into two others—one, O y, parallel to the axis, O A, of the plate, and the other, O x, perpendicular. This vibration will pass without deviation on the right side, but on the left it will be deviated by the plate. The ordinate, O y, being parallel to the axis of the quartz, will not change sign, but the abscissa, O x, which is perpendicular thereto, will change sign, and will come to O x' at 180°, since the plate is a half wave in thickness; so that at the left side the vibration resulting will occur in the plane, O B′, making with O A an angle a', symmetrical and equal to a. This plate therefore has for its object to determine at the left side a principal section, O B′, placed with relation to the line of separation, O A, symmetrically to the principal section, O B, on the right side. If the polariser is fixed in this position, and the analyser is turned so as to render the principal section, S P, perpendicular to O B, Fig. 3, there will be total extinction at the right side, but partial at the left side, as shown. Reciprocally, if the principal section, S P, of the analyser is perpendicular to O A (Fig. 4), there will be total extinction on the left and only partial on the right side. Finally, if the section, S P, be perpendicular to O A (Fig. 5) there will be partial extinction for both sides and equality of tone, since $a = a'$ is fixed in the last position, and the polariser is turned so that the principal section makes with O A angles varying from 0° to 45°, the two semi-discs will always remain relatively equal in intensity, but together will change their common intensity, passing from complete extinction to maximum illumination. In other words, if the apparatus is regulated at zero—that is the equality of tones—and if the polariser is turned, their relative intensity will not be changed, while their common one will pass through all degrees. If, however, after causing the polariser to make any angle whatever with O A, and leaving it fixed in that position, the analyser be turned over a small angle in either direction from S P, Fig. 5, then the equality of tones in the two semi-discs is at once broken, and one becomes dark and the other light. This sudden change allows of the determination, with great precision, of the position of the analyser; that is, of the zero of the instrument when no substance is interposed. If by interposing a substance possessing rotary power the equality of tones is destroyed, it is necessary to turn the analyser until this equality is re-established, and the angle over which the analyser is moved shows the rotary power of the substance.

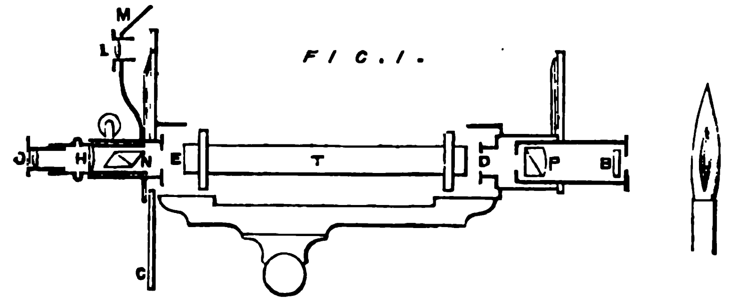


FIG. 1.

FIG. 2.

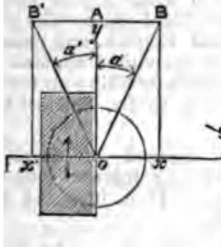


FIG. 3.

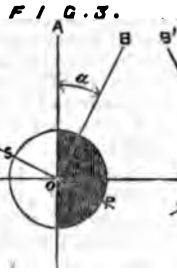


FIG. 4.

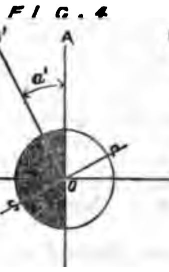
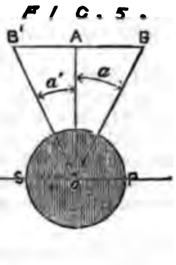


FIG. 5.



DESIGN IN STEAM MACHINERY.

ALMOST the first thing an engineer does when he sees a new steam engine is to express an opinion concerning the merits and demerits of its design. Into questions concerning its workmanship or its material he may subsequently enter. These points require a little investigation; but it is assumed that the good and bad qualities of the shapes which the maker has given to the various parts of the engine can be discovered almost in a moment. It is, perhaps, not too much to suppose that those who pronounce opinions so quickly are not very careful in their own practice; and that they in their own turn decide on the shapes and proportions of the engines which they may build without much reflection or thought. Now, although it is quite true that some men possess the power of estimating any form or detail of a machine at its proper value almost at a glance, the great mass of men do not possess it; and we venture to think that something may be gained if we can induce young men especially to refrain from jumping at conclusions concerning engines, which conclusions may really be quite erroneous. Hasty criticism of the kind to which we refer has two great defects. In the first place, it is based on no thorough or complete knowledge of the engine criticised; and, secondly, it is based on no knowledge at all of the conditions under which the design has been prepared. Before saying that any design is bad or good, very definite meanings ought to be attached to the words. For the moment we shall entirely disregard the qualities of an engine as concerns its consumption of fuel, and to simplify matters a little we shall leave on one side locomotives and marine engines, and deal with ordinary stationary engines only. Now let any one who reads this article ask himself what constitutes the difference between a good and a bad stationary engine, and when he has answered his question satisfactorily, he will be in a position to criticise the work of others, not before. If he will subsequently compare notes with any competent friends, it is possible that he may discover that his ideas of what is right and wrong and those of others do not coincide. Indeed, the ideas held by only too many engineers as to what is good and what is bad in engine design are excessively vague; and this only because they have never devoted the serious thought to the subject which it really deserves.

In order to settle what is and what is not a good engine, we may regard matters from two points of view—namely, that of the maker and that of the user. For all practical purposes, that design will be best for the maker which admits of being carried out at the smallest cost; but in the present day manual labour is more expensive than any other; therefore, if an engine is to be cheap it must admit of being made as much as possible by machinery. Let us suppose that an engineer turns out 200 horizontal engines, of 10-h.p. each, every half year. Now, if he can so contrive matters that the bed-plates of these engines can be moulded by machinery, he will gain very important advantages. Not only will the finished castings be cheaper than would be the case if they were hand-moulded, but all the work of fitting and erecting will be simplified, because all bed-plates will be alike, and an advantage will thus be gained, which engineers ought not to be slow to appreciate. It may so happen, however, that the only bed-plate which can be produced by machinery is not pretty to look at, while the metal in it is not disposed to the best advantage. Are we to condemn the design in consequence? We say, certainly not; nor should any design be condemned until all the circumstances under which it is produced are known. From the maker's point of view the design is very good indeed. Can it be bad in the user's eyes? We think not necessarily. The duty to be performed by the bed-plate of a 10 horse engine is very simple and straightforward. It will not wear out, and the only way in which it can fail is by direct fracture. But such bed-plates seldom or never break; and the difference between one design which may be called good, and another design which may be called bad, is as a rule in this respect simply nothing. Before, therefore, we condemn or praise a bed-plate, for example, we ought to have some good grounds either for praise or blame. We may say that it is ugly; but that is very much, as matters stand, a question of taste, and one purchaser will see nothing but deformity where another finds only beauties. Still the presence or absence of graceful curves and lines are not sufficient grounds on which to say that an engine bed-plate is well designed or the reverse, even from the user's point of view; while from the maker's the machine-moulded bed must be the best, no matter, within reasonable limits, what its form. It may here be urged that it is easy to see almost at a glance whether the materials of which an engine is made are well disposed to resist strains. This is not quite true; but, even if it were, it does not follow that that is the best design in which the metal is disposed to the best advantage. If, for example, the thickening of the metal in one place and its reduction in another entailed difficulties in moulding or casting it would be better to put in a little more metal and sacrifice mechanical propriety. A case in point suggests itself. Several bed-plates were required for some machinery which had nothing, it is true, to do with steam power—but this does not affect the question. These plates were carefully designed, thick in some places, thin in others, the metal being beautifully distributed to take the strains to the most advantage! Not one of these bed-plates could be cast without warping and twisting, owing to causes which will be easily understood, and so, at last, the patterns had to be altered, and the design, in a way, spoiled. The skill of the engineer is shown not in doing what is right, in one sense, but in doing that which is the best in all senses within the limiting conditions; and in estimating the value of any design this fact should never for a moment be forgotten.

Nothing is more common than to hear an engine condemned in the most unreasoning terms because it does not happen to accord in all respects with the tastes or prejudices of the critic. How often are those criticisms borne out? Let us take for example the beam engine. Very few engineers build beam engines now-a-days. When they say that such engines are too expensive, they give an excellent and legitimate reason for not building them; but when they go on to add that they are not so good as horizontal engines, we may ask, without expressing any opinion, on what ground they make the statement? If we had anything to do with the question of economy of fuel, which just now we are not considering at all, we might say that beam engines can be made to burn as little coal per horse-power as any other form of steam machinery. Do beam engines break down, or wear out more quickly than horizontal engines? There are numbers of beam engines all over the kingdom, which have worked more or less night and day for fifty years, and which are working still and working well. There is still a 20-horse power beam engine working, when we indicated it a few years ago, to above 39-horse power, which was put up at Messrs. Frost's rope works by Boulton and Watt in 1819. The side lever engines which drive the City Flour Mills once hauled trains with a rope on the Blackwall Railway. At Soho there was a beam engine some time since which was constantly at work for over forty years. At the Sun Foundry, Leeds, there is a beam engine still running, so old that its history has been all but forgotten. Where, we may ask, can anything like these examples, a few out of hundreds, be shown in favour of horizontal engines?

There are only two grounds on which a design should be condemned; first, that the parts or the whole of the machine may fail to do that which they are intended to do, either almost immediately, or at some not very distant time; and, secondly, because the engine costs more money than it should cost. There is a third reason for condemning or praising an engine—namely, its beauty or ugliness; but into this question we shall not enter. Now, if it appears that slide blocks are too short, guide bars too narrow, journals not long enough, or frames too thin, we have a right to express our condemnation; but have we a right to say as the result of a hasty glance that these defects exist? We once heard an engine, which was exhibited, severely condemned, because of the excessive lightness of certain details. But it turned out on examination that these were made of steel instead of iron, and the condemnation was unfair. Criticism is the very salt of the earth, but unless it is judicious it is worse than worthless; and it is impossible that it can be judicious unless, as we have said, it is based on an intelligent perception of the causes which have produced the design criticised. We may conclude by adding that, as a rule, there is little or nothing to choose between the engines of any half-dozen good builders, no matter how diverse the designs of their engines may be. Nay more, we find that from time to time changes are introduced into the practice of various firms, and that they build no more the engines they built once. Can it be assumed that the change always represents any real improvement in the sense that the new type of engine will use less oil or cost less for repairs than the old one? This, after all, is—leaving fuel out of the question—the true test of excellence; and that engine is best, no matter what its design, which is most often ready to perform its duties, least clamorous in its demands for repairs, least thirsty for oil, and cheapest to buy. Such engines will give satisfaction to the purchaser; and if the maker can turn them out cheaply by sacrificing some theoretical excellences, he may still set critics at defiance, make a fortune, and please his customers.—*The Engineer.*

Resistance of Mercury to the Current.—An elaborate paper by H. J. Rink, on the alteration caused by changes of temperature in the resistance offered by mercury to the passage of the galvanic current, has recently been laid before the Dutch Academy of Sciences. The co-efficients found hitherto range between 0·00086 and 0·00104. The author has, it is said, made experiments with seven tubes of mercury, each a metre in length, and after making all corrections for expansion of glass, &c., obtained the number 0·000989 as the co-efficient for the change in the resistance corresponding to an alteration of a degree C. He finds that the resistance increases in a more rapid ratio than the temperature.

Turpentine as a Tænicide.—Dr. Leared, after many experiments, concludes that turpentine is the most effectual tænicide we possess. He relates a case where kamala, male fern, and kousso failed utterly. Ultimately he prescribed the following:—Sp. terebinth., 3 drachms; tinc. hyoscyami, ½ drachm; mucil. acaciæ, ½ drachm; aq. chlorof. ad., 2oz. The draught was taken on an empty stomach, soon after the bowels were opened, and a worm with its head was expelled. It proved to be a tænia medio-cannellata. It is necessary to be cautious in giving turpentine. All inconveniences, however, are guarded against by the administration of a brisk purge if the turpentine does not speedily act on the bowels.

Whitworth Scholars.—The names of the successful scholars in the 1878 scholarship competition are:—T. Mather, 21, pattern-maker, Preston, with 1,112 (T) and 662 (P) marks—total, 1,774; W. Groves, 20, mechanical engineer, Crewe, with 976 (T) and 780 (P) marks—total, 1,756; W. H. Tozer, 21, engine fitter, Exeter, 803 (T) and 950 (P) marks—total, 1,753; Z. H. Kingdon, 21, mechanical engineer, Manchester, 951 (T) and 751 (P) marks—total, 1,702; T. Duckworth, 21, marine engineer, Liverpool, 1,372 (T) and 269 (P) marks—total, 1,641; J. E. Needham, 21, pattern-maker, Oldham, 1,292 (T) and 101 (P) marks—total, 1,393. The final competition of the 1875 scholars resulted as follows:—Joseph Harrison, 3,230½ (1876), 2,717 (1877), 3,177 (1878)—total, 9,130½—first prize, £200; Joseph Poole, 3,527½ (1876), 1,517 (1877), 1,766 (1878)—total, 6,810½—second prize, £100; Franklin Garside, 2,712 (1876), 1,866 (1877), 1,634 (1878)—total, 6,212; Frank W. Dick, 2,465 (1876), 1,882 (1877), 1,828 (1878)—total, 6,175; George Goodwin, 2,744 (1876), 1,873 (1877), 1,502 (1878)—total, 6,119; John Alldred, 1,934½ (1876), 1,739 (1877), 1,132 (1878)—total, 4,805½.

SCIENTIFIC NEWS.

Next week the scientific congress commences at Dublin on August 14, and the following week will witness the meeting of the French savants at Paris. To a certain extent the French Association meeting clashes with that of the British Association, which is expected to be a quiet gathering, though several distinguished strangers will be present en route to Paris and the exhibition. The following is a list of the principal officers of the forty-eighth annual meeting of the British Association:—President elect—W. Spottiswoode, LL.D., F.R.S. Vice-presidents elect—Right Hon. the Lord Mayor of Dublin, the Provost of Trinity College, Dublin, the Duke of Abercorn, K.G., Right Hon. the Earl of Enniskillen, D.C.L., F.R.S. Right Hon. the Earl of Rosse, D.C.L., F.R.S., Right Hon. Lord O'Hagan, M.R.I.A., Prof. G. G. Stokes, D.C.L., LL.D., Sec. R.S. The following are the presidents of sections:—A.—Mathematical and Physical Science.—President: the Rev. Prof. Salmon, D.D., D.C.L., F.R.S. B.—Chemical Science.—President: Prof. Maxwell Simpson, M.D., F.R.S. C.—Geology.—President: John Evans, D.C.L., F.R.S. D.—Biology.—President: Prof. W. H. Flower, F.R.S. Department of Zoology and Botany: Prof. W. H. Flower, F.R.S. (president), will preside. Department of Anthropology: Prof. Huxley, Sec.R.S. (vice-president), will preside. Department of Anatomy and Physiology: R. M'Donnell, M.D., F.R.S. (vice-president), will preside. E.—Geography.—President.—Prof. Sir Wyville Thomson, LL.D., F.R.S.L. & E. F.—Economic Science and Statistics.—President: Prof. J. K. Ingram, LL.D. G.—Mechanical Science.—President: Edward Easton, C.E. The first general meeting will be held on Wednesday, August 14, at 8 p.m., when Prof. Allen Thomson, M.D., LL.D., F.R.S.L. & E., will resign the chair, and William Spottiswoode, M.A., LL.D., F.R.S., F.R.A.S., F.R.G.S., president elect, will assume the presidency, and deliver an address. On Thursday evening, August 15, at 8 p.m., a soirée; on Friday evening, August 16, at 8 p.m., a discourse by G. J. Romanes, F.L.S., on "Animal Intelligence;" on Monday evening, August 19, at 8.30 p.m., a discourse by Prof. Dewar, F.R.S., on "Dissociation, or Modern Ideas of Chemical Action;" on Tuesday evening, August 20th, at 8 p.m., a soirée; on Wednesday, August 21, the concluding general meeting will be held at 2.30 p.m. Excursions to places of interest in the neighbourhood of Dublin will be made on Thursday, August 22. The German Association meets at Cassel on Sept. 18.

Tempel's periodical comet was observed at the Oxford University Observatory by Mr. W. E. Plummer, on the 27th and 28th July. The apparent R.A. on the 28th of July was 15h. 27m. 25·91s., and the apparent N.P.D. 97° 55′ 49·1″.

Dr. W. H. Stone, in a letter to the *Academy*, gives an interesting account of the results of some experiments he made with Scheibler's tonometer at Her Majesty's Theatre in the Haymarket. He took ten forks from the tonometer, representing pitches of C from 512 up to 548 vibrations, each differing by 4 vibrations. The overture ("Martha") opened to an average C of 520, but some of the wind instruments were far below, especially the first horn. The band rose during the instrumental prelude to 524, but as soon as the voices joined in a distinctly downward tendency was noticeable. The "sceriffo," in reading the warrant, managed to bring C down to 508 vibrations, the only point at which an unassisted ear would probably have noticed the flattening. From his experiments Dr. Stone finds that two points stand out prominently:—1. The antagonistic and compensatory action of cultivated voices and experienced orchestral players, and the great fixity of the vocal intonation. 2. The comparatively near approach to French pitch actually attained. Taking 435·9 as the number for A, or the Diapason Normal (Cavaillé-Coll made it 435·875), C in equal temperament would be = 518·35, which is not far from 520, the predominant pitch of the evening during exceptionally high temperature. This is far nearer to the intended pitch than it was a year or two ago.

The final competition of Whitworth Scholars appointed in 1875 has resulted in the award of the prize of £200 to Mr. Joseph Harrison for 9,130½ marks; Mr. Joseph Poole, the winner of the second prize (£100), obtained 6,810½ marks.

It shows how useless it is to call attention to irregularities in the method of rendering the accounts of Government departments, when Lord G. Hamilton, in response to Mr. Errington's complaint that £15,000 had been spent for purposes not mentioned in the estimate, was enabled to satisfy the House by saying that the sum had been spent for the purposes of an authorised exhibition. We want to know what were the items of that expenditure. Mr. Errington is reported as speaking of "manipulated accounts." What is the exact meaning of the phrase?

Baron von Rokitansky, the president of the Vienna Academy of Sciences, died on July 23, in his 75th year. To the researches of this distinguished member of the medical profession is mainly due the perfection of modern diagnosis.

Grosvenor House will be open daily, including Sundays, during August and September, from 2 p.m. to 6 p.m. Tickets of admission can be obtained from the secretary of the Society of Arts in exchange for a paper containing the names, addresses, and occupations of the party (not exceeding four for each ticket), who must be either designers, artisans, or otherwise employed in any branch of art applied to productive industry.

The "artisan reporter" movement is making good progress, and Paris will be invaded by a small army of intelligent British workmen in detachments. Some of the men have already gone, and others are preparing to start. Many leading firms are sending over their men privately, so that we may rest assured notes will be made of everything of value in the Exhibition.

Drs. Magnus and Pechuël-Loesche, of the Ethnological Museum, Leipsic, have sent round a question circular, with the view of obtaining data as to what degree the colour sense exists in uncivilised tribes. The questions are in German and English, and consuls and others residing in uncivilised regions will do good service by carefully filling up the papers, and returning them to Dr. Pechuël-Loesche, Leipsic.

Prof. Tait is engaged in developing a machine for producing intense sounds with economy of power. It is intended for fog-signalling purposes.

The system of lighting lamps by electricity, which was tried recently in Pall Mall, is said to be a failure, and the local authorities have ordered the removal of the apparatus.

The British Museum has purchased the collection of remains of "pigmy elephants" found in the caves and fissures of Malta. The collection was made by Admiral Spratt and Dr. Leith Adams.

Messrs. Mitchell and Peacock are engaged on a scheme for supplying the towns and villages of the Midland colliery districts with pure water. Many millions of tons have now to be pumped out of the workings of the coal-mines, and it is surmised that if the water supply of the district were taken from the sources of the mine-water, the inhabitants would have a purer water, and there would not be so much to pump out of the mines.

At the Paris Exhibition, experiments have been made with the telephone in combination with a phonograph. The telephone was placed in front of the reproducing drum of the phonograph, and the message imprinted on the foil was transmitted by the telephone to Versailles.

A new line of observation with regard to the transmission of excitation in nerves has recently been struck out by M. Chauveau, who has experimented on large mammals, as horses and asses. The nerves in such animals present an important advantage for the experimenter in their great length. M. Chauveau, from experiments on frogs, found the mean velocity of propagation about 21 metres per second. The neumogastric nerve in the large animals howed considerable differences in rate of pro-agation, both in different parts of the nerve nd in different animals. Thus, in one animal n ass) it was variously 68m., 51m., and 66·5m. er second in the pneumogastric nerve, the so-lled recurrent (a branch of the pneumo-astric), and the intermediate section respec-vely. The law was established that *the excita-ons travel less quickly as they advance towards he termination of the nerve* in the muscle. The ctivity of conduction seems to decrease from he origin to the termination of nerves. In *ost mortem* experiments this law appears to be eversed. Taking the middle portion of nerves, he velocity of propagation is sensibly the same n animals placed in the same physiological con-litions; it is about 65m. per second—*i.e.*, three imes greater than in the motor nerves of the rog. It may rise to 75m. in energetic sub-ects, of good breed and in good health, and may sink below 40m. in common and weak ubjects.

The fact that a good hen will lay annually 120 to 150 eggs, while it can only hatch 30 or 2 of them, has led to many attempts at arti-icial hatching. According to MM. Grünhaldt, of berlösnitz-Radebeul, near Dresden, the reason f the indifferent success of most of these fforts has been that while they have variously imed at producing and regulating the required eat, they have not had regard to the mode of ommunication of this heat. In natural hatch-ng the heat is transferred to the egg from above y close contact of the hen's body, and this is equired by the structure of the egg, in which he germinal vesicle always floats at top, what-ver the position of the egg. In view of this Cantelo (in England) has successfully hatched ggs by means of glass plates put over them, and bathed with warm water. A further step is that of Baumeyer, who replaces the plates with tubes, through which warm water of 40° C. circulates. MM. Grünhaldt have worked on this system for several years, and variously improved it. They supply a small hatching apparatus, consisting of a small elegant chest for 72 eggs. It is heated with a smokeless petroleum lamp, and is furnished with an automatic regulator of heat, so that personal attendance is reduced to a minimum of 5 to 15 minutes daily. The price, without artificial mother, is about £7, with artificial mother £10.

In a prison at Chairvaux (we learn from the *Pharm. Ztg.*) no fewer than 84 prisoners were lately taken ill after drinking milk, into which one of them, by way of malicious joke, had poured a large quantity of commercial sulphate of zinc (which substance was a good deal used in the place). Chemical examination afterwards made it probable that at least 2 grm. of the sulphate had been mixed with each litre of the milk; yet not one of those poisoned noticed an unpleasant taste in the milk. It is interesting to note that the illnesses fell into two groups, as 24 of the prisoners, occupied outside the prison, drank their milk portion several hours later than the 60 others. Both groups of prisoners took ill exactly 15 hours after ingestion of the poison, and presented exactly the same phenomena of copper poisoning. The local phenomena were chiefly severe stomach ache, tenesmus, and diarrhœa. These were accompanied with intense headache, pains in the calves, and great bodily weakness. Vomiting was merely exceptional, and this is attributed to the fact that the sulphate of zinc did not act as such (or hardly at all), but only after it had entered into combination with the caseine of the milk, as caseate of milk. To this is also due, no doubt, the lateness of the phenomena. None of the poisoned persons died; with gentle and careful treatment they all recovered in two or three days. The case shows, among other things, that sulphate of zinc is not (any more than sulphate of copper) always eliminated by vomiting.

A field for cultivation of nettles was arranged at Stralau, near Berlin, last year, and yielded in autumn very branching stems 3ft. to 4ft. in height. Dr. Grothe reports that this year the nettles have been growing vigorously. The plants are everywhere dense, and stems, mostly without branching, have already risen to four, and in many cases five or more feet. The field has not been manured or weeded; but the nettles have suppressed all weeds, with exception of a few species of compositæ. The prediction that the nettles would spread to neighbouring fields has not been fulfilled. The whole field is now in blossom, and a decisive experiment will be made, whether the nettles may be cut down in this period, so as to obtain the fibres in greater whiteness and fineness. Should this be the case (as with nettle culture in China, Java, and India) it will likely be possible to reap the nettles at least twice, doubling the yield, and improving the crop, by more abundant formation of seed. The common *Urtica dioica* stands winter well. Of the foreign nettles tried, only *Laportea pustulata* has survived the winter, but it has not grown very vigorously. It will probably take a little time to acclimatise.

In Cochin China (our readers are doubtless aware), the French troops have suffered greatly from a form of diarrhœa, which is now known to be caused by entrance of small animalcula into the alimentary canal; these have organs of suction and prehension, and fix on the mucous surface (somewhat like leeches), causing an iriritation which is manifested as dysentery. An interesting paper on the subject and dysentery in general by Dr. Dounon, appears in the *Moniteur Scientifique* for July. There are seven varieties of the Cochin China diarrhœa, and it certainly arises from the rivers and marshes, the active principle being conveyed into the body in drinking the water. The Chinese and Annamites are free of it, because they always drink either tea or water purified with alum. Dr. Dounon recommends, as a remedy, the more simple method of boiling the water, as this at once destroys the germs and animals. He thinks it very probable that various other forms of dysentery in other countries are of parasitic origin, and to be prevented by the same means.

The Persians are known to be greatly skilled in the art of dyeing the hair. They chiefly use the plant called Henna. Dr. Tholozan, physician to the Shah, gives the following information about this practice:—Hot water is added to a coarse powder of the leaves, and the paste is applied to the beard, the hair, and the nails (well washed previously). This is done in a vapour bath. As the paste has to be kept constantly moist, this first application lasts an hour and a half to two hours, then the parts are washed with plenty of water. The henna gives an orange red colour, very beautiful on a white beard, so that many old men use it; but recently, with great personages, it has become more common to keep the beard white. Henna is very largely used, even by peasants. To change the reddish colour into a fine lustrous black, the parts are coated, at the same sitting, with a paste formed of another powder—that from the leaves of a kind of indigo tree cultivated in Persia. This is called Reng; it remains applied about two hours. The henna gives different colours according as it acts on white, fair, or dark hair. It alters very quickly in moisture, and loses its properties in long sea-voyages. Experience seems to have proved that it gives suppleness to hair, but it causes it to whiten much sooner than usual. Fair-haired people always colour their hair black, but the black is not so intense as that produced in persons of dark complexion. Skin, reddened and blackened with the two pastes, soon regains its natural colour on being washed with soap and rubbed with the fingers, whereas the dye adheres firmly to the hair, which it penetrates. Reng is sometimes used alone, and gives a blue violet colour.

A committee of the Russian artillery was recently charged to inquire as to the advisability of using cupro-manganese for manufacture of cannon. They pronounce against it, on the ground of the metal not being sufficiently ductile (as proved by the experiments of Lacroff and Küntzel, some years ago). But they consider that alloys, binary of copper and manganese, and ternary of copper, tin, and manganese, have the property of well-filling the moulds in casting, giving very slight liquation, and very sound ingots; hence, they think them suited for the casting of some pieces other than cannon.

LETTERS TO THE EDITOR

[We do not hold ourselves responsible for the opinions of our correspondents. The Editor respectfully requests that all communications should be drawn up as briefly as possible.]

All communications should be addressed to the Editor of the English Mechanic, 31, *Tavistock-street, Covent-garden,* W.C.

All Cheques and Post-office Orders to be made Payable to J. Passmore Edwards.

*** *In order to facilitate reference, Correspondents, when speaking of any Letter previously inserted, will oblige by mentioning the number of the Letter, as well as the page on which it appears.*

"I would have everyone write what he knows, and as much as he knows, but no more; and that not in this only, but in all other subjects: For such a person may have some particular knowledge and experience of the nature of such a person or such a fountain, that as to other things, knows no more than what everybody does, and yet, to keep a clutter with this little pittance of his, will undertake to write the whole body of physicks: a vice from whence great inconveniences derive their original." —*Montaigne's Essays.*

HARVEST MOON.

[14682.]—"F. R. A. S.," at p. 469, gives in reply to query 33395, the method of ascertaining the proper time of the harvest moon; the well-known phenomenon of which is, that the time of rising of the full moon, about 6 p.m., at this season varies but little for several evenings, the rapid increase of its northern declination compensating for the orbital motion to the eastward. The phenomenon of the moon's rising for several days, with little variation, occurs, however, in each lunation. In autumn it is at full moon, and therefore more apparent; in spring, at new moon, and at intermediate lunations at relatively different ages of the moon, and at different hours of the day or night. The setting of the moon is also affected in a similar manner, but not to so marked an extent. I do not remember to have seen the above noticed in any astronomical treatise.

Scientific Club, August 2. R. J. Lecky.

THE SATELLITES OF MARS.

[14683.]—In reading this morning Lecomte's "Empire of China," I was startled by the following passage:—"I cannot, sir, finish this discourse, before I have spoken of some observations we have made of the satellites. These are so many little planets that belong to the train of bigger ones which were detected in our age. They continually turn about Saturn, Jupiter, Mars, &c."

Lecomte was a Jesuit missionary, as many of your readers know, who spent 10 years in China about the end of the sixteenth century. My edition of his book bears date, London, 1737, and the passage above quoted is found on pp. 502 and 503.

Is it not just possible that the great astronomers of the sixteenth century really did see one or both of the newly discovered satellites?

Leeds, July 28. J. Symes.

CLUBBING IN THE BRASSICÆ.

[14684.]—The substance of my letter, on p. 498, is taken verb. et lit (bar printer's mistakes) from *Nature* of July 11, where it appears as an abstract by Mr. E. P. Wright of M. Woronin's paper. Perhaps it is a commentary with an enumeration of the facts. But quotation marks were unnecessary, because it will be noted it reads: The memoir, says Mr. Wright. The paper was read on the 5th of March, 1874. "G. J. H." will see that his never having found a club without larvæ being in it is only negative evidence, and, I venture to think, scarcely upsets the fact that I have found many clubs without the ghost of an insect being visible, unless, indeed, it was a microscopical ghost. Numerous observers have had a similar experience to mine, though they have also found clubs with different kinds of insects in them. Writing some years ago the Rev. M. J. Berkeley stated that "the main root is mostly affected, but the disease sometimes affects the laterals" (a fact corroborated by M. Woronin). The disease, says Mr. Berkeley, is local, or, where not local, capricious, and probably depends upon peculiar chemical conditions of the soil. I should like to ask "G. J. H." if he has ever found the larvæ he mentions in the stalks of brassicæ, and in the midribs of the leaves, for I have found them in those positions, and concluded that they preferred clubs when they could get them, because, according to Mr. Berkeley, many of the cells of the clubs are "gorged with highly nitrogenous matter." The fact that soot, wood ashes, nitrate of soda, and ammoniacal manures will generally prevent clubbing, does not help us to a solution, because, if it be claimed that these warn off the "fly" or insect, it must be acknowledged that they may also present rather too warm a bed for the Plasmidiophora brassicæ. Will Mr. W. G. Smith kindly turn a little light on this subject?

Saul Rymea.

THE ELECTRO-MAGNET A RECEIVING TELEPHONE.

[14685.]—The result I have arrived at while experimenting in this direction seems so interesting, and at the same time, I believe, novel—viz., *that a good receiving telephone can be made from electro-magnets alone, without any vibrating diaphragm*—that I hope, by prior publication, to prevent the possibility of a string of those patents which nowadays so greatly hinder true scientific invention. In my early experiments I made an electro-magnet out of a piece of ¾in. iron gas-pipe ¾in. long, filed flat on one side, and split sufficiently only to allow the wire (No. 24) to be wound on, which was done till it was full inside. The poles were, therefore, together about ¾in. square. This was fixed inside a small cigar box, under a ferrotype plate, covering a rectangular hole cut in the lid 2⅛in. by 1⅛in. With a Hughes carbon pencil microphone tilted to an angle of 45° as transmitter; a small musical-box as source of sound, bath in a distant part of the house, and one Léclanché cell in circuit, this box gave out the tunes, plainly heard by all sitting int he room.

A similar magnet was next made of the same ¾in. pipe, but 3in. long, wound longitudinally with covered wire till full inside. The poles were together, 3in. long by about ⅜in. wide, with a long narrow slit only dividing them. This was placed across the under side of the lid of a cigar box, having an equilateral triangular hole cut in it, and a diaphragm of tinplate covering it well fastened down. This arrangement gave out very curious effects in the musical way. With a watch placed on the base of a vertical microphone on a table near by, the ticks were at first heard loudly, then a low note commenced which became loud and clear, and changed through thirds and fifths of the scale to the octave, and so on up to second octave, dying out, and commencing as before. On removing the watch the song stopped instantly. I traced the primary cause of this to vibrations in the wire from the microphone, but think that, to the shape of the diaphragm, and to the long magnet acting from the narrow to the wide end of the triangle, must be attributed the great range of notes produced.

Whilst experimenting with another similar magnet, I stood it loose, poles downwards, but still connected with the line wires, on a flat tin gunpowder canister with the ends cut off, but still retaining the paper label on which the magnet lay; the tune of the musical box was given out loudly and resonant, but buzzing and jangling; also words spoken to the transmitter were heard, but confused together.

Now this was a very interesting result, which led to the next discovery; for having a small ordinary electro-magnet with its armature in front (as used in electric bells) fixed to a piece of board, I was about to unship it to try experiments on various tin cans, &c., when it occurred to me to connect it, as it was, to the line wires, placing only a slip of paper between the poles and armature to prevent actual contact. To my astonishment, on putting the ear close to the board at any part, the music of the box was heard clearly, every note from highest to lowest being heard distinctly. Now here seemed to be a telephone without a vibrating diaphragm; but to make more sure, the armature was unscrewed from its support and attached to the magnet only by an indiarubber band, with the slip of paper between it and the poles, and so that it touched no other part of the apparatus. On listening to the supporting board, the sounds were still heard as distinctly as before.

But even here forensic ingenuity might claim and attempt to prove that this ordinary armature was a vibrating diaphragm; therefore, an armature being itself nothing but an induced magnet, it was replaced by another electro-magnet, thus:—

Two ordinary electro-magnets (unscrewed from a couple of large electric bells) were fastened, by means of two little wooden saddles and a screw each, to a small piece of deal board about 4⅛in. square and ⅝in. thick, in such a way that the poles were all but touching. Their wires were then joined, so that poles of opposite denominations faced each other—*i.e.*, north opposite south, and *vice versâ*. This, placed on an empty cigar-box and four Léclanché cells in circuit, gave out the tune of the musical-box clearly and loudly into the room.

When both poles were made to touch, the sound ceased, but with a thin piece of paper or stout tinfoil only between them, without any intervening air space, the sound was heard. On gradually separating the magnets the sounds grew fainter and fainter till they became inaudible.

By putting the base-board close to the ear, whistling and singing to the microphone were very clearly and loudly heard, also the voice of the person speaking recognised; but the words hardly sufficiently defined to distinguish all that was said, though now and then parts were intelligible.

By varying the strength of battery, size, or mode of mounting the magnets, or adjustment of the microphone, I have no doubt that perfect definition *can be obtained*. The loudness and volume of sound *are ample, but before making further experiments*, for which I have at present but little time, I hasten to communicate the fact that *the electro-magnet, without any diaphragm whatever*, can be made a reproducer of sounds transmitted by a Hughes microphone, and thus a *complete and practical telephone system produced without the possibility of infringing anybody's patent*.

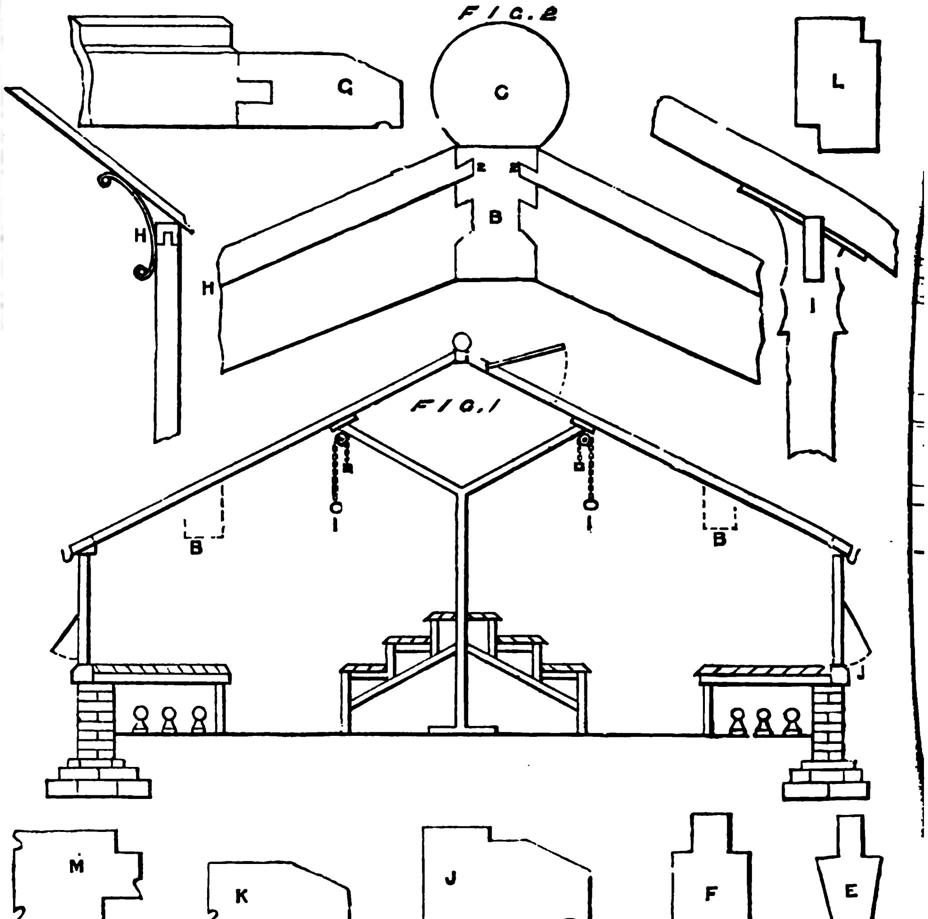
I must add that the same arrangement is also a feeble transmitter, using a good Bell telephone as receiver—which is a very strange fact. I abstain at present from all theory on the subject.

F. G. Lloyd.

Millfield-lane, Highgate, August 5.

HOW TO BUILD A GREENHOUSE.

[14686].—I noticed a few weeks ago a query as to the building of a greenhouse, and seeing what I take to be very good directions in the *Journal of Horticulture*, written by Mr. Edward Luckhurst, I venture to send them for the benefit of your readers, as this is just the time of the year to build. The greenhouse is of the span-roof form about 20ft. wide—a shape that does not find much favour with small amateur growers, who generally prefer to utilise a wall by having a lean-to house. The following are the details:—



The Roof.—This is only 5 feet high at the eaves, and 10 feet at the apex. It consists simply of fixed rafters morticed into a ridge-board at top, and an eave-board at bottom. The width of the ridge-board (B, Fig. 2) depends upon that of the sashbars. Two inches will be thick enough for the house we are treating of. C, Fig. 3, represents the beading fastened by screws or nails to the top of the ridge-board, to preserve it from the action of the weather as well as to impart finish to building. Fig. 4 also shows how the sashbars are morticed into the ridge-board, and how a groove, 2, 2, for the glass is ploughed in the ridge-board above each tenon. In glazing, especial care must be taken to thrust the glass to the top of these grooves, so as to make the ridge weather-proof. The size of the sashbars is determined by their length and whether it is intended to strengthen the roof with stays or pillars with supports as shown in Fig. 1. A bar of the form shown by E, 2⅛ inches by ⅞ at its widest part, answers very well, with every fifth bar like the section F, in size 3¾ inches by 2. When interior supports are not used the bars should be 3 inches by 1¾, with every eighth bar 3⅛ inches by 3. I have given all these bars a thorough trial and can recommend them. The eave-board (G) should be 4 inches by [illegible] and with a small semicircular groove to prevent any moisture creeping into the house under the eaves, as will happen without the groove. In exposed windy situations additional strength may readily be imparted by bolting a few iron braces to the angles of the building at any convenient point, as shown by H. Pieces of bar iron bent to the required angle, flattened, and holes pierced at the ends by a blacksmith, answer admirably, and are neat enough in appearance when painted. To those who prefer the usual plan of side pillars, I will be useful, as showing a longitudinal sectional portion of such a pillar, with a slot cast in the top to admit a flat iron bar on edge, running along under the roof from end to end, and forming a capital support, so light as to make no appreciable shade, and yet very strong; in size it is 3 inches by half an inch. The brackets for hanging shelves in Fig. 1, B, B, are objectionable as spoiling the appearance of the interior; but such shelves are so useful that I have shown where they should be placed for the guidance of those who are compelled to use them.

The roof support shown in Fig. 1 is novel, but Mr. Luckhurst thinks it preferable to the ordinary style. It consists of central pillars with arms, as shown, the pillars being placed about 9ft. apart. The hanging baskets, 1, 1, are suspended by chains with counterpoise weights, which enables them to be lowered at will for watering and inspection.

The Sides.—Here the sashbars are similar to those in the roof, the only difference being in the large size, which, as they help to support the roof, are 3 inches by 3. They are morticed into the wall-plate, J, which is about 6 inches by 2½ or 3, as may prove most suitable, and into an eave plate, K, 4 inches by 2¼. The angle pieces for the corners of the building, L, are 4¼ inches by 3, and have rebates for glazing and for ventilators to shut into. When side ventilators are introduced, as in Fig. 1, they consist simply of a frame 2¼ inches by 1½, grooved for the glass, with sashbars morticed into the frame, and are suspended by hinges to a fixed bar 2½ inches by 1½, into the upper side of which the top side fixed sashbars are morticed. Although mention is made of side ventilators, it is by no means intended to imply that they are an indispensable necessity, for if the roof ventilation be put through, side ventilation is not wanted, and fixed sides point of course to a considerable saving. Let, therefore, the roof ventilators run from end to end of the roof, and consist of a clear space of quite 2 feet in width so as to admit so large a volume of air as to insure a brisk and thorough circulation. Avoid a cheap opening apparatus: let it be strong, and yet so [illegible] that a ɑay set it in motion. The best principle is a spiral shaft and stout-jointed levers ɐh the ventilators may be regulated to a The brickwork of the sides and ends consists ɔourses above ground and six courses below, ʳe of the footings. The walls are 9 inches ɪnd the footings are respectively 13½, 18, and, hes, so that a yard in length of wall and foot- ill require 112 bricks, and to make enough for five hundred bricks it requires three of new grey lime and eighteen bushels of

ɫoors should be 1½ inch in thickness, and the ɪts 4 inches by 3, with rebates and beading ʳn by M; one for door, the other for glass. ɪtral stage has upright supports 2 inches by 2, ɔ braces are 3 inches by 2. The strips form- s shelves are 2 inches by 1, with half-inch between every two strips. The woodwork of ɔ stages is of the same size. glass for the roof to be 21oz. seconds; size res, 20 inches by 12; and for the sides and ɔz. answers very well. The hot-water pipes inch, and slightly elevated above the floor on ɪnds, as shown.

ɪte Mr. Luckhurst almost verbatim, but your will have no difficulty in making modifica- For instance, instead of the pillars with ɪg arms, many would prefer to use simple s, and tie the main rafters together across se by iron rods, merely stepping them into ɜs board instead of morticing. The wall, too, vith advantage be made of concrete where the ɪls are handy. I should be glad to read sug- ɜ for alterations, and any other information ɑ be given on the subject.

H. Stebbings.

ːRING WORK FOR THE LATHE.

ɪ7.]—In the English Mechanic for June 7, present volume, is an article upon accurate ː; again on p. 333 is described and clearly ɐd a new and elaborate apparatus made by ɑ for centring work for the lathe.

FIG. 1

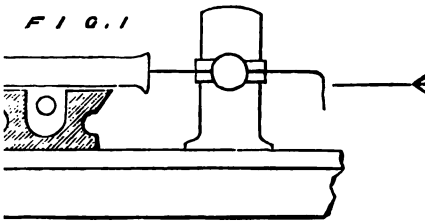


FIG. 4

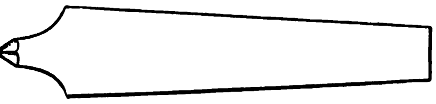


FIG. 2

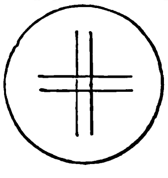
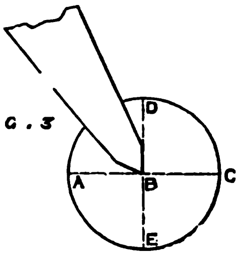


FIG. 3



ɘ mechanical readers of "ours" are just now ɜ upon lathe matters, and centring methods ɪ our minds, I think the few remarks I pur- aking will just now be comparable with ethods, and assist towards the arrival at a nion of the value of each method, in a manner disjointed series at distant times could do, contribute towards a thoroughness of treat- f this subject similar to that which I hope athe treadles receive now they are in the ɪf "D. H. G.," whose further contributions wait with eagerness.

ʳriter on p. 309 remarks, "I have seen boys rk to the vice, drive a centre punch into it, ɔ the lathe, chalk the full sides, take it back vice, draw the centres, and try again." I to think this tedious changing of the cen- ch mark and alternate trying in the lathe ɪave been avoided by following a methodical n making the first centre punch mark. I fully describing two simple methods of find- centre for drilling—viz., with the scribing nd by measurement with the eye, also the of correcting either with the square centre; if carefully marked with the scribing block, ɐ centre cannot improve it. I think these nethods will be sufficient for all ordinary nd the scribing block in the hands of a ɐ will centre some most extraordinary jobs. thod chosen will depend principally upon the he work. If you wish to centre a rod 1in. ster, first see that it is straight to the eye, ɜ the ends have a tolerably smooth surface niddle; if from the forge they will be good but if it has been cut cold and broken, a few ith a round-faced hammer will set down the ɪd produce a small surface in the middle of good enough to scribe upon. Now for ɐ you may lay the rod across the slide-rest, ɪ the irregular burrs from the chisel to project, but not more than shown in Fig. 1. Now set the scriber to come a little above or below the assumed centre, make a horizontal scratch across the end of rod, by sliding the scribing block on the lathe bed, then turn the rod a quarter of a turn—*i.e.*, till the first scratch is vertical. Scratch again horizontally, and so proceed till you have four lines on the end of the rod, as in Fig. 2. Now, as these lines are all marked the same distance from that part of the rod that rested upon the rest, it is evident they will all be equally distant from the centre, and if a hole be drilled in the centre of the little square (see Fig. 2), it will be truly centred. When the rod is fixed end-up in the vice, look obliquely at the end you intend centre-punching until you see the scribing lines at the same time as your centre-punch is held uprightly over the little square, and from such a position that two of the scratches appear as lines running away from you. Now adjust your centre-punch so that it appears an equal distance from either the right or the left scratch. If these scratches are from 1-16th to 1-8th of an inch apart this can be done with all the exactness desirable; but the idea of the distance of centre-punch from the front or back scratch will be very indifferent; therefore, before striking the centre-punch, shift your eyes a quarter way round so that the other two scratches appear as lines running away from you. Then again adjust the centre-punch sideways between what were in the first view front and back lines, carefully avoiding any motion of the centre-punch towards or away from you, as it would evidently disturb the first adjustment. When adjusting the punch the hand may be conveniently steadied by resting it upon the vice. If you would centre with great exactness do not drive the centre-punch deep, even for the heaviest work, but rather commence with a smaller drill than ultimate centre hole. If punched lightly, the centre-punch mark can be placed as near the centre of the little square by eye, as any rule, measure, or diagonal scribing could have made it. The point of centre-punch should be turned about the same angle as the corner of a three-sided file (*i.e.*, angle of 60°). Short work can be centred with a scribing block upon the surface plate. Two cast iron blocks, planed true with broad V-grooves in their tops, are very convenient for this work. A long shaft may be laid along the bench or on blocks on the floor, and the scribing block slid across the end upon the surface plate, and it matters not how rough a rod may be cut off so long as you can hammer a surface in the middle large enough to scribe the little square upon. Nearly any thing can be centred with the scribing block without once trying in the lathe—for instance, anything of a dumb-bell form might be centred for the balls at the end to run true or for the neck to run true according to which could afford most cut-off, or a bolt with eccentric head can be centered for the neck to run true.

If the diameter of the work is, say, ½in., it would be a waste of time to use the scribing block, for it is almost as easy to find the centre of a ½in. circle by eye as to find the centre of the small square you might scratch upon it; and as the end surface is so small there is little labour in filing the end square to the sides when the edges of the circular ends can be nearly as easily defined as the scratches in the preceding case. The error of measurement for centre of the 1in. rod needs not exceed 1-200 of its diameter, and in the ½ rod the actual error of eye measurement will be about the same; but relatively to its diameter the centre is now 1-50 out of truth, but still 1-200 of an inch is near enough for most work of ½ dia. And this eye measurement is so near that upon the filed end of even a half-inch rod, centred by eye only, the finest drawing compasses would as often show an eccentricity on two sides as an eccentricity in any one direction, showing that the iron rod was somewhat oval, and at the sides from which the thickest cut is turned off was the result of ovalness in the rod rather than from eccentricity of the centring.

The reason many make a bad guess at the centre of the circular end of a round rod is that from the front of the vice they look obliquely down upon the end of rod, and proceed to adjust the centre-punch sideways until the distance A B = B C, Fig. 3, which can be done with nicety; then from the same point of view they attempt to divide the distance, D E, or else to make B E equal to the other two radii, A B and B C, with the result that, as they view the distance, B E, between the centre-punch and front edge of the rod obliquely it appears less than it really is. The same person wishing to divide a stick into equal halves by eye would place it in a line from right to left, so that corresponding parts of each half shall be equally distant from the eye—that is in a position analogous to the distance, A C, and would not for a moment think of viewing the stick as a line with its end towards him; yet this is exactly the problem he is attempting when he tries to divide the diameter, D E, from the same point of view as he divided A C.

For this reason, after having halved the distance from right to left, A C, it is well to take another view at right angles to the first view before attempting to halve the diameter, D E. This is the same method as recommended for finding the centre of the little square scratched upon the end of the inch rod. By viewing the end of the rod perpendicularly truly, you view both diameters fairly; but, then, to view the point of the punch, it must necessarily be inclined considerably, and the shaft of the punch being close to radii, A B and D B, they have not that similiarity of appearance which is desirable for comparing with B C and B E; neither can the exact point of centre-punch be so clearly defined as when held vertically.

Again, some make a very light punch-mark first, and correct it afterwards, for on a ½in. rod you can see perfectly well if a light punch-mark is central after the punch is removed; but if it should be slightly eccentric, to correct it with the punch is not so easy, for the second centre-punch mark must run into the first, and then a small centre mark is impossible. I must admit this can generally be done near enough, but consider making the first punch central, by viewing the punch from two directions at right angles, a more exact method. This eye measurement is all rather a matter of method than of experience. For making the centres of light work exact, even down to 1-16in. or less, a sharp square centre is very useful, though it can only be regarded as a time-saving process when there are several pieces to be centred. This method is briefly described at page 309, thus:—

"If they would put a square of centre cutting in the spindle of the tail-block or head-stock, and push a tool gently against the full sides, it would come true in an instant."

But if any one who was not already acquainted with the method understood the principle, it must have been rather the inference of their own mechanical genius than from explicitness of the writer. Even now I cannot myself understand how work can be trued by putting the square centre in the headstock, as generally so-called. Fig. 4 will explain the square centre, which is turned conical, and then filed to a square pyramid at the point and hardened. I have thought it worth illustrating, because I have usually seen them made with pyramidal part as large as the ordinary centre, and as it angles only cut for about 1-16in. from the point, I have reduced the facets of pyramid, thereby saving time in sharpening, which must be an object to the amateur who has no power grindstone to go to; still, great stiffness is required. This square centre must be fitted in the place of ordinary right-hand centre. The work roughly centred with punch is mounted in the lathe between centres, with the carrier fastened on it just as for ordinary turning; but place the tool in the slide-rest, with its end reversed towards the work, so as to rub instead of cutting it. It is well, though not essential, to have a broad groove filed horizontally across the end of tool, or piece of metal used in the rest, with centre of groove the same height as centres of the lathe. Now bring this rubbing bearing to press the work as near the end as possible, but avoiding any irregular roughness or burr from cutting off. This bearing is now gently pressed against the revolving work, while the square centre is advanced end-ways, but not tightly, until the finish, and using oil upon the outside to reduce friction, and on the centre to save the cutting edges from abrasion; and, if the work was originally round externally where the tool bears, the centre will be cut true, as concentric as if the work had been turned upon it, for when the side that is most eccentric comes round to the front, it is squeezed between the centre and the tool, and cutting corner of square centre is squeezed deepest into the metal cutting out the centre hole towards that side. This principle is just the reverse of ordinary turning when we make the sides of greatest eccentricity squeeze between a smooth round centre bearing internally, and a fixed cutting tool externally, cutting most where the squeeze is greatest, until all radii equal the distance between centre and tool, when the work is geometrically round. It will be easily understood that, if the rod to be centred is oval, the square centre will cut the centre h somewhat oval also, but symmetrically so with the external forms—so that is still a useful guide for drilling the round centre holes, for it is to be remembered that the square centring process does not dispense with drilling.

If an oval or irregular external form is copied when used as a guide for turning out the centres, conversely an oval centre hole (such as made with a punch ground on a stone), used as a guide, produces a corresponding form externally, although in this case it is not so apparent, because the actual deviation from the circle is not greater than that of the small centre hole, whereas they are now viewed relatively to the circumference; hence, for exact work, especially in steel, round centre holes are necessary.

The explanation of a practice is much simpler to follow and shorter to write than this reviewing of the *rationale* of different processes from all points; but such views must greatly assist learners in their choice among the many methods open to them, and if their mechanical reasoning commences with the fundamental operation of centring, I trust it will be extended to the after processes.

A. E. Dancaster.

RATE OF INCREASE OF POPULATION—NEBULAR HYPOTHESIS.

[14688.]—In reply to letter 14641, I may say that I did not intend to found an exact calculation on the basis of the Bible chronology. The fact that there is a difference of 1,000 years between the chronology of the Septuagint and Hebrew versions is sufficient of itself to raise doubts as to the correctness of either. Moreover, as the rate of increase must be conjectural, any conclusion drawn from the result is open to obvious objection. However, so far as our experience is capable of furnishing data for calculation, it is seen to be quite possible that man may not have been an inhabitant of the earth for a longer period than the Bible assigns to him. No doubt the rate of increase is greater now than in earlier ages, but we may be sure that tribes, such as overran the Roman Empire, must have maintained the full average of human fecundity.

I have no doubt that many readers of this paper, as well as myself, are obliged to "W. G. P." for putting the nebular hypothesis to the test. I read lately about Comte having ascertained that, at the times when the various planets were thrown off, the rotation period of the solar mass was sensibly equal to the revolution period of the planet. So far is this from being the case with the earth, that its revolution period, compared with 25 × 207 days, seems to present a similar difficulty in the way of this theory as the period of the inner satellite of Mars does. I suppose "W. G. P." would not think it worth while to make a calculation of the same kind for the earth and moon.

J. A.

INCREASE OF POPULATION.

[14689.]—I desire to thank B. Riley for his interesting contribution (letter 14679), and to supplement it with the following note. From his figures, used as data, we obtain the following equation:

$$100,000,000 \times 2,850 = 13.000.000 \times 21,923.$$

The first term here is the total 2,850 years ago. The third term is the difference between the first term and the present total. The fourth term is the proportion, wrought out by B. Riley as 21,994 years. The small difference, 71, being due, I suppose, to some arithmetical error. Here I have to remark that this simple proportion is at variance with the geometrical law according to which populations increase, and therefore the conclusion deduced from it requires revision.

Mr. Riley expresses his belief as to the chronological record not being high enough for the antiquity of the human race as indicated by the existing remains of geological man. Now the idea of geological man does not enter into this problem. It is confined to chronological or intellectual man—an entirely different sort of question.

J. Steel.

DEEP-SEA SOUNDING.

[14690.]—At page 529 you give some of the results of the soundings off the coast of Africa, taken by Captain Schley, U S.N., in which he mentions the "abrupt" descent of the ocean's bottom as 900 fathoms in 60 miles, and 3,000 fathoms in 700 miles. The term "abrupt" tends to mislead, as the former is 1 in 58·66, and the latter is 1 in 205·33—the first by no means a steep gradient for modern railways. "High falluting" in scientific subjects is better avoided—truth invariably defeats its object.

Scientific Club, August 2. R. J. Lecky.

MAGIC SQUARES.

[14691.]—In my letter (No. 14571) I gave a few examples of various magic squares, and at the desire of "Amara" and "J. F. G.," I append a formula for their construction of any size or apparent degree *of complexity*.

Let us first consider a square of 5 or 25 cells, and let it be desirable that the digit, 1, shall occupy the central cell.

Take the first 5 numbers in the natural progression—viz., 1, 2, 3, 4, 5, and place them in *any* order in the first horizontal column, thus:—

2	1	3	4	5
3	4	5	2	1
5	2	1	3	4
1	3	4	5	2
4	5	2	1	3

A

Then take the next prime number, less than the root—this is 3—and for this reason *commence the numeration of the second column from the 3rd figure in the first column*—viz., 3, 4, 5, 2, 1. Then, for the third column, begin with the 5th for the 4th column, the 7th, and so on. This will form a magic square (A), measuring 15 each way.

For the formation of the next square, we assume the multiples of the root, commencing with 0—viz., 0, 5, 10, 20. As we have perfect option for the arrangement of these figures, we must so do it that 0 occupies the centre cell, and repeat at every 4th *figure*, as follows:—

20	5	10	0	15
0	15	20	5	10
5	10	0	15	20
15	20	5	10	0
10	0	15	20	5

B

Here we have a magic square measuring 50, and by superimposing A on B, we have a square measuring 65 every way, and answering the conditions of carrying the digit, 1, in the central cell.

22	6	13	4	20
3	19	25	7	11
10	12	1	18	24
16	23	9	15	2
14	5	17	21	8

A + B

As in the foregoing we have perfect option in the adjustment of the figures, it is plain that any number may be made to occupy any cell; and, within certain limits, two or more numbers may be made to occupy given cells at pleasure.

This formula holds good for squares having prime numbers for root; of course as the squares become larger the number where the *repeat* takes place is different; 5^2 is a convenient number to exhibit this property. When a large square is constructed it becomes laborious to add up.

For squares not having prime numbers for root, such as 9, 15, 21, &c., the above formula fails, and it is then necessary to use another, which restricts somewhat the number of squares formable. All that is necessary is in the first square (A) to make the *middle number*—say 5 (in a 9^2)—run diagonally from corner to corner, right to left; and in the square, B, the middle number of the multiples—say 36—run in the contrary diagonal. This will give a magic square.

Even squares.—There is more difficulty attending the production of these squares than those having an odd root. A small square of 4 will show the principle without going to the trouble of a larger one.

Take the first 4 numbers—viz., 1, 2, 3, 4—and arrange them in the top horizontal band in such a manner that the extremes add up to 5, and also the intermediate figures equidistant from the centre (in the case of an 8^2 the top line would run thus—1, 6, 5, 2, 7, 4, 3, 8).

1	3	2	4
4	2	3	1
4	2	3	1
1	3	2	4

C

For the second line repeat this order backwards large squares repeat the 1st line again for the line, and so on) until half the square is filled. the lower half repeat the upper half *from the cen*

For the second square take the multiples commencing at 0, 4, 8, 12, and arrange a sim square to the last, only taking care to arrange columns *vertically*, as follows:—

0	12	12	0
8	4	4	8
4	8	8	4
12	0	0	12

D

These two squares, added together, make

1	15	14	4
12	6	7	9
8	10	11	5
13	3	2	16

C + D

This formula holds good for all even squ having a root divisible by 4 without a remain but for all the others—viz, 6^2, 10^2, 14^2, &c breaks down, and the numbers have to be picke and transposed in such a complex manner th cannot describe it. I should suggest the makin such squares as follows:—Make a square, one smaller, which will be divisible by 4) after the given formula, and make a border on to it, which then render it a twofold magic square; for inst to make a 10^2 one of 100 cells, form into an 8 the figures from 19 to 82 inclusive, and then arr the 86 remaining figures in a border round it, t care to make the opposite figures add up to the sum.

The formula for the big square in my let cannot place my hand on; but it is formed quantity of smaller squares, each of which is ma

Sidney Jewsbu

Victoria Park, Manchester.

ON IDENTIFICATION OF ORGA SUBSTANCES BY THEIR PHYSI CHARACTERS, BY HEAT, BY AGENTS, AND BY SOLUBILITY.

[14692.]—In the identification of organic pounds we require to take into consideration physical characteristics, such as colour, taste, or crystalline form, separately or collect For instance, the colour of indigo, or picric and ferrocyanide, or ferrocyanide of potassi characteristic, and so is the odour of carbo acetic acid, camphor, or alcohol. The taste cerine sugar or the alkaloid is characteristic, is the crystalline form of many substances urea or its salts, oxalic acid, or sugar. S some substances can be identified at once colour or by the odour, or by the taste or form, or by one or more of these combine others cannot be identified by their physical racters, and we have to avail ourselves of the of heat in the determination. The applicat heat in heating up to a certain point in boili evaporation, in heating in a tube open at both or on platinum foil, or on a piece of porcelain, the blowpipe, or by any other means, often certain indications by which we may identi organic substance. Heat breaks up most substances, leaving a black carbonaceous resid evolving an odour often characteristic of th stance operated upon. If the carbonaceous from an alkaline salt is soluble in water it ind that the substance was an alkaline salt of an id, and if insoluble it shows that an alkaline rthy base is present. The organic compounds ntaining the alkaline and alkalaic earthy bases ave carbonates when heated, and the compounds ith the heavy metals either leave the metal or an ide of the metal.

The free organic acids are either volatile or non-latile—that is, they can either be sublimed or stilled without or with decomposition. The fatty ids distil unchanged, while citric and tartaric ids, &c., suffer decomposition. The acetates on nition are decomposed, producing acetone. Aniine, cinchonine, gelatine, albumen, morphine, inine, urea, &c., give the odour of ammonia when ated in a small glass tube, and when heated on rcelain, and the heat continued until all the carbon burnt off, there will be a residue if the compound ntains any metal except arsenic or mercury. etic acid, alcohol, aldehyde, aniline, butyric acid, rbolic acid, chloroform, ether, glycerine, lactic id, nicotine, &c., on evaporation leave no residue.

Albumen, when heated up to 70°C., becomes milky, d when subjected to a higher temperature it agulates.

Again, organic compounds have definite boiling ints, by which means we may often distinguish e compound from another. Thus the alcohols ginning with C_2H_5Ho. boiling point 78°C., up to $H_{17}Ho$, boiling point 190°C., increase by a fference of about 19 degrees. And the acids from H_3COHO, up to C_8H_7COHO, increase from 118°C. 254°C., with an average difference of 18 degrees; t up to C_4H_9COHO the difference is approximately 2 degrees. In the paraffin series, as the boiling int increases from 1°C. for C_4H_{10} up to 124°C. for H_{18}, the difference decreases.

Many substances like tartaric acid, when heated a small tube, blacken, and give the odour of rnt sugar. Others blacken and give the odour of rged hair, as uric acid, morphine, &c. Some ive the odour of coal tar, as cinchonine and quinine, hile benzoic acid, &c., give an agreeable odour.

Formic and oxalic acids, when heated in a test-be with strong H_2SO_4, gives off CO without ackening, while citric acid similarly treated adually blackens and evolves CO, while tartaric id blackens immediately. Again, re-agents are ry useful for the identification of organic subances. For instance, brucine in the state of wder, moistened with strong H_2SO_4, gives a red lour, and some chlorine water and an excess of monia, added to a solution containing quinine, ves a green colour, and with a narcotine solution reddish orange colour would be produced. If a ttle potassic bichromate is added to strychnine, it ll give a dark purple colour. A brown precipite, with a solution of iodine, indicates an alkaloid, ue precipitate indicates starch, a yellow, plumbic etate, and no colour, acyanide. Potassic or monic hydride gives a brownish red colour in a lution of gallic acid, and with tannic a brown lour. Ferric chloride, with meconic acid, gives a d colour, and the same colour is produced in solutions of acetic, formic, and hydrosulphocyanic acids.

Plumbic acetate gives a white precipitate with alic acid. Colcium chloride, in a neutral solution tartaric acid, gives a white precipitate, and with tric acid no precipitate is produced until boiled. t also produces a white precipitate with a solution oxalic acid, or an oxalate. It gives a white ecipitate with neutral citrates, and gives a precipitate with malic acid, or the addition of alcohol.

Argentic nitrate gives white precipitates with utral solutions of formiates and acetates.

Ferric chloride gives, with neutral solution of nzoic and succinic acids, brown precipitates. any organic substances dissolve readily in cold ater—some dissolve moderately, or with difficulty, not at all. Again, many substances that will t dissolve in water will dissolve in alcohol or her, or in both easily, moderately or sparingly.

Cold or boiling water dissolves to a greater or less tent acetic acid, albumen, benzoic acid, brucine, tyric acid, caffeine, caramel, caseine, chloral drate, cholesterine, cinchonine, citric acid, cream tartar, creosote, dextrine, formic acid, gallic id, gelatine, glycerine, gum, hippuric acid, malic id, meconic acid, morphine, narcotine, nicotine, lic acid, oil of bitter almonds, palmitic acid, ric acid, potash salts, pyrogallic acid, quinine, icine, soda salts, starch, strychnine, succinic acid, gar, tannic acid, tartaric acid, urea, uric acid, tes, &c.

Alcohol dissolves, to a greater or less extent, ucine, butyric acid, caramel, carbolic acid, chloroform, cholesterine, cinchonine, citric acid, creosote, mic acid, gallic acid, glycerine, lactic acid, malic id, meconic acid, morphine, naphthaline, narcotine, nicotine, nitrobenzol, oil of bitter almonds, ic acid, oleine, oxalic acid, palmitic acid, picric id, pyrogallic acid, quinine, salicine, spermaceti, ar, tannic acid, stearic acid, stearine, strychnine, ccinic acid, tartaric acid, urea, wax, &c.

Ether dissolves to a greater or less extent benzoic id, carbolic acid, chloroform, cholesterine, creosote, lic acid, glycerine, hippuric acid, lactic acid, phthaline, narcotine, nicotine, nitrobenzol, oil of ter almonds, oleic acid, oleine, palmitine, paraffine, pyrogallic acid, quinine, spermaceti, tannic acid, &c.

If a substance is easily soluble when shaken in small quantities with cold water it cannot be albumen, benzoic acid, caseine, cinchonine, gallic acid, gelatine, gum, hippuric acid, morphine, palmitic acid, palmitine, paraffine, quinine, salicine, spermaceti, strychnine, starch, stearine, urates, or wax. This is negative evidence, which enables us to say that it is not one of a certain number of substances, but must be some other.

If the substance dissolve when heated in boiling water it cannot be albumen, caseine, palmitine, paraffine, spermacetti, stearine, or wax.

Again, there are substances which dissolve more freely in hot than cold water. For instance, caffeine is entirely soluble in boiling, but only slightly soluble in cold water. Chloral hydrate forms oily drops in cold water, but dissolves when the water is heated And dextrine, gallic acid, gelatine, hippuric acid, soap, starch, or the nitrate and oxalate of urea dissolve in boiling, but not in cold water.

Again, aniline, benzoic acid, benzine, carbolic acid, cholesterine, meconic acid, narcotine, nitrobenzol, oil of bitter almonds, oleic acid, oleine, and stearic acid are very soluble in alcohol and ether, but slightly soluble, or not at all, in water.

Further, butyric acid, nicotine, and pyrogallic acid are soluble in water, alcohol, and ether; and indigo and starch are insoluble in water, alcohol, and ether.

Caffeine is soluble in boiling water and ether, but only sparingly soluble in cold water and alcohol.

Caramel is only slightly soluble in alcohol, but it is very soluble in water. Cinchonine is soluble in alcohol, insoluble in ether, and nearly insoluble in water.

Citric acid is insoluble in ether, and soluble in water and alcohol.

Morphine is soluble in boiling alcohol, insoluble in ether, and sparingly soluble in water.

Palmatine is soluble in ether, insoluble in water, and insoluble in boiling alcohol. Paraffin is soluble in ether, sparingly soluble in boiling alcohol, and insoluble in water.

Picric acid is readily soluble in alcohol, but only sparingly soluble in water. Quinine is sparingly soluble in water and ether, but readily soluble in alcohol. Strychnine is scarcely soluble in water, and it is insoluble in alcohol and ether. Succinic acid is soluble in water and alcohol, but only sparingly soluble in ether.

Sugar is soluble in water, scarcely soluble in alcohol, and insoluble in ether. Tannic acid is soluble in water and alcohol, and sparingly soluble in ether.

Tartaric acid is soluble in both water and alcohol.

The solubility and insolubility of various compounds in certain reagents is one of the most important means for isolating compounds that are mixed together. If we have two compounds mixed together, and one is soluble in alcohol and the other is not, we put the substance in alcohol which dissolves one and leaves the other. And on the evaporation or distillation of the alcohol we obtain the compound that was in solution in alcohol, it may be in the crystalline form. And in the same way we can isolate certain organic substances from others by water, ether, or other reagents.

Hugh Clements.

PRINTING TEXTILE FABRICS BY MEANS OF PHOTOGRAPHY.

[14693.]—I should like if you will allow me to draw the attention of calico and other printers on textile fabrics to the importance of taking up the use of photography for printing designs on cloths and stuffs. Some years ago very charming effects were produced by printing photographs of lace upon parasols, and recently the manufacturers of Lyons submitted to the French Photographic Society long lengths of silk printed with medallions of large size representing pictures of the old masters. It will be seen that by calling in photography there will be no lack of really good designs, for the combinations possible are simply uncountable. I send you the details of a process patented by Mr. Winter, of Prague, not as a method to be copied, but as affording an insight into the processes necessary, and the direction in which to look for improvement. The object of his invention is to produce magnified positive photographs on woven fabrics, such as linen, cotton, silk, or wool, and with the use of iodide or chromide of silver. The process consists essentially in impregnating the woven fabric with iodide or chromide of silver, and thereby making it so sensitive to light that from a negative plate of about eight square inches a magnified positive photograph of up to more than forty square feet may be produced on the woven fabric. When electric light is employed the positive photograph may be produced in from one to four minutes. The proportions of the chemicals to be used vary, not only according to temperature but also according to the density and material of the woven fabric, so that in the case of lower temperatures and denser woven fabrics, which do not so easily absorb fluids, the solutions must be made stronger, and iodides must be used in preference to chromides. By way of example it will be well to describe the proportions that may be used at a temperature of from 60° to 70° Fahr., with linen or cotton fabrics of average density and fineness. This description will serve as a measure for the possible variations under the previously-mentioned circumstances. The woven fabrics must be first freed from all chemical impurities, and the subsequent operations may then follow in the manner now to be described.

1. *The Treatment with Chromides.*—The woven fabric is passed through a solution composed of four parts by weight of chromide of potassium, one part of chromide of cadmium, and 240 parts of water, so as to be equally wet on both sides, and is then hung up to dry.

2. *The Treatment with Silver.*—The dried, woven fabric is passed through a solution of four parts by weight of nitrate of silver, one part of citric acid, and 140 parts of water, and again dried.

3. *The Exposure to Light.*—For this purpose it is generally preferable to use electric light, which may be produced by a dynamo-electric apparatus. In all other respects the proceedings are the same as in the production of magnified photographs by means of the solar camera. The sensitised woven fabric is exposed to the light until the positive photograph is distinctly visible thereon. The time necessary for this exposure depends upon the size and strength of the negative—generally one to four minutes.

4. *The Development.*—A solution composed of 10 parts of pyrogallic acid, 45 parts of citric acid, and 410 parts of water is put into a large flat pan, and the woven fabric is left in the solution until the photographic picture or print thereon is sufficiently developed. The remaining proceedings are as usual in photographic processes. The picture is well washed, then toned and fixed, and finally again well washed.

I should be obliged if any of your chemical readers would tell me what the patentee means by chromides?

Manchester. J. S. B.

PHOTOGRAPHING A TROTTING HORSE.

[14694.]—It will be remembered that when Miss Thompson exhibited her first picture at the Royal Academy a discussion arose as to the position of a horse's legs during the action known as trotting. The question has been practically settled by an American photographer, named Muybridge, who has taken a series of instantaneous pictures of a well-known trotting horse while careering over a race track at San Francisco. The following account of the arrangements will doubtless interest your readers:—

Under a shed on the south side of the track, were arranged, upon a platform, twelve cameras, in spaces of 21in. each, with lenses manufactured expressly for this purpose by Dallmeyer. In front of these cameras were placed the shutters, to each of which was attached a magnet and armature, communicating with an electric battery, and so arranged that on the completion of the electric circuit at the proper instant of time the shutters would expose the sensitive plate to the action of the light and immediately close again. Upon the opposite side of the track was placed a screen about 50ft. long and 15ft. high at a suitable angle to secure the greatest amount of reflected light, covered with white linen cloth, and divided by vertical strips into spaces of 21in., each with a consecutive number. 18in. in front of this background was placed a footboard 12in. high, with longitudinal lines 4in. apart. In front of this footboard a strip of wood was fastened to the ground, upon the top of which wires were properly secured at an elevation of about 1in. above the ground; each wire was held in proper tension by a spring on the back of the footboard, so arranged that the depression of a wire drew the spring and completed the electric circuit. These wires were placed at distances corresponding with the cameras on the opposite side, and with the spaces on the background. From this it will be readily seen the depression of the first wire would cause the exposure in the first camera; of the second wire, the second camera, and so on; and if everything was properly arranged, the driver would simply have to keep the wheel of his sulky in the track provided for it, and as it successively depressed the wires, and established the electric circuit, a series of photographs would be made by the mechanical action of the wheel itself. Everything being properly adjusted, and the track whitened, Abe Edgington, a well-known trotter belonging to Mr. Stanford, was brought out for the trial, the driver started round the track, and came dashing by in front of the background at a 2·24 gait; the wheel passing over the wires completed each circuit in succession, and during the half second or less occupied in passing the cameras twelve successive exposures were made in the cameras. In a few minutes' time the negatives were developed, and found to be perfectly sharp, showing in each of them every foot of the horse perfect in its outline, and the body, harness, &c., full of detail—even the slender whip was as well defined as if it had been motionless.

In the first picture the horse is seen with his nose in the space 9, and his left hind foot in space 3, in the act of leaving the ground, the right fore foot, which moves in unison with it, having already been raised nearly 12in. from the ground as is shown by the third horizontal line, which is 12in. above the track. These two feet, the left hind foot and the right fore foot, do not again touch the ground until in picture 8, and then remain on the ground until 11, where the stride is completed, and they are in the same position as in figure 1. Fig. 1 admirably shows the fact that the fore leg is raised first, as would seem necessary from the fact of its being the shorter.

In Fig. 2, taken at a point 21in. further on, the left hind foot is clear of the ground, as it evidently has been a part of the time between Fig. 1 and 2, and the horse is literally flying in mid air. The right hind foot and the left fore foot have been stretched forward as far as possible, and are just about to strike the ground.

In Fig. 3 the left fore foot and right hind foot have struck the ground, where they remain as long as the horse can swing himself forward on their leverage, as shown in Figs. 3, 4, and 5. The left hind foot and right fore foot are being drawn up before being carried forward—note how close the fore foot is doubled under the breast.

In Fig. 4 the horse has gone forward another space, bringing himself directly over the left fore leg, which is nearly vertical. In Fig. 5, which nearly completes a half stride, the horse is exerting his greatest propulsive force by the muscles of the right hind leg and the straightening of the pastern of the left fore leg. In Fig. 6 the right hind foot and left fore foot have left the ground, and the horse is again in mid air, and remains so during the time represented by Figs. 6 and 7, and apparently during a part of the time intervening between Figs. 7 and 8. In Fig. 8 the left hind foot and right fore foot, which left the ground in Fig. 1, again strike; the right fore foot, which last rested on the ground in space 5, now strikes in space 15, and the left hind foot, which last rested in space 3, now strikes in space 13. The horse's head, which in Fig. 1 is entering space 9, is now entering space 16. These two feet remain on the ground while the horse, by their leverage, passes through spaces 16, 17, and 18, as shown in Figs. 8, 9, and 10, until in Fig. 11 he is again about to leave the ground in the identical position shown in Fig. 1, thus completing one full stride. The left hind foot, which is just leaving the ground in space 3, Fig. 1, is again just leaving the ground in space 13, Fig. 11. This would make the stride about ten spaces of 21in. each, or 17½ft., but by measurement of the footprints on the track the stride was actually 18ft. By an analysis of this stride it will be seen that the left hind foot and right fore foot, which left the ground in Fig. 1, do not strike until, in Fig. 8, the horse has moved about 12ft., and they then remain on the ground until he has completed the stride, or while he passes over about 6ft. more. This is shown by the position of the horse's nose in Figs. 1, 8, and 11. In other words, any two feet of a horse, with this stride and speed, will rest on the ground about one-third of the time, and will be off the ground about two-thirds of the time and distance. During the stride the opposite hind and fore feet were also on the ground while the horse was moving about 6ft. (see Figs. 3, 4, and 5) or about one-third of the whole time. This would leave a distance of about 6ft., or one-third the time, in which no foot touched the ground (see Figs. 2, 6, and 7). The relative time that a horse is off and on the ground depends, of course, upon the length of stride and speed.

It is to be hoped that copies of these photographs will be sent to this country for the benefit of those who disputed the accuracy of Miss Thompson's picture. **E. J. M.**

A NEW BEEHIVE.

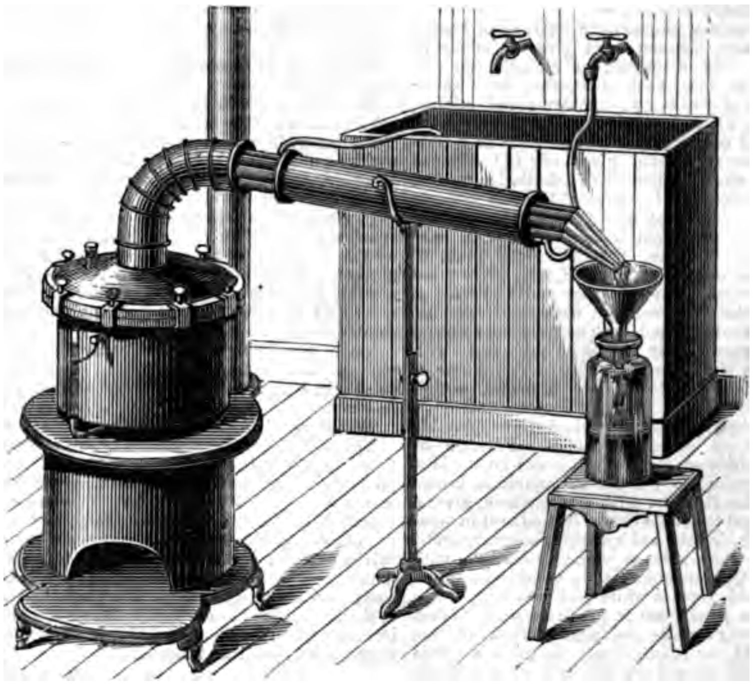
[14695.]—The beehive of which "Ligurian" (let. 14643), has so kindly given us particulars at page 501, is, in my opinion, not so suitable for the use of English bee-keepers as the modern bar-frame hives already in use here. In many points the hive resembles Nutt's collateral—a hive which is not much used now, the modern bar-frame being found better suited to the most advanced style of apiculture. I presume the central part is fitted with bar-frames, such as are described in the divisional hive paper. The feeder, too, is a bottom one, which is rather in opposition to the general opinion—and rightly so, I think, as they encourage robbing more than "top-feeders" do. The sun-shade would be quite unnecessary in our climate if no ventilator were fixed in the super cover, and the whole of the case painted a light colour. The design of the porch is good, and much prettier than the generality of porches. The porches of some hives quite spoil the appearance of otherwise handsome accessories to a gentleman's garden or lawn. The plan by which the sides are made detachable is very ingenious, but would be quite unnecessary in any hive which had no side honey boxes, as the removal of the super cover exposes the whole of the upper boxes. I may just mention here that there is no worse conductor of heat than "dead air," and that the hives which have a "dead air space" round the sides, as the Cheshire and Abbott, give better protection against excessive heat or cold than any wooden hive with a movable cover.

Of the suitability of the hive to the American style of apiculture I am unable to judge, but have no doubt that the points which are objectionable in our eyes are such as will be found to answer very well in such El Dorados of honey as are to be found on the other side of the Atlantic.

W. S. Travis.

DISTILLING APPARATUS.

[14696.]—The distilling apparatus represented in the drawing is intended primarily for the use of pharmaceutical chemists or druggists, but it possesses features which will recommend it to many who have need of a trustworthy and quick acting still. The wide delivery tube is a useful feature allowing as it does for the accumulation of vapour and permitting of the introduction of the hand. The body of the still is of wrought iron or copper, with a lid fitting on ground edges, and held together by screw-clamps, as seen in the engraving. A gauge is fitted to show the quantity of liquid in the still. The condenser, it will be seen, consists of a number of glass tubes, which, if they are 1in. diameter and 24in. long, expose a surface of 264in. while that of the surrounding cylinder is only 188⅓in. The ends of the condenser tubes are drawn together and tapered, as shown in cut, to permit, if desired, of the collection of the distillate in a narrow-mouthed bottle. The advantage gained by this apparatus, aside from the general one of convenience is thus seen to be in the notable increase of condensing surface it exposes, which to that extent increases the effectiveness of the device—*i.e.*, its rapidity of action. Compared with a Liebig condenser of similar dimensions, this apparatus exposes probably three times as much condensing surface. The idea of a tubular condenser, employed in the manner set forth is in the opinion of the *American Journal of Pharmacy*, an excellent one, that may find useful imitation in the chemical laboratory and elsewhere. The device illustrated and described was invented by Joseph P. Remington, whose recommendation of its merits is based upon a continuous use of it for three years. I think many of your readers will be able to appreciate its advantage and turn them to account.



Beloit, Wis. **Silas P. Cooper.**

CONTINUOUS BRAKES—SANDERS' AUTOMATIC VACUUM.

[14697.]—The very able letters of your correspondents, "Nun. Dor." and "Locomotive Engineer," and the editorial note, upon pages 499 and 500, are so conclusive that very little remains for me to add to the statements contained in my former letters upon the subject of Sanders' automatic vacuum brake, pages 315 and 443, more especially as Mr. Sanders in his last letter does not even attempt to disprove any of the statements in my last letter. All he does is to take up a column of the English Mechanic (p. 473), with extracts from the Westinghouse circular, and my letter, with a view, as "Nun. Dor." and "Locomotive Engineer" points out, of making your readers think that the "latter is a copy or rechauffé of the former."

In my last letter I stated clearly that this was not the case, and I will now give further proofs of this fact.

Having, as your readers know, given diagrams and descriptions of the Westinghouse automatic brake, I desired to give similar information respecting the Sanders automatic vacuum, as I considered it the best of the vacuum brakes.

I therefore obtained an official diagram of this brake as used upon the Great Western Railway from which I made the drawing upon page 315. The description I gave from my own knowledge of the brake, supplemented by information I received from the railway officials, and also by information sent to me not long ago from the Sanders' Brake Company.

As I was most anxious that my description should be accurate, I thought the better way would be to adopt some portions of the information sent to me from the inventor's company contained in his own official circular issued in January last, and from the paper he read before the Institution of Mechanical Engineers on the 31st of the same month (some particulars of which are given in last volume, page 542).

I will at once answer all the "insinuations," "extracts," and "conclusions" contained in R. D. Sanders' two letters, pages 397 and 473, by stating that at the time of writing my letter, page 315, on the 29th of May last, *I did not copy the Westinghouse circular, had not read or even seen it, and in fact did not know that one had been issued upon this subject until after my letter was in print.*

The first six paragraphs, page 473, are the very six "extracts" I made from the information sent to me by the Sanders company. The last two are taken from information I received from a locomotive official.

Although I adopted some of the wording of the "extracts," still every part of the description and every figure contained in my letter upon page 315, I had thoroughly proved myself before writing.

I have to-day again read the much-talked-of Westinghouse circular, and I notice on the first page that it states "they have adopted Mr. Sanders' description of his own brake as far as the information contained in the circular and paper referred to has permitted."

It thus appears that Mr. Sanders has furnished the Westinghouse company with similar information to that which he sent to me, and then made a personal attack on me because some of the information contained in the Westinghouse circular is also contained in my letter.

"Locomotive Engineer," page 499, is quite correct in his statement that Mr. Sanders has altered his brake, and I have had an opportunity of examining his present arrangement in working order.

Mr. Sanders has resorted to the use of "Smith's sacks" or cylinders, in place of his own "drums," and he now uses 12 square feet of rubber cloth in the two "sacks," instead of about half of that quantity in his Great Western plan.

He still retains all his costly apparatus on the engine.

His new brake will thus be more costly to main-his old one, as counting the hose coupling 4 square feet of rubber cloth are used for iage. Also it is not yet automatic upon the nd tender, as the parts are too large to be pon either, and it is often the case that the brake makes an *apparently* good stop, he steam brake upon the engine and tender about three-fifths of the work.

lusion, the brake question, which appears troublesome to railway companies under circumstances, is one that could be settled days if submitted to a commission of dis- d engineers, with power to make competi- riments by running the trains side by side el lines, where there would necessarily be conditions for the two brakes being tried ne.

t 1st. C. E. S.

CTIVE HEAD LAMPS UPON THE MIDLAND RAILWAY.

.]—I NOW send the diagram and explanation idland system of head lamps, which I upon page 526. The arrangement at pre- se (with slight alterations and additions) ned by the late Mr. Kirtley, and came into on Monday, September 2nd, 1872. It was tioned in my letter, Vol. XVI., p. 141. engines running over the Midland line carry lamps as follows :—

—Engines of express or fast passenger eak-down van trains, and special fish trains white lights, one over left-hand buffer and ot of chimney.

—Engines of slow passenger trains, very t express goods or cattle trains, and light carry one white light over the left-hand

—Eng nes of special passenger and empty trains carry two white lights—one over d buffer and one at foot of chimney.

—Engines of important express goods or ains. One purple light over the left-hand nd one white light over the right-hand

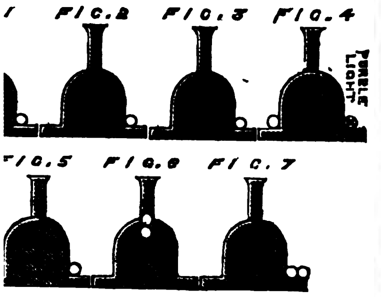


FIG. 2 FIG. 3 FIG. 4

FIG. 5 FIG. 6 FIG. 7

—Engines of express goods or cat t'e tra lights, one over each buffer.

—Engines of through goods, mineral, empty waggon trains, also return empty s, two white lights at the foot of the placed one above the other.

—Engines of stopping goods, mineral, r empty waggon trains, also shunting when running upon the main line. All engines employed exclusively in station l sidings must, after dusk, carry both head amps, showing a red light.

inguish the Midland trains when running following portions of the Manchester, and Lincolnshire Railway, Cheshire lines, and and Sheffield joint railways, the follow- gement is in use : Between Derby, Buxton, er, and Liverpool, and between Swinton caster, the engines of ordinary passenger ust carry a white light over the left hand l a purple light at the foot of the chimney, engines of special passenger and empty trains must carry the lights shown m 3. Between Rowsley, Buxton, Man- nd Liverpool, between Barnsley and Man- and between Swinton and Doncaster, the f express, goods, and through goods and rains must carry a purple light over the buffer and a white light at the foot of the and between Rowsley, Buxton, and Man- d between Swinton and Doncaster, the stopping goods and mineral trains must hite light and a purple light, side by side, ft-hand buffer.

ecial arrangement, it will be noticed, is red till the trains have arrived at New tion, but the lights are carried from and and Rowsley, as with some trains they are r first stopping stations on the Midland r correspondent, p. 352, also asks " what ard, plain or with crosses, denotes at es (Met.)?" It is part of the system of discs and lights carried by Midland trains running between Hendon, South Tottenham, Moorgate-street, and Victoria. The whole system of lamps, carried by all the trains running past King's-cross, is very elaborate, and would take up many columns of the ENGLISH MECHANC to describe. I, therefore, only give the following portion which refers to the Midland passenger trains :—

Trains.	*Discs.*	*Head lights.*
Midland and L. C. and D. passenger trains between Victoria and Hendon.	Two diamond-shaped boards, one on smoke box and one on left-hand buffer, between Victoria and Snow-hill, and one diamond on smoke box between Snow-hill and Hendon.	Two white lights, one on smoke box and one on left-hand buffer.
Midland trains between King's-cross and South Tottenham.	One square white board on left-hand buffer.	One white light on left-hand buffer, and one blue light on right-hand buffer.
Midland trains between Moorgate-street and King's-cross.	One square white board with black diagonal cross on centre of buffer beam.	Two blue lights, one on each buffer.
The lights and discs to be changed at King's-cross.		
Midland and L. C. and D. passenger trains between Finchley-road, Kentish-town, and Ludgate-hill.	One white diamond disc on smoke box.	Two white lights, one on smoke box and one on right-hand buffer.

August 2nd. C. E. S.

THE LAND QUESTION.

[14699.]—So Mr. S. Mayer (14652) thinks it makes a difference between coveting and stealing land and brooms—that no human being made the land, but one did make the brooms. Did any human being make the materials for them, or make horses and cows, sheep and oxen, and corn? And does he maintain the right to steal them? God did not make the Three per cent. Consols, nor the money in savings banks or railways—at least, not directly; and has "the intelligent working man, who produces capitalists," a right to take them as he wants? And, if not, why the land for which they are continually being exchanged? He really seems to imagine that people get land without paying for it, but that everything else is paid for. Such nonsense as that is beyond answering. Suppose he got a law passed that nobody should acquire more land than a certain quantity—what good would it do him? It would only cause land and money to be somewhat differently distributed, and increase the income of would be landowners from 2 per cent. or less to ·04 or ·05 on their capital.

I am amused at his anger at my talking of the Berlin peace doing any good. Last winter we were told by the defenders of strikes over and over again that trade was only temporarily depressed by the Russian war, and the fear of it becoming an European war. All men of sense knew better; and, now the peace has come, the idea of it doing working men any good is laughed at by themselves or their advocates. I have not the least doubt that he "has seen before" my statements about the price of building having nearly doubled in the last thirty years, and for the reason that workmen do less for the same money, for it was stated many times by builders and other persons of experience last winter. Things are not less true because they have been said before. When he asks me to prove them by figures he simply does not know what proof is. It is simply a fact that a house of any given size does cost nearly twice as much as it did about thirty years ago. If this is the best defence the coveters of their neighbours' houses have to make—and I believe it is—I quite agree with his concluding exclamation—such people can only come to Ruin.

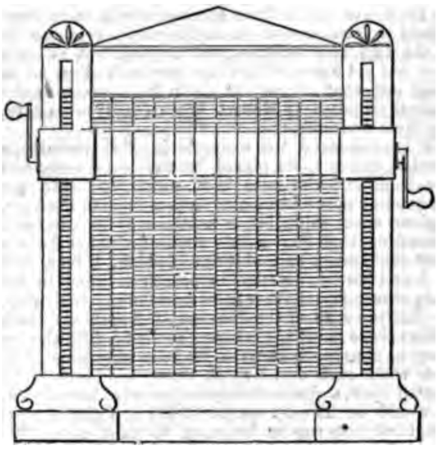
A TRANSLATING MACHINE.

[14700.]—SEEING in the ENGLISH MECHANIC recently, a design for such an instrument I am induced for the benefit of my mechanical friends, to send a drawing of one which I contrived, and no doubt if hung up in the halls or laid in the coffee-rooms of hotels, this would be found a valuable convenience to foreign visitors. It might also facilitate business in the custom-houses, the exchange and merchants' offices of our ports.

Referring to the drawing it will be seen that in this example there are a dozen languages given (indicated by their initial letters)—English, French, Spanish, German, Dutch, Italian, Danish, Russian, Greek, Turkish, Hindostani, and Celtic; the study of the latter now being considered by the historian and the antiquarian of unlimited importance, and the capabilities of the instrument being thus further illustrated. By lengthening the machine the Asiatic languages can be added, or classic Greek, Latin, or Hebrew may be given.

The card, which fills the front of the instrument, is ruled into a number of parallel spaces, and in each of those spaces, which are again divided by vertical lines, words, sentences, or numbers of similar meaning are consecutively arranged, being written or printed in the several languages. Even short phrases may be expressed in a space 1½in. long by one-tenth of an inch wide, so that a card about 18in. square would hold 150 questions. Thus the instrument need occupy no inconvenient proportions—about the size of an ordinary writing desk. In front of the card, and capable of being moved up and down by a rack and pinion movement, as shewn in the drawing, is an ivory slip bearing the titles of the languages given on the card, the space of each title corresponding with the language and columnar arrangement of that card.

There should be several cards treating on those matters necessary to the tourist or commercial traveller, also cards bearing words and numerals, any of which can easily be slipped into and taken out of a groove made for its reception in the sides of the front pillars. Those cards must be numbered and assorted into words and questions having reference to special subjects.



Now, to use this instrument, we shall suppose a foreigner—it may be a Turk—arrives at some hostelry where no interpreter is retained; he observes the translating machine, and selecting a card expressive of his wants, he places this in the groove. It may be card marked "No. 7, Hotel." He now turns the handle, and the ivory indicator moves up or down, stopping at the Turkish words or phrases as may be, which he selects to express his wishes. Parallel with those phrases, and just underneath the title "English," we read the translations; perhaps it may be "I require a bed," "Bring coffee," "Get me a pipe," "Serve up supper," and no doubt in 150 sentences belonging to the same order he discovers enough to tell his requirements. Through card No. 8, marked "Commerce," he may ask such questions as "Where is the bank?" "Show me the station," "Ticket for London," &c.

I hope I have written enough to commend the utility and simplicity of this translator. The same principle can, of course, be carried out in other ways; for instance, the cards may be replaced by rollers, between which the columnated translations may wind and unwind like an educational apparatus we sometimes see in our infants' school; but we must remember that after all, in a scheme of this kind, our aim essentially must be to contrive an instrument which can be at once used by anybody who can read his own language, and the mechanism of such an instrument ought to require no study or prolonged application. Again, we must not expect too much from the instrument. It can be useful, but to a certain extent those who in their travels have used a French or Italian phrase-book can best judge of its utility, and estimate its convenience.

E. B. Fennessy.

TRANSLATING MACHINES.

[14701.]—Having read with some astonishment the letter (14639) of "Mercurius," I am curious to know how the machine in question overcomes the difficulties of idioms, &c.? Especially should I like to hear how it would translate such words as "box," "bark," "lead," &c.? Also the well-known French epigram, beginning—

> "Je suis ce que je suis,
> Mais je ne suis pas ce que je suis?"

S. D. K.

THE HYPHARMONIC THEORY—THE THEOREM STATED.

[14702.]—Mr. Fred. J. Jackson, letter 14672, recommends me to investigate the hypharmonic theory mathematically, as he has for some time stated it. If I understand his proposition it is that as there is an ascending series of notes bearing certain relations to each other, termed the diatonic scale, so there is a descending series bearing similar relations and exactly corresponding with the ascending one. Thus the latter, commencing on do, comprises the notes do, re, mi, fa, sol, la, si, do^1, and the descending series, commencing on mi^1, the notes mi^1, re^1, do^1, si, la, sol, fa, mi. But inasmuch as that, in the ascending scale, the interval from do to re is what is termed a greater tone, and that from re to mi a lesser, in order that the analogy may be exact, in the descending series the interval from mi to re requires to be made a greater tone, and for the purpose of distinguishing it the term rah is used. Then as I understand the proposition, the descending series of notes commencing on mi, placed upon the ascending series commencing on do, will correspond as to interval relation exactly as two triangles do, having the properties described in Euclid 1, 4. Before entering upon the calculations that W. Jackson recommends, perhaps he will kindly state if his proposition is apprehended.

Isaac Fowler Ballard.

NEW MUSICAL NOTATIONS.

[14703.]—I quite expected to see several letters on the above subject from correspondents more competent to form an opinion on the merits or demerits of the two new systems put forward, but as such have not yet appeared perhaps you will allow me to point out what appears to me to be a defect in the system proposed by Robert Wark (14617)—namely, the time divisions.

If I understand the example (p. 474) correctly, a vertical line is to be placed between each note, and the length of the note is to correspond with the amount of space from one vertical line to the next, a given space being taken as the unit or one beat. Assuming that this certain amount of space for one beat can always be maintained (which, I fear, will be found hardly possible in practice, owing to the bars or measures having to be made longer or shorter, so that the ends of the lines may fall even with each other) there might, perhaps, be little difficulty so long as simple divisions of the beat only were used, but when such divisions as those represented by dotted lines, and also in triple time were introduced, it would be no easy matter to tell at a glance what length of time was to be given to each note. We are not told either how the rests are to be indicated. If by leaving the spaces blank of course the same difficulty would be experienced as with the notes themselves. Would there not also be a difficulty with the vertical lines when the notes in the various parts were of different lengths? Then, again there seems to be no difference between the line dividing the bar and those dividing the notes, but perhaps that may be the fault of the engraver or printer. Though I have learned both old notation and sol-fa I am quite ready to welcome any improvement on or in either notation, but it must be shown to be a *real* improvement in practice, and not in theory merely. I have not found that persons, not even children, taught the sol-fa system experience any difficulty with regard to the "up and down" of the notes, except of course when the octave marks are not clearly printed; but that is the fault of the printing, and not of the system. If Mr. Wark has had any practice with his system he will be able to say whether any difficulty has been experienced with regard to the above matters.

C. Lark.

MUSICAL TONES.

[14704.]—Mr. Jackson, then (14583 and 14670), asserts that the sharp of the note below in the diatonic scale is sometimes sharper, sometimes flatter, than the flat of the note above! To such an assertion I have no reply to offer. To other readers I would say the value of a sharp interval is $\frac{16}{15}$, equal to that of a diatonic semitone. This can be demonstrated to be true, and of course invariable (1), by the educated ear, and the assistance of the siren or tonometer, (2) by the illustration I gave on p. 474 (in which, by the way, are two obvious misprints); and this being so, I ask again how it is possible in the nature of things for all the intervals in the scale of the key of C to be exactly equal to those in the scale of G, D, &c., where a sharp or sharps occur—there being no room for inserting a sharp in one tone without trespassing upon the tone above?

I also repeat in other words what I have insisted upon already. It is futile to apply mathematical treatment to any subject before you have correct data to go upon; and, in this instance, I say, without any fear of contradiction, you have no trustworthy data. To obtain them you must resort to the ear, not argue from assumptions.

I have stated my case distinctly. I find from experiment that the value of a sharp in relation to the note below in the scale $\frac{16}{15}$, equal to that of a diatonic semitone. In this I am supported by the evidence of Montferrier and Campagnoli. Can any one show, by similarly bringing the matter to the test of actual experiment, that I am wrong?

H. C. K.

MATHEMATICS OF MUSIC.

[14705.]—I desire to thank D. Fraser for his hopeful contribution (letter 14673), and to say in reply that his inferences as to the correcting of the false 4th, false 5th, false 6th, and false 7th are just as necessary as the correcting of the false 3rd. Moreover, the operation is just as easy for the singer and the violinist in practice as the demonstration is for the mathematical musician. All the requisite notes for this purpose are given in the scale, p. 509, Vol. XXV.; and references to the experimental proofs in Germany, France, America, and England are given in subsequent letters. I am pleased to see Mr. F. Jackson progressing in the right track towards a complete development of the whole series in these pages.

J. Steel.

A METHOD OF SOLVING PROBLEMS IN MAXIMA AND MINIMA.

[14706.]—I wish to return thanks to "J. F. W." for his answer to my letter, and acknowledge the important correction—or, rather, improvement—he has made in my method. There are two things, however, in his letter which are not clear to me. One is the sentence—"It is only an *algebraic way of treating geometrically* certain problems involving one variable;" and the other, the reason for the mode in which he would solve these problems.

Why I formed the rule as I did will perhaps be best explained by relating how I arrived at the idea of the method, which I will endeavour to do in as few words as possible.

At the time when my mathematical knowledge did not exceed the first few books of Euclid and quadratic equations, I became acquainted with the fact that D. and I. Calculus was peculiarly appropriate to the solving of problems in maxima and minima. How the consideration of small increments or decrements—which I understood was the base of the D. and I. C.—could effect this was the subject of my thoughts in connection with the simple problem—Divide a given line into two parts, such that the rectangle under the segments shall be a maximum—I soon perceived that if the line was cut on each side of and near to the required point, the rectangles under the respective segments could be considered as equal to each other. The outcome of this perception was the idea of substituting $(X+d)$ and $(X-d)$ for X—the use of y and z being only introduced as substitutes for the compounds $(X+d)$ and $(X-d)$ during the manipulation.

"J. F. W." seems to think that the method is only applicable to cases involving one variable; but the following example, I think, will show that it is also applicable to cases involving two or more variables.

Example.—Given the superficial area of a rectangular trough, required the dimensions when its capacity is a maximum. Let A, X, and x be the superficial area, length, and breadth respectively.

Then the depth $= \dfrac{A - X x}{2(X + x)}$ . . . . (1)

and the capacity $= \dfrac{X x (A - X x)}{2(X + x)}$.

Substituting y and z for X and equating $\dfrac{x y (A - x y)}{2(x + y)} = \dfrac{x z (A - x z)}{2(x + z)}$

dividing and expanding $A x y + A y z - x^2 y^2 - x y^2 z = A x z + A y z - x^2 z^2 - x y z^2$

deleting and transposing $x^2 (y^2 - z^2) - x (A - y z)(y - z) = 0$

dividing $x (y + z) - (A - y z) = 0$

replacing X $X^2 + 2 x X - A = 0$

extracting $X = \sqrt{(A + x^2)} - x$ . . . . (2)

Operating upon x in a similar manner—

$x = \sqrt{(A + X^2)} - X$ . . . . (3)

Substituting (3) in (2) $X = \sqrt{2}\,[A + X^2 - X \sqrt{(A + X^2)}] - [\sqrt{(A + X^2)} - X]$

deleting and transposing $\sqrt{(A + X^2)} = \sqrt{2}\,[A + X^2 - X \sqrt{(A + X^2)}]$

squaring $(A + X^2) = 2 (A + X^2 - 2 X \sqrt{(A + X^2)})$

deleting and dividing $\sqrt{(A + X^2)} - 2 X = 0$

tran $4 X^2 = A + X^2$

deleting and extracting $X = \sqrt{\frac{A}{3}}$ . . .

Substituting (4) in (3) $x = \sqrt{(A + \frac{A}{3}} - \sqrt{\frac{A}{3}}) =$

Substituting (4) and (5) in (1) $\dfrac{A - \frac{A}{3}}{4 \sqrt{\frac{A}{3}}} = \frac{1}{2}$

Recapitulating.—The length and breadth to each other, and to twice the depth.

I have forwarded the rule as revised, thin the circumstances called for it.

Revised rule.—Represent an unknown by X, and form an expression for the subj consideration. Form two other expression stituting y and z for x, which equate and far as possible. Replace X and deduce its

S. S

SELECTED CORRESPONDEN

The Microphone.*

The pleasure with which those beauti veries and inventions, the telephone, t graph, and the microphone, have been a by the world, has been unhappily, and I I think unnecessarily, marred by one of disagreeable things that can be thrust on —a personal claim of priority, accomp accusations of bad faith, especially w against any one in whose name and fame has come to feel concerned.

Before troubling the public at all wi matter, Mr. Edison might surely have rea his claim with Mr. Preece, with whom he from the beginning in correspondence, or have written immediately to public journa pointing out the close relation between "carbon telephone" and Mr. Hughes' s "microphone." The scientific public c have calmly judged, and would have felt rest in judging, how much in common or not in common there may be in the phys ciples concerned in the two instruments. violent attack in public journals on Mr. P Mr. Hughes, charging them with "pir "plagiarism," and "abuse of confidence," rendered it for the time impossible for eit or others to give any consideration wh his claims. Nothing can be more unfounded accusations! Mr. Preece himself gave, at mouth meeting of the British Association las a clear and thoroughly appreciative desc Edison's carbon telephone, and published printed reports of his lecture which appea public journals. The beautiful results sho the beginning of the present year by Mr. with his microphone were described by h such a manner as to leave no doubt th worked them out quite independently, an had not the slightest intention of appropri credit due to Mr. Edison. It does seem to the physical principle used by Edison in hi telephone and by Hughes in the micropho and the same, and that it is the same as by M. Clérac, of the French "Administr Lignes Télégraphiques," in the "variable carbon tubes," which he had given to Mr. and others for important practical applic early as 1866, and that it depends entire fact long ago pointed out by Du Mon increase of pressure between two cond contact produces diminution of electric between them.

I cannot but think that Mr. Edison will he has let himself be hurried into an inju that he will therefore not rest until he re accusations of bad faith publicly and am made them.

William Th

Yacht Lalla Rookh, Cowes, July 30.

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* From *Nature*.

Three of the Bristol and Exeter Rail pany's engines, which were originally tank with 9ft. driving wheels and bogies at le trailing ends, have been converted int engines; the rear bogie has been remov single pair of wheels substituted, and th wheels reduced from 9ft. to 8ft. diamete alterations were made to enable these e work round with the main-line engines of Duke class.

N.W. Gales and the Sea.—It may be in any gale, whatever the force of the win that those from S.W. never pile up a dang but a few hours after a "north-wester" blowing with equal force, the difference is felt in an unmistakable manner. Further ness of the latter tears the surface water harrow had passed over it. If statistics piled showing the loss of boats and other d ships, they would prove, says the *Nautic zine*, that in nearly every instance the mis been wrought by the north-west sea. It the fetch, since the winds from south certa as great a range as those from the north.

REPLIES TO QUERIES.

⁂ In their answers, Correspondents are respectfully requested to mention, in each instance, the title and number of the query asked.

[32269.]—**Systematic Memory.**—The vice of 'eg's system, in the "Memoria Technica," is, that thing less than a miraculous memory can retain e barbarous jargon into which the things to be membered are crowded. "Old Oxonian" gives a ed sample of its capabilities, and his illustrations the signs of the zodiac will, also, illustrate in a riking way the inferiority of Greg's system to the storial. Instead of trying to remember a fraction each one of a dozen Latin names all jumbled together, read the following twice and repeat it menlly thrice, and then forget it if you can: The ram tted the bull, the bull tossed the twins, the twins e the crab, the crab clawed the lion, the lion ightened the man, the man used the scales to igh the scorpion which stung the centaur, who ot the goat which drunk the water that held the hes.—OLD BINGO.

[33474.]—**Brake for Ore Tram-cars.**—If Mongibello" will advertise his address in the NGLISH MECHANIC I will furnish him with drawgs of a powerful brake that I have invented, which at work on a gradient of 1 in 10, and giving every tisfaction. Simple in construction, instantaneous action, and only requires a small boy to work it. auge, diameter of wheels, and weight similar to Mongibello's."—CONSTANT READER.

[33007.]—**Tuning Forks.**—"Fiddler" thinks my swer to his question a "curious" one. It appears at Mr. Thunder, fifty years ago, was an "old an:" suppose, then, we say that had he lived until 78 he would have been 120 years of age. The fork the possession of the Rev. G. T. Driffield is tolebly well authenticated, and is stated to have been ft by Handel, in 1751, at the Foundling Hospital. was invented by M. Shore, sergeant-trumpeter in e time of H. Purcell. No doubt there are plenty Handelian forks; but, unless "Fiddler" can ow that Handel tuned with something else, I think is fork of 127 years old (and how much more?) uld not have been made by Mr. Thunder. This is e best record I can give: probably other readers n supply further particulars.—S. M.

[33079.]—**To Watch Jobbers (U.Q.).**—Let Country Jobber" purchase a tool for centring and rilling pinions for replacing pivots, price about s., in case, which can be had at most tool shops, nd it will do all that he requires.—AMATEUR.

[33151.]—**Drying Oils.**—"Dandie Dinmont" akes exception to my explanation of the action of riers upon oils, and so far as it goes in the abstract, is is a pertinent inquiry. I said, p. 477, that "boilg with litharge and other substances facilitates e absorption of oxygen by removing from the oil bstances which would tend to keep it liquid." D. D.," p. 530, believes that "driers act through tting the oil into a more active state—that is, ey impart to it an increased power of absorbing xygen." That, I imagine, is a distinction without difference, and my explanation, though not satisactory, does attempt to point out the cause of the fact. When we speak of removing substances from he oil we do not mean they are necessarily precipiated, for, if certain bodies are broken up into their mponents, or changed, they are practically removed, because they exist no longer in their original tate. That is supposed to be the action of driers hich facilitate the absorption of oxygen by oil, probably by changing some of the components.—S. L.

[33156.]—**Cupola.**—Mr. Holland, of Sheffield, ad a paper on "The Manufacture of Bessemer teel," as carried out at Brown, Bayley, and Dixon, imited, which "Cupola" will find in *Journal* of on and Steel Institute, No. 1, 1878. In this paper e states that, with blast heated to 400°—500° F., ad of 1lb. pressure, 1,079¾ tons pig (hæmatite, or essemer) took 70 tons coke—1cwt. 1qr. 5¼lb. per n, say. And 2,187 tons pig were melted with 114 ns coke, say 1cwt. 1qr. 7½lb. per ton pig charged. s regards time, 8 tons had frequently been melted half an hour. This was regarded by the eminently ractical and experienced ironmasters present as ry excellent work. A saving of 2cwt. coke per ton as claimed for the hot blast over the previous plan f working the cupolas. Now, our friend, "Cupola," ithout hot blast works with 147lb. coke, or, practically speaking, every whit as economically as above stance of first-class practice. I think we ought ther to seek information from him, as he evidently nderstands the business better than most ironounders, which, probably may account for his difficulties in obtaining the information he seeks. ersonally I can only refer him to "Crooke's and ohrig's Metallurgy of Iron," p. 590, &c., where he ill find that there are reasons which are found in ractice to limit the value of heated blast in cupola ractice. As regards his "theoretical" fuel requirement I fail to perceive any allowance for fusion of e flux acid coke ashes. This item, and waste heat ly allowed for, ought to reconcile him to the 14lb. case fuel used.—F. W. S.

[33240.]—**Insoluble Gelatine.**—Gelatine may be ot clear, and yet rendered insoluble, by mixing th it when in solution about three grains of alum, which is best added in a weak solution, and well mixed; when dry it is insoluble, and keeps well.—FINEM RESPICE.

[33251.]—**Parallel Motion.**—"Fitter's Apprentice" may true his parallel motion by setting the centres of the gudgeons to their original distances by means of liners. For liners between the brasses use thin sheet brass, and between the pillars or distance blocks use sheet iron.—WEAR ENGINEER.

[33204.]—**Anti-corrosive Metal.**—"Guido" in search of an anti-corrosive metal, to permanently withstand the action of ordinary black inks, and not much dearer than brass, is not likely to find what he wants. Such a query seems remarkably too simple to me, for, if such a metal were known, there are not a few pen-makers who would pay liberally for the information. "Guido" should experiment with various metals, and try the electric process of washing, say, steel, with an incorrodible metal. He may rest assured that nobody knows of such an article as he wants.—BRUM.

[33300.]—**Drying Closet.**—I doubt whether the pipes as described would do more than heat the room 10° above external temperature.—J. T. M.

[33306.]—**Glue for Violin.**—Try the best clear glue rather thin, slip it in with a thin knife, and clamp the part until dry.—S. M. P.

[33311.]—**Smell of Creosote.**—The odour of creosote cannot be removed, but it may be smothered with other scents. Wash out the writing-desk with benzoline (out of doors in the daylight), and try what effect camphor, essence of bergamot, oil of thyme, pennyroyal, cloves, ambergris, or indeed any scent you prefer, will have upon it when left in and shut up for some time.—J. P.

[33325.]—**Measuring Heating Surface of Firebox.**—Add together the area of the two sides, the top, the back and front (deducting the area of tubes and door), and the heating surface is apparent in either inches or feet, as you please.—OMICRON.

[33326.]—**Hard Enamel Paint.**—You want one of Szerelmey's paints, but perhaps ordinary paint mixed with copal varnish, instead of oil and turps, would answer the purpose. Get a small quantity of ready-ground paint from the oilshop, and tell them to add varnish instead of oil.—J. O.

[33329.]—**Hydraulic.**—"L. W." means the accumulator. It consists of a strong cylinder with a plunger. The latter carries strong cross-heads, attached to which are tanks loaded with stones The engine pumps water in and forces the plunger with its load up to the full extent of its stroke. The system of pipes being also full of water, it will be seen that it is only necessary to open a valve to obtain a pressure per square inch equal to the weight on the accumulator plus that due to height of water above level of site of application of power—less, of course, friction.—OBERHOF.

[33330.]—**Casting Plaster Medallions.**—Sulphur is the best substance for moulds; but, if the original would be injured by the heat of the molten sulphur, try guttapercha, softened in boiling water, and put under a press until cold. Oil the mould carefully, and put a rim round it. The rim is easily made by dipping a strip of thin paper about 1in. wide in melted paraffin, and passing it around the edge; then wind other strips of plain paper over it, and paste the end. The object is to make a ring which can be slipped on and off the mould, and yet fit it so closely as to prevent the plaster getting in between. Mix the best plaster rather thin (try this: no one can give a plainer direction), and pour over the mould. With a clean camel-hair brush work all over the face of the mould, through the plaster, to remove air bubbles, and you should obtain a fine casting. Like other things, a little practice is better than a bushel of words.—GIUSEPPE DENZI.

[33331.]—**Breadth of Organ Pipes.**—If "C. T. S." will look in the back volumes he will find plenty of scales for organ pipes. If he cannot find them, or has not back Nos., I will look him up a few references, if he will write and say so—that is, unless some one answers his query before.—E. G.

[33348.]—**Crack in Clarinet.**—Run in glue, and bind round well until dry.—O. S.

[33360.]—**Willows.**—If "Semaj" will plant his willows in September 1 foot deep, and cut off the tops so as to leave only 1 joint above ground there will be nothing for the children to lay hold of, and by the time they begin to grow they will have formed roots. I don't think any of the willows seed; at the same time I am doubtful of cuttings doing much good if planted in grass. It is pretty nigh certain that seed would not grow in that case, as even weeds will kill young seedlings.—G. D.

[33368.]—**Hay Fever.**—Thanks to "Incog." I think he will be glad to learn he has taken a remarkably correct view of the treatment of this complaint. I have adopted his suggestions, and find that the benzoline is a local resolvent of much greater efficacy than the glycerine I formerly used. The chlorate of potass and the benzoline together have certainly done me good, only they have resolved to choke me, I think, as I am now frequently nearly choked with the stringy phlegm set loose. I may add I gave some of the benzoline and olive oil to a lady to rub her little girl's throat with, who has been very deaf since down with scarlet fever, and "Incog." will be glad to hear it has relieved the child already, as she can decidedly hear better since its application. I understand that ordinary paraffin oil, well rubbed in, is known to greatly relieve rheumatism. Does this statement accord with "Incog.'s" experience? I should be very glad to have the means of communicating with him further as to hay fever, which I also have had for 21 years; but, unlike Professor Helmholtz, have been unable to get rid of by using quinine. In return for his ideas as to the treatment desirable I could give "Incog." full details of my experiences, and, I think, he would then understand hay fever more exactly, and so be better able to relieve it more certainly.—F. W. S.

[33372.]—**Sulphuric Acid.**—Warm H_2SO_4 having a specific gravity between 1¼ and 1½, containing about 79 or 80 per cent. of water, forms about the best strength of the acid for combining with scrap iron. The iron is dissolved in the acid in vessels lined with lead, and the neutral solution is evaporated until a portion of the liquid on being rapidly cooled deposits a sufficient amount of the salt. At this juncture the evaporation is stopped, and after settling the liquid is drawn off from the sediment into tanks, where it is left for a day to clear, and it is afterwards run into the crystallising vessels. Pieces of wood are placed across these vessels, from which string, straw, or wood is suspended, passing down into the fluid, so as to facilitate the formation of the crystals of ferrous sulphate. When the crystallisation is completed, the mother liquid is drawn off, and the crystals taken out, washed with water, and dried. But the best method of drying is to place the crystals on a filter, and wash with alcohol, which removes any trace of ferric sulphate, which if not removed, would speedily initiate a state of higher oxidation, and so spoil the crystals. However, these crystals are produced in large quantities by other methods.—HUGH CLEMENTS.

[33387.]—**Silico Ethers.**—"One in a Fog" is correct in stating that the sum of the elements in silicic triethylate and siliconylic alcohol are identical. It is one of the leading peculiarities of organic chemistry that it includes in its domain many compounds having other compounds called isomers, the sum of the elements being equal, but the properties different. There is, therefore, nothing very unusual or remarkable in the above statement. Ethylic diethoxalate may be written $CEt_2HOCOEtO$, transformed into $CEt_2EtOCOHO$ or into $C_7H_{15}COHO$ gives the formula for caprylic. Chlorether $(C_2H_4Cl)_2O$, ethyl-chlorether $(C_2H_4)_2EtClO$, and diethylated ethylic ether may be written $(C_2H_4Et)_2O$. On what authority does "One in a Fog" state that the silicon compounds referred to are one volume?—HUGH CLEMENTS.

[33488.]—**Greenhouse.**—The building Acts will only apply to residences, public rooms, and places where large numbers of people assemble. If "Nemo" should build his glass house where persons' limbs or lives may be imperilled, no doubt the building surveyors would be down upon him; otherwise they are not likely to trouble themselves about the question. Why not have gone to the public offices (surveyor or borough engineer's department), and ask the question straight. He then would have obtained authoritative information.—RED HERRING.

[33493.]—**Writer's Cramp or Scrivener's Palsy.**—Noticing the reply of "R. P. G.," Harcourt House, Anerley, I cannot forbear telling the querist a little bit of my experience. I, too, am a victim (as I suppose) to the above-named affliction, and have consulted four medical men for the same. No. 1 gave me medicine, but did not think electricity would be of any service. Result, *nil*. No. 2 (twelve months after) gave strychnine, and advised the employment of galvanism. Result: After one bottle, slight improvement in appetite and spirits; after second bottle, stationary; during third bottle results most disastrous, violent palpitation of the heart, difficulty of breathing, and a period of nervous terror and anxiety I shudder to think of, followed by symptons of diabetes and wasting of muscles. No. 3 was called in at this time (No. 2 being out of the way), who gave soothing medicine of some kind—bromide of potassium, I think. He made light of the cramp or palsy. Didn't know of it, apparently. Had never seen a case. Gave it up of his own accord. No. 4 called in, and was told the whole history of the case. Advised going to a hydropathic establishment for two months. Took some medicine for the improvement of the stomach, and followed his advice in regard to diet with advantage. Did not go to the hydropathic establishment—expense too great. Present condition, nine months after: In fair health, out of employment, cramp much about the same. My advice is, have nothing to do with drugs, especially strychnine; attend to diet, confine yourself to vegetables, fruits, and farinacea, get glenty of fresh air and exercise, try to forget your affliction, and hope for the best. Can anybody improve upon this?—VICTIM NO. 2.

[33493.]—**Writer's Cramp.**—I would suggest a type-writer. Remington's is worked with foot and any finger (one) of either hand. Altissaf's has a handle to turn. These are, however, costly, probably more so than "Scrivener" can afford (about £31).—GEOFF.

[33504.]—**Honey Dew—Aphides—American Blight.**—On page 533, "G. J. H." contradicts my statement that the "feathery specks of white" are produced by an aphis (the American blight), and says that they are the aphides themselves. Now, the aphis itself is a fat-looking reddish-brown insect, not unlike the familiar "Norfolk Howard" on a small scale, and no doubt if it could and did read the ENGLISH MECHANIC would be greatly astonished at being described, as it is by "G. J. H.," as "a feathery speck of white." The feathery filaments that cover and protect the insects are no more the aphides than the cocoon is the chrysalis; moreover, it is not the white filaments that stain, but the blood of the insect. If "G. J. H." will advertise his address I shall be happy to send him some fine specimens of the American blight, for I have enough and to spare of these interesting but troublesome insects.—R. P. G.

[33519.]—**Civil Service Examinations.**—As "Micawber" has kindly consented to furnish any information he could in these examinations, I would ask if he would oblige me with particulars of qualifications required for Post-office and Copyhold and Inclosure Commission (in Patronage Department)? Who are best as nominators—peers of the realm or M.P.'s—and also is it necessary that the nominator should be a member of the Government in office at the time the nomination takes place?—ENQUIRER.

[33523.]—**The Isle of Man.**—A single man can live there on £50 a year, no doubt. There are four towns. Douglas, the principal one, will not do for an asthmatic person, as it is on a dry subsoil. It always makes me short-breathed when I go there. Castletown and Peel are very dull towns. Ramsay is pretty, and, I think, suitable for persons affected with their breathing. One side of the town is alluvial, the other side sandy, where damp will necessarily drain off with rapidity. "Handy Man" would undoubtedly escape the London fogs, but I don't know about gloomy skies. One of the chief products of the island is rain, with wind *ad lib.* It is not cold in winter—very little frost or snow. Any one with a fair share of health may enjoy himself there very much, especially if possessing proclivities for salt-water fishing. I prefer Port Erin or Port St. Mary, fishing villages at the south end of the island, where the air is very bracing, with a trifle less of rain, and a sandy subsoil. But lodgings there are not so plentiful. I don't think he would be disappointed at trying one of the two last-named places, particularly if he admires wild rock scenery, similar to that of Cornwall, but of course on a smaller scale. I do not know anything of Jersey, and so cannot enter into any comparison.—RED HERRING.

[33529.]—**Tank.**—It is much to be wished that persons who write queries would read them over before despatching them to "our" Editor. What is meant by "a tank, 12ft. long and 6ft. wide, and about the same in depth?" It, fortunately, does not affect the question. Why not try concrete? Just the very thing, I should think.—RED HERRING.

[33531.]—**Artificial Stone.**—Does Alfred Stone know that the blocks he saw are not concrete? It is quite common now in large towns to lay down a large concrete bed upon which the stone pavement is imposed.—RED HERRING.

[33543.]—**Nocturnes and Harmonies.**—If "K. S." would go to the Grosvenor Gallery, Bond-street, London, he would see drawings, by Whistler, called nocturnes, in blue and gold, &c., and would get a much clearer idea than from any explanations of them.—ARCHIMEDES.

[33544.]—**Spring Brass.**—Hard rolled brass may be obtained at many tool-shops, or soft sheet may be hardened by hammering.—S. D. K.

[33548.]—**Multiplication.**—You cannot correctly speak of multiplying ½in. by ½in., any more than you can speak of multiplying two apples by three oranges. It is true, however, that ½in. × ½ = ¼in., for this reason:—Multiplying ½ by 3 (for instance) means taking the ½ three times; so multiplying ½ by ½ means taking the ½ half a time. The term multiplication is here used as describing the process, and not in its strict sense of actual increase. If, however, "Erasmus" is thinking of a square inch, a simple diagram will clear up his difficulty. Let him draw a square inch, and divide it into 4 equal smaller squares by lines bisecting the sides. Then each small square will be ¼ square inch, and its sides will be ½ lineal inch.—S. D. K.

[33548.]—**Multiplication.**—It is incorrect logically to multiply inches by inches, because you cannot say, "an inch times an inch." But, as it is necessary that we should know what we are multiplying, and what our answer is to be, we say that ½in. multiplied by ½in. = ¼ square inch (not ¼in., as "Erasmus" puts it). We must distinguish this operation from ½in. multiplied by ½, which gives ¼in., or from ½in. multiplied by ½ sq. in., which gives ¼ cub. in. And so on. Perhaps the more common word "by" expresses the same most logically, as, "a piece of wood ½in. by ½in. has an area of ¼ sq. in.," although this also expresses the idea of "multiplication by." Conclusion: Although the numbers only are multiplied, the denomination must be taken into account.—PLONI ALMONI.

[33548.]—**Multiplication.**—"F. R. A. S." has seen the flaw in the question; but it is not an unusual one in workshops, and he can easily understand how it is introduced in connection with bars of ½in. section. "A. E. S." gives the correct explanation according to the arithmeticians, and seems to think it extraordinary that any one acknowledging its correctness should ask if it would not be better to employ some other word. In questions of this kind, if it be agreed that a word shall have a certain meaning, all applications, if in accordance with that meaning, will be accepted as correct by those who understand it, but those who do not so understand it are often puzzled. "To multiply" usually conveys the idea of increase;" when, then, a ½ multiplied by ½ is said to equal ¼, the non-mathematical person is apt to ask how by multiplication anything can be decreased, and what is the difference between the so-called multiplication and the division of a ½ by 2?—ERASMUS.

[33551.]—**Wheel Gearing.**—A wheel having two-thirds the number of teeth of same pitch must, of course, be two-thirds the diameter—*i.e.* 1in. Pinion will similarly be ½in. diameter.—S. D. K.

[33556.]—**Chemistry**—For a beginner may be learnt from Miller's "Inorganic Chemistry," in "Textbooks of Science" (Longmans, 3s. 6d.), which gives experiments; or Roscoe's "Elementary Chemistry," which gives outlines of many of the most important experiments. When these—or one of them—are read through, you will judge what further works to read.—PLONI ALMONI.

[33556.]—**Chemistry.**—On commencing to study chemistry I was advised by my teacher to read only Buckmaster's "Elementary Chemistry" for the first stage South Kensington examination, May, 1877, by which I got a Queen's prize. Under the same advice, last winter I read Buckmaster's "Advanced Chemistry," with Valentin's "Analysis," by which, at the May examination this year, I got a Queen's prize.—J. M. S.

[33556.]—**Chemistry.**—Read and study Fownes' "Manual of Chemistry" for the theoretical part, and Stevenson's "Macadam's Practical Chemistry" for the practical part of your study.—D. STRATHEARN, Medical Student.

[33558.]—**Unfermented Wines.**—Many of these are shams, and not what they profess to be:—"'Tis ginger wine, from the home-brewed bin; and it's got no spirit, for I put none in." Distil it in a small retort, and test the distillate which comes over for alcohol, by the hydrometer (alcohol, of course, is lighter than water), or by smell.—PLONI ALMONI.

[33562.]—**Chemical.**—I think "Miller" advises the iodine to be put in first with water, and then the phosphorus added. If you can get a stoppered retort, put phosphorus and water into the retort; then attach the flask containing powdered iodine to the tubulure of the retort by an indiarubber tube. You can thus add small quantities at a time, without admitting air. Another way is by gently heating a mixture of the same ingredients with KI, when the gas will be given off. If a solution is desired, pass H_2S through powdered iodine suspended in water, which will liberate sulphur, and leave HI in solution—$2I_2 + 2H_2S = 4HI + S_2$.—PLONI ALMONI.

[33562.]—**Chemical.**—I have not Miller's "Chemistry," but Buckmaster says:—"Place a small piece of dry phosphorus in a dry test-tube, cover it with eleven times its weight of iodine, when the two bodies combine. After the action is over, add water, when hydriodic and phosphorous acids are formed." The H I is then collected by displacement.—J. M. S.

[33567.]—**Ancient Literature.**—Translation of Deluge tablet given in *Daily Telegraph*, for Dec. 4, 1872.—B.

[33567.]—**Ancient Literature.**—The Râmâyana and Mahâbhârata were reviewed in the *Telegraph*, 19th May, 1875; the Creation (Smith's discoveries), *Telegraph*, 4th March, 1875. Mr. Smith gave a lecture on his discoveries which was reported in the *Daily Telegraph* of 12th April, 1875. There is a leading article upon them in *Nature* of 8th April, 1875, relating chiefly to the Deluge. Has E. Sprague read "Childhood of Religions," by Edward Clodd? School edition is 1s. 6d. Professor Max Müller's lectures are being published in one of the 2s. 6d. reviews, but I shall be glad to know if they are to be published separately, and the price. The first lecture appeared in the *Times* of 26th April, 1878, and the last on 7th June, 1878. I did not see the others.—S. V.

[33570.]—**The Leamington Kitchen Range.**—In answer to "Engineer," I would say that having had a Leamington range (Flavel's) in my house for about 15 years, I find it answers well in every respect—convenient and economical. See that it is set by efficient workmen.—A. W.

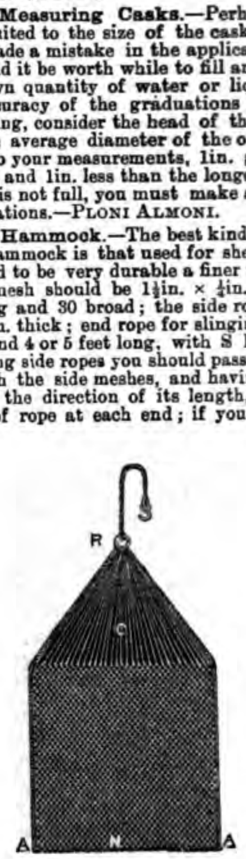
[33570.]—**The Leamington Kitchen Range.**—The Leamington range is expensive to start with, and, I think, wasteful. It will work well if the flues are kept clean (a sweep's job about every 5 to 7 weeks). Everything you cook is smelt all over the house. "Engineer" does not say for what purpose the range is required. If for hotel use a 5ft. by 6ft. range would cook a dinner for 50. For a private house there is nothing to beat the open fire and oven, so common years ago, and the next best in my experience is the "Newark range." I have lived in four houses with Leamington ranges, and must say they were anything but satisfactory, and in the two last residences I removed them. In one I put a plain open fire and oven, and in the last the Newark range, and each gave satisfaction to all concerned, even to cook, which though last named, was of the greatest importance. You may buy Leamington ranges in every builder's yard in this town (Birmingham), almost as good as new ones, which have been removed simply to make room for others. The Leamington range, in my experience, is rather an extravagant fire grate, not easy to manage, and calculated
one out of temper with the smell of cookery a
coal bill.—BESSIE.

[33571.]—**Communication Between**
Shops.—I think "T. R." will find the co
speaking tube will be much the best and least
sive to put up, since he would have to hire
phone from the company at £5 a year, as t
not sell them, and the speaking tube, when o
up, never gets out of order.—ARCHIMEDES.

[33571.]—**Communication between**
Shops.—By all means fix a speaking tube.
will find it simple, effective, and always in
and first cost would not, if distance is small,
greater than for telephones. 1in. iron g
answers well.—S. D. K.

[33575.]—**Measuring Casks.**—Perhaps t
used is unsuited to the size of the cask, or p
you have made a mistake in the application o
rule. Would it be worth while to fill an empt
with a known quantity of water or liquid,
test the accuracy of the graduations of th
In calculating, consider the head of the cask
circle of the average diameter of the oval—t
according to your measurements, 1in. greate
the shorter, and 1in. less than the longer dia
If the cask is not full, you must make allowa
your calculations.—PLONI ALMONI.

[33578.]—**Hammock.**—The best kind of tw
netting a hammock is that used for sheep ne
not required to be very durable a finer twine
do. The mesh should be 1½in. × ¼in.; the
meshes long and 30 broad; the side ropes of
sash-line ⅜in. thick; end rope for slinging ha
½in. thick and 4 or 5 feet long, with S hook a
In measuring side ropes you should pass them i
out through the side meshes, and having str
the net in the direction of its length, leave
18 inches of rope at each end; if you neglec



your hammock will be too baggy. A A, side
C, clews, which should be about double the th
of twine used in net; R, stout iron ring ab
inches in diameter, into which side and en
are neatly spliced. In fixing the clews, k
end of twine to mesh nearest the side ro
twine through ring, and knot to next mesh.
cut it off and proceed in the same way with t
meshes. This will avoid knotting clews
A pair of sticks notched at ends will be ver
as spreaders. I have had a hammock 4 years
to this, which I made myself, and it is still i
W. A. R.

[33581.]—**Midland Bogie Engines.**—I
inform "W. E. H." (page 507) that several
have been changed as follows:—1,250 an
(tanks) are now 1,280 and 1,281; 1,280 a
(express) are now 1,310 and 1,311; 1,310
(Kitson's) are now 1,312 to 1,321; 1,320
(Dubbs's) are now 1,327 to 1,346. This
done to make room for 5 tanks from the
line, which are now 1,322 to 1,326. 1,347
are a new class; these are the last, but som
are being built.—PASSENGER.

[33586.]—**The North Pole of Magne**
north-seeking pole of a compass or magnet
called its north pole. This is, however, not
correct, as similar poles repel; therefore
which seeks the earth's north pole must re
south polarity. Still, it is always spoken
north pole. As to direction of current p
follows:—Hold telephone with south end
towards your face; then make your batt
nection so that the current may circulate
the wire in the same direction as the ha
watch move if held facing you in the same
as telephone. Another way is to hold teleph
or west of a compass needle at such a dista
the needle is only slightly deflected. Th
battery contact suddenly, and see if the
more or less deflected. If more, you are
less, reverse connections.—S. D. K.

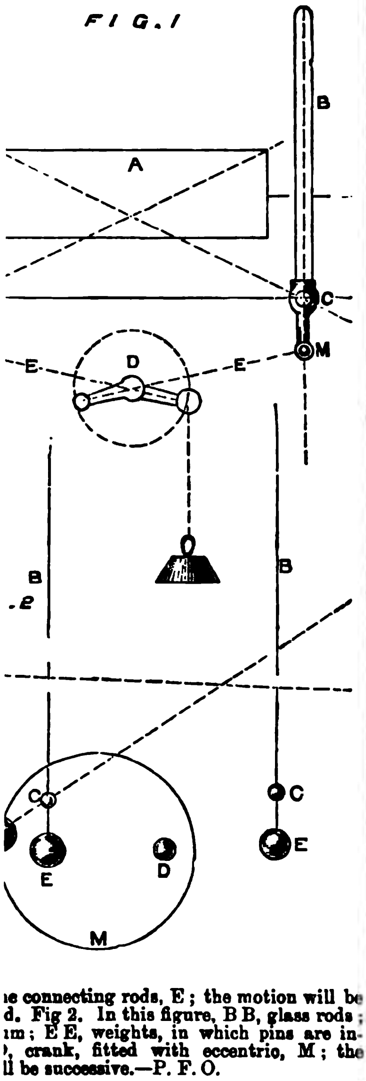
[33586.]—**North Pole of Magnets.**—
like poles attract each other, the pole of th
which the N. pole of the earth attracts is
logical sequence, called the S. pole. The E
practical nation) call it the north pole;

already answered this portion of the gine yourself swimming with the cur- face to the magnet: that pole of the ch lies to your left will be the N. pole Look at your telephone as though about it. Then, if the N. pole be next the the current must circulate against the watch; if the S. pole, with them. To which is N. pole, present one pole of , galvanometer or compass needle. If it) north pole, it is the south pole, and —PLONI ALMONI.

North Pole of Magnets.—In England t pole of a magnet which (when freely points to the geographical north, the f the magnet; but in your case, "What's " Present a suspended magnetic needle of the magnet (say, the end next dia- otice which end of the needle is attracted. 'e your magnet from the telephone and , piece of good soft iron in its place; then attery current each way until you make the iron rod next the diaphragm of the ty (as shown by the suspended needle) as onding end of the telephone magnet. en testing polarity of magnet, in first nust be no current.—J. M. S.

·Mechanical Motion.—I submit the nnexed. In Fig. 1 A is the barrel; B B, ods cemented in the sockets; C C, which in a pin, M M. A double crank, D, re- ween the glass rods connected with M,

FIG. 1



ne connecting rods, E; the motion will be d. Fig 2. In this figure, B B, glass rods; im; E E, weights, in which pins are in-), crank, fitted with eccentric, M; the ll be successive.—P. F. O.

—Bismuth for Plumbers.—Commercial i.e., not chemically pure—which, I sup- be about 9s. per lb.—PLONI ALMONI.

— Lathe Crank. — I presume that s" is only a single crank, and he is advised double crank. If he tries it he will find a erence in the working with a double crank ne has another separate treadle for help ut by all means couple them upon one JACK OF ALL TRADES.

—Lathe Crank.—Have your crank at les, and as you do not both then "tread" your power is more equally distributed, and avoid dead centres (almost). You will find working gain of about 25 per cent.—FINEM

—Powdered Wood Charcoal.—Distil d retort, and observe whether coal-gas —NIGHTS.

[33596.]—Powdered Wood Charcoal.—If W. Foster will take 100 grains of the charcoal and heat it in a small crucible to a red heat, and allow it to cool, the difference in weight will represent the loss if coal has been added. If he then heats the residue to a red heat, so as to burn away all the carbon, the residue will represent the weight of any inorganic matter added to the original mixture.—ANON.

[33596.]—Powdered Wood Charcoal.—To test the above, take an ordinary flower pot—those called thumb pots will do—stop the hole in bottom with clay, fill nearly to the brim with dust and cover the top with clay, inserting a piece of iron tube—tobacco pipe, or glass tube will do. Stand it on the hob and allow to get gradually dry, then plunge the pot into the crown of your kitchen fire. In time, if coal is there, you will have a gas come through the tube that will ignite upon the application of a light; if soot is there you will detect it by the smell and white fumes; if pure charcoal no visible fumes will arise. —JACK OF ALL TRADES.

[33599.]—Rubber Stamps.—I do not know the process by which they are made, but will tell you how I think they can be made. Get some good type and good plaster of Paris, set up the type in a frame the size which you require, and make a mould or take a cast of it. Now, get some good vulcanised rubber sheet, about 3-16in., and subject it to the vapour of bisulphide of carbon. Thus: Take a soup-plate or saucer and half fill with water, in this put another small glass saucer, with a portion of bisulphide of carbon in, cover this with a gridiron, perforated plate, or gauze wire, upon this put your rubber, and cover the whole with a bell-glass, and let stand for some time. Take it out, and you will find that it is soft. Put it into your mould, and subject the whole to pressure and about 220 degrees of heat, taking care that the heat is applied gradually. This will drive off the bisulphide, and according to heat applied, so will it vary in pliability. The higher the heat the harder the rubber will be, but 260 degrees is the highest it should be subjected to.—JACK OF ALL TRADES.

[33600.]—Expansion.—The simplest and cheapest would be to get a new slide-valve with more lap, and shift the eccentric to suit. If this will not do, put a separate valve in the steam-pipe, and work it with an independent eccentric or tappets.—WEAR ENGINEER.

[33601.]—Haydn.—There were two Haydns—viz., the great Joseph, whose works are known and admired everywhere, and his brother, Michael. Of the latter Dr. Busby says, "According to the testimony of his brother, Michael Haydn was in no way inferior to himself as a musical genius, though he has not been equally distinguished and successful." They neither of them left any family. The English composers, George Hayden, circa 1723, and Thomas Haydon, circa 1810, should not be confounded with the above.—NE SUTOR.

[33605.]—Brickmaking.—The Hoffman kiln is said to use about 1cwt. of very small good coal per thousand bricks burnt; and it has other advantages, such as saving in labour, cost of the bricks, and convenience for customers, who can rely upon finding a kiln opened every day. The first cost, however, is high, say, £1,200 to £1,500.—F. W. S.

[33606.]—Blacking Ironwork.—This is done by heating to a red heat, quenching in oil, and blazing off by holding the quickly-dipped iron over a fire.—OMEGA.

[33606.]—Blacking Ironwork.—Hinges, rim locks, and small ironmongery are coated with Brunswick black, which is a solution of asphaltum in linseed oil. For larger works, melt ¾lb. asphaltum and ¼lb. resin in 2lb. tar oil in an iron kettle, and when cold it is ready for use.—GIMCRACK.

[33610.]—Aquarium Cement.—Mix white and red lead together with stiff gold size to the consistency of dough. A little lampblack will darken it. This sets quickly, and becomes as hard as iron in a few days. The various complicated receipts are all troublesome bosh. Small aquariums are best made of sash-bar zinc. This is not expensive, and easily soldered together. There should always be a zinc bottom under the slate, above which a perforated zinc bottom raised about an inch and movable will keep the water clear. Do not place the aquarium in too sunny a position, and keep it shaded in very bright weather.—JACK OF ALL TRADES AND MASTER OF NONE.

[33610.]—Aquarium Cement.—Try indiarubber dissolved in naphtha, and a little emery added.—SUSSEX.

[33614.]—Plaster of Paris.—The plaster of Paris figures carried about by the Italians are cast in plaster moulds, cast by themselves in segments. Some of them consist of many pieces. Take a walk to Leather-lane, London, and see the seams upon the unfinished figures. Every one of those shown upon the figures are junctions in the mould.—JACK OF ALL TRADES.

[33614.]—Plaster of Paris.—Plaster of Paris figures are cast in plaster of Paris moulds. When the moulds are in pieces, so as to be removed from the cast with ease, they are called safe or piece moulds. The pieces are saturated with boiled oil, and are oiled slightly every time they are used. When the pieces are numerous they are covered with an outer case—also of plaster of Paris—in two pieces. The mould is fitted together, bound with strong cord, the gauged plaster (plaster mixed with water to the consistence of batter) is poured into the mould, and the mould turned about so as to insure a nearly equal thickness of plaster in every part of the cast. When the cast has set or hardened the mould is carefully removed, and the process repeated if more casts than one are required. The thin ridges covering a rough plaster cast are the marks left by the joints of the mould. A waste mould is made by covering a figure modelled in wet clay or wax with plaster of Paris. The mould is in two pieces if the model is of clay, in which case, when the plaster is hard, it is forced off the clay figure, and the latter picked and washed out of every part. If a wax model is used it may be melted out by placing the mould in a dish or pan over a stove. The plaster mould is then soaked in water until perfectly saturated and filled with gauged plaster. When the cast is set hard, the mould is chipped off with a carpenter's chisel and mallet, care being taken not to chip off any part of the inclosed figure. This process is called "knocking out." To guard against injury to the cast the waste mould is usually made of plaster coloured with red or yellow ochre. Large moulds are strengthened with rods of iron bent as necessary and imbedded in the plaster.—GIMCRACK.

[33616.]—Turkey Red.—Subject the parts that you want white to pressure between two dies while the other is being dyed, and after the article is dried the pressure removed, and you will find the pattern white.—JACK OF ALL TRADES.

[33616.]—Operetta.—Try at Pitman's, 20, Paternoster-row.—NE SUTOR.

[33620.]—Microscopical.—Having dissected your insect, boil for a few seconds in caustic potash. Wash well to remove all traces of potash, and arrange the dissections on a glass slip. Drain off all water with a piece of blotting paper, and drop on a few drops of acetic acid. Cover with another glass slip, and let it remain for an hour or two; then wash away all traces of acid, and thoroughly clean the dissections. If you intend mounting in jelly, transfer now to glycerine; but if you prefer balsam as the mounting medium the objects must be thoroughly dried between two pieces of paper. (I prefer paper which has not been sized for this purpose.) When quite dry, immerse for an hour in absolute alcohol, and then in turpentine or oil of cloves till transparent. The alcohol will remove any traces of dampness, and expel the air from the objects. In selecting pieces of the skin of onion for mounting see that they are not opaque. Some parts are quite useless for your purpose. If you select the transparent parts, and dry them under pressure, treating them afterwards with alcohol and turpentine, you ought to have no difficulty in making good mounts of them. The skin of the eschalot is much better for your purpose than the common onion.—THOMAS LISLE.

[33620.]—Microscopic.—First place your leg of dytiscus in potash for two or three days; then take it out, wash it well in water, and place it in turpentine for about a week; then get a tin cell the size suitable for your object, and place the leg in; then pour your Canada balsam upon it, and slightly warm, to displace air bubbles; then add some more balsam until the cell is quite full, and free from bubbles; then take a warm cover, and place it on. When all is finished give a good coating of spirit varnish.—SUSSEX.

[33621.]—Artist's Canvas.—The raw canvas must be stretched on a frame, wetted, and restretched if loosened by wetting, and coated with a mixture of equal parts of dry whiting and white lead, ground up with raw and boiled linseed oil, and laid on with a trowel like a plasterer's trowel, but longer and thinner in the blade. If the canvas shows through the first coat, a second and a third may be applied, the under coats being rubbed down with pumice stone. A little raw umber may be added if a stone-coloured surface is preferred. The use of the trowel, of course, requires the dexterity acquired by long practice.—GIMCRACK.

[33625.]—Boat Building.—"W. A. R." will, I think, find it best to build his flat-bottomed boat of two thicknesses of thin (3-16) white deal, with canvas between. The templates or moulds may be of ¾ pine, 3ft. 4in. long, 11 wide, and 4ft. apart, fastened together in the middle of each by two thinner boards, 4ft. long, 11 wide, placed at right angles to the moulds, and 1½in. apart. These last will form the case for the centre board, and will allow the latter to be shifted a little as trial may prove advisable. Nail the first thickness of the bottom to the under side of the moulds and centre-board case, strengthening the latter with strong fillets where it joins the bottom and moulds, and nailing cross fillets across the bottom, inside, at 1ft. apart., with bracket-irons here and there to the sides of the centre-board casing. The side may be of 3-16in., white deal bent to the form of the boat, nailed to the ends of the moulds, and to strong fillets curved and fitted to the edges of the bottom, and to the stem and stern posts. These last, of oak or elm, 6in. wide, 16in. high, set up on and nailed to the bottom. The stem and stern posts should be cut out of 1½in. planks, and have a rabbet cut out deep enough to receive both thicknesses of the skin flush. The top edges of the moulds will support the thwarts or seats, and these last will also be attached to the sides by knees or iron brackets. When the first thickness is fitted on it should have several coats of white lead and boiled oil (or of tar), and the canvas should be laid down on the last coat while it is tacky. Then several coats of paint should be applied to the canvas, and the outer skin of wood put on while the last coat of paint is wet or tacky, and longitudinal runners of oak should be securely fastened to the under side of the bottom for strength and for security when the boat takes the ground. A boat of the dimensions given would have a displacement of about 180lb. for every inch of draught, and with two persons, should draw less than 4in. of water. For smooth water she need not have more than 8in. of freeboard, though if the stem and stern rise a foot out of the water the sheer thus gained would improve her appearance very much. The centre of the submerged part of the centre board should be vertically under the centre of the area of the sail, or a little forward of this to insure a good weather helm. A standing by with a light boom and the mast stepped very near the stem would be a simpler, and therefore handier rig than a sprit-sail and fore-sail. It would be advisable to make the sides quite straight for about 4ft. in the middle, and perhaps to deck over the fore and after parts. Such a boat would sail about 2 points close, with her centre board down; but, of course, without it she would only run before the wind, and that very wildly. —GIMCRACK.

[33627.]—**Musical.**—"Punch's" advice "to persons about to marry" is "don't;" and, from experience, I would say the same, to prevent any person from entering upon what, to the vast majority, is a very precarious profession, and especially to one who seems to have so little idea of the time requisite to become a first-rate artist, while the competition among the numbers of those whose impetuous desire to become musicians will, in a few years, reduce the already scanty incomes of professors to a very low ebb indeed. I see, in a circular from Trinity College, London, that the number of enrolled local musical students is 10,580! How many more thousands unenrolled there may be who can tell? Probably, 20 times as many. If, therefore, "Amor Musicæ" can insure a respectable livelihood as a bookseller, I would earnestly advise him to restrain his impetuous desire to the extent of cultivating his taste for music only as a pastime or relaxation from the toils of business.—F. F. C.

[33627.]—**Amor Musicæ.**—I do not like to take the responsibility of advising you to enter a profession which, in London, is notoriously overstocked; but, I suppose, the "impetuosity" of your desire will prompt you to try it anyhow. I take it for granted you have some knowledge of music, and that you can play a little on a keyed instrument; if not, don't dream of becoming an organist at your age. You seem to think that in your spare hours, after a hard day's work, you can "pick up" the organ, the violin, and theory. Oh, the ambition of youth! and alas, the disappointment so frequently following such aspirations! Why, when I was studying, I devoted 7 hours a day, 5 days a week, for 7 long years to the organ and theory alone. However, talent and perseverance will do wonders, and if in your bookselling experience you have picked up a little knowledge of the sheet music trade, you will stand a chance of getting a berth in one of the great music publishing houses, of which Cocks and Co., and Novello are the only people likely to give employment to one not brought up to the trade. Try Novello's first, addressing Mr. Littleton personally. They employ a great many people otherwise than behind the counter. And now we will suppose you have obtained employment, and got away from business about 6 o'clock: you want to know where to go to learn. You can go either to Scotson's Clark's organ school, Vigo-street, where you can get instruction in your three branches during the evenings, with the advantage of having the choice of organs in several parts of London; or you might enter as a student at Trinity College, where you would be taught harmony on Monday evenings, organ on Wednesday evenings, and violin on Wednesdays. Write for a syllabus the Secretary, Trinity College, Weymouth-street, Portland-place, W. But the more excellent way would be to article yourself for four years to some well-known church musician, by whom you would be thoroughly taught the organ and theory, with abundant opportunities of playing services, and learning choir management. You can generally find an advertisement for an articled pupil in the *Musical Times*; but if you think well of this plan in six months' time, I will willingly advise you in your choice of masters. In the meantime read up Bannister's "Music," which I have so often recommended, and grind away at Rinck's "First Three Months at the Organ" on any keyed instrument you can get at.—NE SUTOR.

[33628.]—**Diving.**—I think that "Law Student," in his query, has correctly named most of the reasons why the hands are usually placed before the head in diving. I have never read Mrs. Brassey's book, and "Law Student" does not say whether the natives of one of the South Sea Islands dive with or without the hands in front of the head. I myself, however, have never had curiosity enough to induce me to try the effect of diving without them so placed, and should be very unwilling to do so from such a height as 100ft. There is another reason why the hands should be placed before the head in diving—viz., that, while the force of the plunge lasts, if the palms of the hands are in a horizontal plane, a very slight bending of the wrists and *shoulder joints* will vary the course at will in any *direction with the greatest nicety*. If the eyes be kept open, and the water is clear, I do not think it necessary to keep the hands before the head in swimming under water.—AMPHIBIAN.

[33628.]—**Diving.**—If "Law Student" will take a header from a height of 8 or 10 feet with his hands anywhere except above his head he would not ask any more questions about the general adoption of this position. The 100ft. dive witnessed by Mrs. Brassey in the Sandwich Islands was feet foremost, I should guess, from the text and illustration. More than 40 years ago I saw Scott, the diver—who soon after accidentally hanged himself on Waterloo Bridge—jump from the foretop-gallant yard of a brig in the Thames—a height of about 109ft.—and he seemed to curl himself up, and strike the water in a lump.—GIMCRACK.

[33629.]—**The Atomic Weight of Uranium.**—Since 1789, when Klaproth discovered an oxide which he mistook for an element, uranium has passed through many vicissitudes. In 1841 it was isolated in the pure form by Peligot, and it was not until 1856 that it was obtained in a compact form. At first an atomic weight of 60 was assigned to it, for certain reasons; this was doubled for better reasons; and now it has been doubled for the best of reasons—viz., that it differs from the metals of the iron group in forming salts of the type UO, plus an acid radical, instead of (UCl_3 and U_2Cl_6) U with an acid radical. It also differs in forming a volatile chloride, UCl_5. Its specific gravity is much higher, being 18·4. Its oxides are weaker bases than the corresponding ones of iron, and its atomic weight is much greater. The salts of uranium are not isomorphous with those of magnesium—for instance, its oxide does not correspond with that of magnesium, and the sulphate crystallises in the oblique system, forming double salts, to which magnesium can give no parallel. Further, it forms the chloride UCl_5, which, on analysis, has given as a mean result 57·47 per cent. of uranium, and 42·32 per cent. of chlorine. And the percentages, calculated on the assumption that the atomic weight of uranium is 240, and five of chlorine 177·5, give, when we state as the sum 417·5 is to 240 so is 100 to 57·49, the percentage of uranium, and 42·51, the difference between 100 and 57·49, gives the percentage of chlorine. These numbers are so remarkably near the result of analysis that we are forced to admit that the atomic weight must be 240, and not 120, or 60, or any other number. The only objection to urge against the number 240 is that when it is multiplied by ·0619, the alleged specific heat, it gives 14·856—more than double what it should be according to the law of Dulong and Petit. But this, in reality, is no objection, as it is extremely doubtful if ·0619 is the correct number. According to the law above stated, it should be about ·027, which, multiplied by 240, gives 6·48, which is approximately near what the specific heat of the atomic weight should be. Further, the specific gravities of gold and platinum are about the same as that of uranium, and their specific heats are approximately equal, being about ·0324. It is, therefore, not improbable that the specific heat of uranium is about ·027.—HUGH CLEMENTS.

[33633.]—**Entomological.**—The new objects are water-mites, but of what family your description affords no clue. Are you sure they have only six legs? Are there not eight?—T. LISLE.

[33633.]—**Entomological.**—What you have are what are known as infusoria astasia hæmatodes. They are of a blood-red colour, with hair-like appendages, and are very interesting objects for the microscope.—SUSSEX

[33636.]—**L. and N. W. Engines.**—Helvellyn, No. 890, is broken up; so is President, 1,007. Dædalus, 896, is, or was recently, piloting between Euston and Willesden. All three of those were large Bloomers of McConnell's design. Many lists of these have already appeared, and I am rather surprised that "Tamerlane" should be in doubt as to there being more of the same design, since his namesake is one of the most famous of them. However, once more, there are now 36 of the large Bloomers, and 29 of the small. Precursor is No. 2,145: she has a cab, and is the type of her class. There is no such name on the line as either Panthus or Panther. The only names beginning with Pan are Pandora, 1,430, and Panopea, 1,432. They are both 7ft. 6in. engines, similar to 1,436.—ITZAEX.

[33637.]—**Models of Ironclads.**—The *Illustrated London News Almanac* for 1877 contained pictures—and, I think, the dimensions—of every type of ironclad in the British navy.—GIMCRACK.

[33638.]—**Whiting and Limewash.**—The following will be of use to "W. H. K. E.:"—One doz of whiting, 2lb. size, and 1oz. celestial or ultramarine blue; this will cover about 12 square yards. Mixing: Take the whiting and break up in just enough water that you can just work it about in a bucket with a stout stick. Next take a saucepan, about 3 quarts, and put a pint of water in and boil; take off the fire, and drop your size into it, and let it stand upon the hob until melted. When tolerably warm pour into your whiting, being careful to keep stirring it. Mix up your blue with a flat stick upon a slate or board, and add until it becomes of the shade required. When I was engaged in a brickfield near Guildford, Surrey, that is the only place that I could obtain lime that would produce what you require—viz., a fast limewash. The lime then was burnt in the bottom of brick kilns, the bricks upon the top, and fired with heath, fir loppings, coal, wood, ferns, and gorse. The sand from the bricks, t chalk and the potash from the wood combin covered the chalk or lime, as it was then, with a si cate soluble in water. To use this we used to get fresh burnt, break it up, and pour boiling water up it; it would go off with a series of sharp report and subside into a beautiful cream-like consisten Now this, owing to the soluble silicate in i must be used, and made fresh. It is fast, a frequently presents a glazed surface, and, if not p on too thick, is very durable. This, of course, is a comeatable. A peck of lime will do you about square yards; this is merely lime, the fresher t better. Slack it. Make it of the proper consistenc and add to every bucket one gill of turps and linse oil, mixed. Some use tallow, some size; these a waste.—JACK OF ALL TRADES.

[33638.]—**Whiting and Limewash.**—Lime always apt to turn a bad colour. The way to whit wash a ceiling is to first thoroughly wash with cle water, not one pail, which speedily gets dirty, b with several. Then steep balls of whiting in wate and the next day reduce them to a thick cream. P a kettle on the fire, with sufficient size, and when h pour it on the whiting, adding, at same time, so fine ground blue-black. The proportions are, say, balls whiting, 2lb. size, and from ½ to 1oz. of bl black, according to taste. I prefer a blue tinge, a sometimes use washing blue for the purpose. T mixture must be allowed to cool before using. I limewash, clean first, and then proceed to make u the following: Take ½ bushel of lime, and slake i add 1lb. common salt, ½lb. of white vitriol, and gallon of skim milk. With a clean surface this w not shell off, neither will lime-white and size, wh properly prepared and laid on a clean surface.—OMEGA.

[33640.]—**Cabbages.**—The first and most probab explanation of the reason why "A., Liverpool," ge "ragged jacks," bastards, &c., instead of cabbage with solid hearts, is that he has a bad sample o seed; if, however, he obtained it from a good hous that is unlikely, for seedsmen are most particular i this respect, as a field of ragged jacks would soon become known amongst farmers, and would be an effectual sign to keep away from the house that sold the seed. Assuming then that it was good seed, the explanation may be found in soil too forcing: if the plants were put out to stand the winter on rich ground, they would have a tendency to run to seed rather than to cabbage in the spring; but, on the other hand, if the ground is too poor and too light, the heads would not turn in. Cabbages planted late to stand the winter should not be manured, but when they start to grow in early spring, having made good stumps during winter, they may be liberally supplied with manure; if planted early, say at beginning of September, they may be put on rich land, so as to get as much growth as possible before frost. Earthing up is always beneficial, because it implies loosening the soil, while it enables the stump to send out more roots, and so support the head better, especially if the lower roots are troubled with clubbing. At the same time, it is not necessary. As to cauliflowers, they must always be sown at the times specified by the salesmen. In their own season, properly treated, they will do well; but it is useless to attempt to produce a winter cauliflower in summer or *vice versâ*. They require good feeding, and when once started should never be checked for want of water. So many conditions, however, enter into the questions asked, that the opinion of a cottage gardener in "A., Liverpool's," neighbourhood would, doubtless, be worth far more than anything I could tell him, always presuming that he has obtained good seed. Opinions differ as to the length to which the main runners of marrows should go before stopping: 4ft. is a favourite distance with some but a great deal depends on the robustness of th plant, and the habit of the variety; some bear be when allowed to become more like bushes: others like to ramble for yards. I have grown the ordinar yellow and green sorts both with and without sto ping, with and without artificial fertilisation, an cannot say that I noticed much difference in t quantity of the crop, or the rapidity with which t plant came into bearing.—SAUL RYMEA.

[33643.]—**Harmonium.**—To MR. W. H. DAVI —For clothing socket-rails, the cloth is cut i slips about 9in. long, and as wide as the circumf ence of the holes—there should not be less than 6 these. One end is tapered and stiffened, this e being pushed through the holes, and the slips pul through to within a short distance of the end, va ing according to the thickness of the rail. They then touched with glue, which should be pretty thi in order to prevent it soaking through the cloth, a again pulled till the glue shows on the other si They are then cut and pressed with a warm bras the glued ends must not be trimmed till they hard.—W. H. DAVIES.

[33644.]—**Bleaching Oil.**—You had better it with animal charcoal, and filter.—SUSSEX.

[33645.]—**Boat-building.**—If "G. H. A." wo be satisfied with a flat-bottomed boat, my answe 33625 would help him; but if he aims at buildi boat moulded upon regular lines, he must study science of naval construction, at least far enough understand the terms, and something of the the Boats are certainly built by rule of thumb by who have served an apprenticeship to the art, wo ing upon lines handed down by tradition. "Wea Rudimentary Series" contained a treatise u ich may be sufficient guide to "G. H. A." clever amateur joiner, and has access to where boats are built, and can see them put from the keel to the top streak.—Gim-

—**Ink Stains on Furniture.**—I believe a large number of recipes for the above, llowing is an old-fashioned one:—To one f oil of vitriol add two spoonfuls of water. s parts with a feather, and watch, for if o long it will leave a white mark. It is, perhaps, better to rub it off rather quickly, ch if not enough. Or undiluted spirits of be used in the same manner, with care. pect that either of these will take the polish not French polished I should say a little and turpentine well rubbed on would C. Lark.

—**Etching on Copper.**—V. Le Peintre, if London, had better join the Etching Class ath Kensington Art Schools for a session, will learn the whole art and mystery of iting in, and printing, too. If this is not e will find the process, which is quite lly detailed in any of the cyclopædias or, oughly, in Spon's "Workshop Receipts." erials and tools may be obtained from artists' colourman, Long Acre, who also all press capable of printing from plate . square. Small copper plates may be om any engraver of address cards quite ugh for the certain failures which must ccess.—Gimcrack.

—**The Phonograph.**—Since I last wrote ceeded in obtaining very good results with iaphragm of vegetable parchment. I will lain it without a new drawing by reference page 157, Vol. XXVII. The parchment is and stretched like a drum over the end of tube or "sprout" on E E, and is secured ly-fitting band of metal. The spring carry-int is of the same size and substance as recommended, but instead of turning out-hen free) it turns inwards towards the t. The spring is made to assume the posi-n in Fig. 2 by interposing between it and ragm a light rod of pine ⅛in. diameter. e inserting this little rod cement to one disc of ferrotype plate ¼in. in diameter, other end a disc of indiarubber 1-16th of an and 3-16ths of an inch in diameter. When in its place the ferrotype disc will press centre of the diaphragm and the india-on the back of the spring behind the point. should be secured by cement. The outer diaphragm should be coated with india-sue to protect it from the moisture of the With this arrangement I have been able to sentences spoken into the paper resonator nce of 10ft. from the phonograph. D, G, Fig. 2, are, of course, dispensed with.—D Bidwell.

NSWERED QUERIES.

bers and titles of queries which remain unan-five weeks are inserted in this list, and if still are repeated four weeks afterwards. We trust will look over the list, and send what information r the benefit of their fellow-contributors.

our last "Amateur" has replied to 33079.

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QUERIES.

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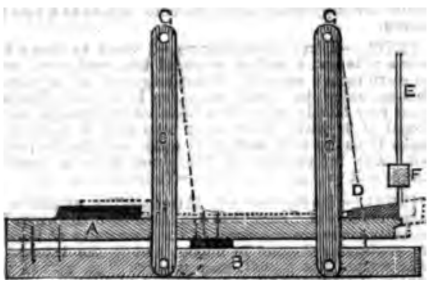
[33666.]—**Indiarubber Balloons.**—I wish some one would answer the inquiry as to how these are made. Such friends as have responded have misapprehended the query. The balloons meant are used as advertisements, and also as a sort of bellows to a squeaking toy. When inflated they look more like a soap-bubble blown from muddy water than anything else; and I should not be surprised to learn that they are made in a similar way.—Old Bingo.

[33667.]—**Marine Engines.**—Will some correspondent kindly inform me which is the best book on marine engines for one who wants to go to sea?—B. A. H.

[33668.]—**Steel Works' Laboratory.**—Would any of "ours" kindly inform me what is the nature of the routine of a steel works' laboratory? What analyses are the most important to be done, and what are the best methods?—F. C. S. C.

[33669.]—**Worm in Red Deal.**—Can any of your readers inform me of the best or any method to be adopted to stay the progress of the worm in red deal flooring? The floor in question is in a large drawing-room that had remained unfinished for a period of 35 years, and during that time the flooring was cut down and laid on the joist face downwards. Some 12 months since the board was turned over and laid, and the floor finished, as the boarding had become blackened, and was laid before it was planed; it was not noticed the worm had attacked the edges of it. Can your readers suggest anything that would destroy the worm, and so prevent the necessity of taking up the floor, which would be very inconvenient?—N.

[33670.]—**Swell Organ.**—I shall be glad to have the opinion of any correspondent of a simple plan for obtaining expression *à la main* in organs. My idea is to suspend the keyboard by the bars, CC, from the points, GG, so that by pushing the keyboard back (dotted lines) the swell shutters are opened. But it must be so balanced that it will stop in any position to which it may be put—A, key; B, keyboard; CC, suspending bars; D, piece of wood glued on key to keep the sticker, E, always in contact with the key; F, guide for stickers. The swell may be opened either by levers or by cords from the board.—E. Wright.



[33671.]—**Heel-ball Stains.**—Can any one tell me the best way to take out the stain of heel-ball in a rubbing, where it has gone over the outline?—E. D.

[33672.]—**Copying Mouldings.**—Will any practical reader kindly say what is the most reliable and correct method of obtaining the profile of a moulding without the use of the cymagraph? This question has been asked several times in these columns, but, I believe, never satisfactorily answered.—Cyma.

[33673.]—**Grey Bricks.**—Is there a composition which will have the effect of making bricks burn grey after being dipped into it, or after it has been applied to them? If so, I shall be glad if some of your readers will kindly favour me with particulars. I want to burn bricks grey on the ends and one side, but the clay I have to make them from will not burn grey in its natural state.—C. M.

[33674.]—**Construction of Roof.**—I have a roof to construct for a public room, the span of which is about 20ft. Will some of your readers kindly favour me with their opinion as to the strongest and cheapest plan to construct it? The roof must be open to the purlins, and I wish to avoid the expense of curved ribs, and the use of tie-beams.—A Young Builder.

[33675.]—**Ventriloquism.**—Will some reader kindly inform me of a thorough good work on ventriloquism?—Mimic.

[33676.]—**Working Men at the Paris Exhibition.**—A few hints on the cheapest way to see the above would oblige. I do not want to join any "tourist" party, but to know a little about the best route, the best part of the city to lodge in, and the best way to economise the little time (a week) at my disposal.—Montreznous.

[33677.]—**Gas-Holder.**—What shape and size would your readers recommend for a gas-holder to contain 120 cubic feet of gas, and stand a pressure of such force of water as shall press this 120ft. into 1 cubic foot, and say, per square inch, what that pressure will be; also at what height our cistern for water should be above, that it may so compress the gas?—An Old Patron.

[33678.]—**Chiming Clock—Repeater.**—For what price ought I to obtain a small chiming clock, new, and a plain gold English keyless repeater—the latter with compensation balance, and adjusted for any temperature? These articles seem to be catalogued by the dealers at fancy prices. Are none made for men of small means? I want average prices—not individual; makers recommended.—B.

[33679.]—**Instrumental Music.**—I should thank any one for a few hints about the arrangement, working, and playing several instruments by one person at the same time.—Glass Shade.

[33680.]—**Magic Lantern Canvas.**—I should be obliged for information about a convenient screen erector for canvas about 18 to 20 feet.—Judge.

[33681.]—**Cast-Iron Chambers of Pumps.**—Can any reader tell me how to find the proper thickness of cast-iron for feed pump, 3in. diameter, to work against a pressure of 60lb. to square inch? Any hints on proportions of cast-iron chambers for cylinders or pumps will oblige, or are there any works to get on proportions of cast-iron cylinders to be had?—Industry.

[33682.]—**Cleaning and Rebronzing Old Lamp Stands.**—Would any correspondent inform me how to clean old paraffin lamp stands which have been rusted with damp, and how to rebronze them?—H. K.

[33683.]—**Tobacco Machinery.**—Could you inform me of the title of a book relative to the manufacture of tobacco and snuff?—Dux.

[33684.]—**Pain in the Head.**—Would any contributors kindly inform me of a remedy, if such there be, for a pain in the head, from which I have suffered very acutely for the last four or five years? It commences with a dull heavy pain at the top of my head, slowly increasing each day until all the top of my head, the back of my right eye, and gradually the back of my ears, neck, and spine are one mass of pain. At this stage the suffering is almost unbearable, and it has weakened my sight until I am compelled to wear spectacles. When the pain is at the worst I find it difficult to resist the impulse to do some violent action. I need not say these attacks leave me very weak; they return very speedily, leaving me only a few days, and lasting from a fortnight to six or seven weeks. I am 35 years of age, the mother of three boys, the youngest being ten years old, and have my own household duties to attend to. Any advice on the above would be gratefully received, but medical readers only are requested to reply, as I have no time to try nostrums.—Esther Wait.

[33685.]—**Filter for Water Used in Steam Boiler.**—Can any of your readers tell me how to construct a cheap filter for cleansing large quantities of dirty river water for feeding steam boilers? Will gas coke serve as a filtering agent under pressure?—Smithfield.

[33686.]—**Bevel Wheels.**—I should be obliged if some correspondents would give a general rule of marking bevel wheels of different sizes, 6in. to work in 12in., or 9in. to work in 13in., or 4in. to work in 18in., and whether the same rule works all sizes?—H. W. N. W.

[33687.]—**Potted Meats.**—Can any one tell me what process is used to expel the air in putting up potted meats in hermetically-sealed tins?—W. C.

[33688.]—**Phonograph.**—To Mr. Shelford Bidwell.—I have constructed a phonograph according to your very lucid description, and without deviating but in one thing, and that is I have used, or tried to use, a tin disc, but have utterly failed to produce any impression. There is a difficulty about ferrotype plates, as they are always more or less bulged when sent by post, and I have as yet failed to get what you call charcoal iron. I have my cylinder and shaft accurately turned, and have made a very good disc of parchment. Could you now oblige me with a sheet of tinfoil with a message, that I might try my parchment disc and compare the impression I may be able to obtain when I get the disc of charcoal iron? I would not trouble you but for your oft-expressed willingness to comply with such a request.—T. M. Brown.

[33689.]—**Setting Common Slide Valve.**—Could any reader inform me if in setting a common slide valve more lead is given on one side than on the other, and under what circumstances? For example, in the shop I work in there was an engine made for driving an air-pump, a circulating pump, a feed pump, and a bilge pump—there is another engine for driving the propeller. The foreman in setting the valve gave it one-eighth of an inch of lead on the bottom centre, and none on the top, believing that by doing this he gave the piston more steam on the up-stroke than on the down-stroke, so as to counterbalance the weight of the pump-gear.—J. C. R.

[33690.]—**Waterproof Covering.**—I have some cellars covered with flags laid on joists, the flags being open to the weather; I want to make this covering entirely waterproof. Can any one recommend anything with which to fill the joints which may be depended upon, or any substance which can be put on in a thin layer which will wear and be waterproof? Some of the London streets are laid with a kind of asphalte, or similar substance, in layers of from 1in. to 2in. thick—would that answer? If so, what is the substance? Any opinions will oblige—J.

[33691.]—**Cider.**—I should like to have a barrel of cider, but I want a little information on the subject first. What is the best time of year to buy? Is it wise to buy from the farmers or growers? Will it keep in the barrel; or, supposing I was to bottle half of the barrel, will the other half in the barrel keep? Or, supposing I was to buy now, will it be better to use right off or keep it until next year? And about the cost per gallon? Any further information on the subject will be thankfully received by—E. G. P., Liverpool.

[33692.]—**Lambertype.**—Would some of our able photographists give me the details of the above process of photography?—D. Strathearn, Med. Student.

[33693.]—**Magnet.**—Can I make a magnet that will lift or attract a one-ounce steel weight if the magnet be suspended six inches above the weight, and, if I can, how long will the magnet retain its power of attraction to full amount?—Magnetism.

[33694.]—**Phosphorescent Clocks.**—Can any of your readers kindly inform me what is the substance on the face of these clocks? The emitted light is of a beautiful purple colour.—Inquirer.

[33695.]—**Screw Pump.**—Is it possible to raise water by means of a screw working inside a short cylinder or pump barrel? If so please describe one, with height to which it would raise or force water; also how far it would draw water. Would the downward pressure of water on the blades of the screw make it take more power to work than a lift and force?—Derby.

[33696.]—**Amber.**—How can I tell real from imitation amber, and how can I bend amber mouthpieces for pipes?—R. H. Thomas.

[33697.]—**Metheglin.**—How is this made, and will it keep well?—R. H. Thomas, Fermoy.

[33698.]—**Dialyte Telescope.**—In your number for September, 1876, at page 659, this form of telescope is mentioned in a paper by Mr. G. Pearce as offering a means of placing in the hands of amateurs refractors of considerable aperture at small expense. I am under the impression that inquiries regarding it have been made more than once in your pages, but I do not remember any response to them, though I feel sure that many of your readers besides myself would greatly value information on this subject. I notice that Mr. Herbert Ingall is possessor of a dialyte with 7¼in. aperture. If he would favour us with particulars of its performance I am sure it would be greatly appreciated. How is his compound lens for the correction of the chromatic and spherical aberration formed? Where is it placed? What length of tube does his 7¼in. dialyte require? Facts as to its performance both in regard to definition and to its dividing power would be of great value.—SPECTATOR.

[33699.]—**Midland Expresses.**—The Midland now run several north trains direct, and do not go to Trent. How many trains run the new direct route, and how much shorter is it? Also some run direct through Derby. How much distance is saved by this from Liverpool to London? Will any one also give the booked running of the 8 o'clock express from London to Edinburgh in 9h. 57m.?—PASSENGER.

[33700.]—**Spindle of Fan.**—Would some reader tell me how the spindle of Platt and Schiele's fan is fitted? I have a set of castings, and would like to know how to fit them up.—W. C. N.

[33701.]—**Cheshire Lines Railway.**—Some writers lately spoke of the above. Where does it run? Is it the same as the M.S. and L. Committee? What do the letters M. and S.C. mean at Marple, also M. B. and M.?—PASSENGER.

[33702.]—**Horse-Shoe Telephone.**—Will Mr. J. N. Masters (letter 14626) give details of the horse-shoe telephone alluded to, the size and number of magnets, description of coil, length and size wire, and size of diaphragm?—C. P. COOMBS, M.D.

[33703.]—**Silver and Copper Crystals.**—I have looked backed in vain for the numbers of answers given by Mr. Blakeborough (?), describing the mode of obtaining crystals of silver and copper on microscope slides. There is some "latitude" about the second answer, in which the writer does not seem certain as to what metal is used for the cells in which the metal is deposited. Please give directions as to the material of these cells.—C. P. COOMBS, M.D.

[33704.]—**Giffard's Air Gun.**—Can any of your readers give me any information as to the construction of Giffard's air gun? I have one in my possession which requires doing up and fitting with new valves, &c.; the makers of the ordinary kinds of English air-guns in Birmingham cannot understand it at all. If any of your contributors can assist me I shall be much obliged.—UJIJI.

[33705.]—**Colonial Land Grants.**—For one having a little capital, together with a slight knowledge of land working, would it be a good step to go in for one of the usual colonial land grants? Are the usual emigration pamphlets a sufficient and reliable source of information? If not, please state the best source.—WATCHMAKER.

[33706.]—**Mining.**—It is proposed to drive a heading from the bottom of a pit to cut a seam of coal at a distance of 25 yards perpendicularly above the bottom of the pit. The heading is to be driven truly level in front of the dip. The stratum dips so as to form an angle of 30°. Will any of "ours" kindly inform me how to find the length of the heading?—HOMO.

[33707.]—**Strain on Crank Pin.**—Four tons is placed outside of a winding drum 16ft. in diameter; the distance from centre of shaft to centre of crank pin is 2ft. 8in. What will be the strain on the crank pin? A rule for the above would greatly oblige—HOMO.

[33708.]—**S.E.R. Locomotives.**—Will any one give me information respecting the dimensions (and other particulars) of the locomotives that usually take the Continental mail on the South-Eastern Railway?—F. C. B. B.

[33709.]—**Electrotyping Insects.**—I wish to electrotype a few insects. Can any of "ours" inform me how to do it? I wish to have a solution so that by simply dipping and placing in the bath the copper will be deposited upon them.—ECONOMICAL.

[33710.]—**Cupola Furnace.**—I am building a small cupola furnace (for melting metal) about 12in. or 13in. square. Would any practical correspondent tell me the height I should leave it so as to be able to make hot iron from broken pieces of pig metal?—1. The depth from filling hole to centre of blast-pipe? 2. The depth from centre of blast-pipe to bottom of furnace? I would feel obliged also by any additional information that may assist me in its construction. The furnace is to be built of fire-brick without any lining.—W. N. M.

[33711.]—**Freezing Mixture.**—How is an aqueous solution of glycerine reduced to a low temperature so as to make a freezing mixture? Would Mr. H. Clements be kind enough to inform me if methylic chloride can be cheaply reduced to the liquid state, and how to do it? Also what material the sealed tubes are made of—whether glass or metal—and how they are sealed?—JOHN YUILL.

[33712.]—**Vacuum Engine.**—Can a fall of water be used to keep a vacuum in a condenser sufficient to work an engine, 10in. diameter cylinder, by atmospheric pressure only? Please give height of fall, size of pipes, quantity of water required in gallons per minute, with estimated pressure of air per square inch on piston when at full work?—SHIRE.

[33713.]—**Mechanical Stoker.**—Can any correspondent give any information in regard to the above from practical experience? Will small coal produce as much steam when the "stoker" is used as round coal with hand-stoking? If so, it would save the firm with which I am connected an immense sum yearly, as they can buy small coal at three-fifths the price of round coal. Are the "stokers" very expensive to keep in repair?—M. R.

[33714.]—**Anemometer.**—Would Mr. Lancaster or some meteorological reader kindly say the size the vane should be on a Prestel's pendulum anemometer for a pendulum plate 6in. square, and how to graduate it (the vane), to show the pressure of the wind correctly?—UNCAS.

[33715.]—**Etching on Glass.**—Will some kind reader please inform me of a good etching varnish for glass? At what temperature (about) should it be applied, and whether with a brush or by immersion? I want to *etch on small glass cylinders.—FLUORIC ACID.*

[33716.]—**Etching on Glass.**—Will some one inform me the most simple way of marking or etching on glass bottles?—A POOR MECHANIC.

[33717.]—**Nickel Plating, Battery, &c.**—I wish to electro-plate small brass goods with nickel. "Wolfram," on page 477, states in answer to a query on above subject that the only useful process is a patent. I beg to differ with him there, for I know of several places in Birmingham where they electro nickel plate, and do not pay a royalty to the patentees of a patented process. What I want to know is how much salts, &c., to a gallon of water, what dips to use to dip the work in previous to hanging it in the bath, together with the amount of potash to a gallon of water to cleanse from all grease, &c.; also how to make a battery to work, say, five gallons of solution. Any hints from a practical hand (if possible) will oblige—A BRASS-WORKER OF BRUM.

[33718.]—**Softening Cast Iron.**—Can any reader inform me of a cheap and easy way of softening cast iron which is run on wrought-iron spindles 6in. long? The casting run on the spindle is very hard in consequence of the spindle chilling the iron, and breaks the tool when turned in a lathe. The castings are small, only 1in. in diameter. —IRON TURNER.

[33719.]—**Mechanical Question.**—In what modern book on mechanics are examples worked out of the ratio of the power to the weight or resistance in oscillating levers?—THOMAS WALKER.

[33720.]—**Harmonium Reeds.**—Thanks to Henri Etienne for his notice of my query. I am not, as he supposes, about changing narrow reeds for broad ones, but am building a large harmonium of five or six rows of reeds, and think of putting some broad and some ordinary reeds in for variety. I have a scale of channels (by "Saul Rymea") for the ordinary reeds, but want to know if it requires larger channels for the broad ones. If so, should be thankful for the sizes for 8ft. and 16ft. rows, also size of apertures. Please say if they require a heavier pressure of wind, and where to get the best reeds, properly voiced, and probable cost?—T. B.

[33721.]—**Chromos.**—Can any one tell me whether the folio of chromos called "Gems of Art" by Birkett Foster are copyright; also if chromos are so as a rule?—SAXON.

[33722.]—**Line Resistance.**—I want to ring a bell over a mile and a half of overhead telegraph wire, with an earth return current. What length of No. 36 wire is this equivalent to, earth resistance included? The bell rings very faintly with three Léclanché's through half a pound of 36 wire. How many cells shall I require? I make them up with carbon in outer and zinc in porous pot. Any information on the above from a practical source will very greatly oblige.—YOUNG TELE.

[33723.]—**Bachelor of Music.**—The attention of many readers of "ours" has doubtless been drawn to the recently made arrangements of the University of London for conferring degrees in music; and in the interest of others who, like myself, may wish to "go up" in this subject, I venture to ask for some information as to the books which should be studied for the first B. Mus. Examination, which takes place next December. Below is the list of subjects in each of which the candidate must show proficiency:—"The relations between musical sounds and the vibrations of sonorous bodies as affecting the pitch of the sounds; the simpler properties of stretched strings and the sounds produced by them; compound vibrations; nodes; the nature of harmonics; the general theory and simpler phenomena of compound sounds; the theoretical nature and values of musical intervals; the theoretical construction of the modern scales; temperament; melody, time, rhythm; the theoretical nature of consonance and dissonance as determined by Helmholtz; the principles of the construction of chords; the history of music in so far as it relates to the growth of musical forms and rules." A sufficiently comprehensive programme this, to my mind. I should be glad to hear of some of the standard books on these subjects, as they would be well worth purchasing. Perhaps some of our scientific readers, who happen to be read up in any of these subjects, will kindly assist me. For the information of those who may not be aware of it I may add that candidates for this examination must have passed matriculation at least a year previously, and that the second B. Mus. Exam., which takes place a year after the first, relates to the practical part of the theory of music. The candidate has to submit a musical exercise, written for five voices, with accompaniment for a quintett string band, which must contain examples of canon, imitation, and fugue. If this is approved he is then examined in harmony, counterpoint, et hoc genus omne, no reference to any musical instrument being allowed during the examination.—LONDON UNDERGRADUATE.

[33724.]—**Hens and Eggs.**—How many eggs is it possible to make a hen lay? I have seen it stated in an advertisement that over 1,500 eggs were obtained from 22 hens in the depth of winter. Before purchasing the book I should like a hint or two. If each of the 22 hens laid an egg every day in the week that would be 154, and it would take 10 weeks to make over 1,500 eggs. Can 10 weeks be called the "depth of winter," and when is that? Then can 22 hens be made to lay every day in the depth of winter? I am very sceptical, because I have always found that hens would not lay every day, except in spring, and then only if they had a good grass run.—S. M.

[33725.]—**Personalities.**—Will any one give a good definition of "personalities" in discussions? I find that the man who gets the worst in a controversy says his opponent has been guilty of using "personalities," and thereupon retires from the contest.—NEMO.

[33726.]—**Circulation of the Blood.**—It is stated that the whole of the blood passes through the heart in a few minutes. Can the statement be true, seeing that a considerable quantity has to ramify through the capillaries, and be transferred from the arteries to the veins? I can understand that the great bulk of it may complete its round in the time given, but surely that which goes into the capillaries to replenish wasted tissues cannot return to the heart so quickly.—J. T. M.

[33727.]—**Printing Machines.**—Which is the quickest working machine, and what is the greatest number of copies of a newspaper that can be turned out complete copies at each impression—not two at once?—S. M. P.

[33728.]—**Thunder and Lightning.**—In counting the seconds elapsing between a flash of lightning and the clap of thunder, by what do you multiply to find approximate distance of the direct course of the flash —OBSERVER.

[33729.]—**Naviget Anticyram.**—What is the of this phrase?—H. P.

[33730.]—**Hexagon Heads to Screws.**—W "J. K. P." kindly tell me how to make an accurate h gon head to a screw?—A YOUNG HAND.

[33731.]—**Barometer as a Weather Guid** What is the actual value of a barometer as a wea indicator? I find people talk of the "glass rising," they prophesy fine weather, but storms often follow.— PURCELL.

[33732.]—**A or An.**—Which is correct, "an univers or "a university;" "an one" or "a one;" "a ewe" "an ewe;" and why?—ETYMOLOGOS.

[33733.]—**Fish-joints for Rails.**—A recent opp tunity enabled me to watch the hammering action on t ordinary fish-joint of rails. Would it not be an improve ment to "scarf" the joints, and put a pad of rub between, using the plate the same as now?—J. M.

[33734.]—**Sunstroke.**—What is the explanation this phenomenon, which seems a misnomer, as simi effects are produced by heat without exposure to the su —H. K.

[33735.]—**Angular Aperture.**—What is the mea ing of "angular aperture," and why is there so mu discussion about it? I wish some one would explain simply.—T. H.

[33736.]—**Maple Sugar.**—How is maple sugar pr pared?—SABBAS.

[33737.]—**Lobelia Cardinalis.**—A few hints on the culture of this handsome plant will oblige. Is it rai from slips or seed? I have three handsome specimens full bloom. Are they of any use when finished flowering? —AMATEUR.

[33738.]—**Black Diamond.**—Will any one tell the value of a good sized working spark of carbonado grindstone turning, whether it is to be got in Englan and if it would also cut plate-glass?—[illegible]

[33739.]—**Brass.**—Can any reader inform me how bright sheet brass is manufactured and sold, carr paid, at 6½d. per pound? which appears to me to little over 4d. per pound nett for the metal, and no m ing that I have ever seen in print could be made at cost, with copper £66, and spelter £18 per ton, say, these are the lowest prices known yet, I believe. I told that in Birmingham yellow metal sheathing is pr duced at materially lower prices than the above These prices point to a knowledge of alloys which books do not enlighten us upon. I should also be glad a sketch of a gas furnace (or description), such as I unde stand is used in brass-works in Birmingham.—F. W.

[33740.]—**Balloon.**—I want to make the figure of man, carrying two flags, to rise and remain in the 1. What material and proportions would be best? How many cubic feet of town's gas would it contain? Would the town's pressure fill it? 4. What weight rope, &c., would it then carry? 5. How often would gas want renewing? 6. Probable cost.—X.

[33741.]—**Sea Fishing.**—Will somebody kindly commend a healthy watering-place on the south or w coast where I should get some sea fishing from the without requiring a boat? Should I find this at T mouth?—H. S. E.

[33742.]—**Machine Weight Driver.**—Is possible to drive a hairdresser's brushing machine two minutes only) with a weight and band round extra large drum which shall multiply the shaft by wheels? The rim of these wheels to have as many as cogs, which are fastened on by screw nuts, so as to replaced when worn. The weight would only get 10 or feet fall, and the hairdresser would have to wind it each time, but he would be able to do without power or a boy. How heavy would the weight have to to counteract the break power of the indiarubber attached to the shaft and brush?—R. H.

[33743.]—**Phlegm in Throat.**—I am nearly troubled with phlegm (bronchial mucus) in the which defies all efforts at removal, either by swallo or expectorating, and which sometimes makes it difficult to speak clearly, and is much in the way attempting to sing. It also at times causes me to in a very distressing manner. A lump of sugar occasionally give temporary relief, but it is soon as ever. Of course, when I have a cold the quantity mucus is considerably increased, and is then expect without much difficulty, but the condition complained is when in ordinary state of health. Can anything done, by medicine, diet, or otherwise, to remedy and vent this very unpleasant state of things?—C. LAKE.

[33744.]—**Swimming below Water.**—Have any "ours" ever met with the difficulty alluded to in Franklin's "Advice to Swimmers," as quoted in seve articles on swimming (that in the "Boy's Own Book" one)? I do not remember the exact words, but they to the effect that the eyes should be opened before below the surface, because it is impossible afterwards open them on account of the pressure upon the eyeli the superincumbent weight of water. For my own p always dive with my eyes shut, for fear of injury coming in contact with the surface, but I find no diffi in either opening or shutting them below the surface. does it cause me any pain or inconvenience even in water.—AMPHIBIAN.

[33745.]—**Coin Cabinet.**—Can any reader advise as to the best method of boring holes in trays for reception of coins? I want to bore about 2,000 holes pine, from ¼in. to 2in. in diameter, and from 3 to 4 deep. The requirements are a smooth rim, and a fla nearly flat bottom. The ordinary centre-bit is apt to the edge, and leaves the bottom too rough. The made by centre-pin is not objectionable.—W. G.

[33746.]—**Shaky Writing.**—I am an elderly enjoy good health, moderate in eating, a strict abst but all my life have been an inveterate smoker of tob I cannot now write with the general or usual sl letters; but am obliged to form them what may be te leaning backward, with my elbow far from my side, the pen-hand steadied by the fingers of the other h I should have great pleasure in presenting an honora of two guineas to any one of our mechanicians who a pen-steadier or rest. Waste of time to tell p smoking.—KINGSTON.

Telegraph Line.—I am about to construct graph 7 miles in length. It is intended to use l the earth for a second with electric bells and Would any of our able contributors kindly what number of posts I should require, their rt when erected, and to what depth must they he ground? Would 10ft. above ground be nsidering that the line passes through an open ere nothing is likely to touch the wire? Also e best form of insulators to use; the size of ed wire (would the ordinary galvanised wire ing do, as I have a large stock in hand?); eans are employed to tighten the wire? A above will be greatly esteemed, together with formation that may assist me in carrying out COLONIST.

·**Gramme Magneto Machine.**—Will pondent be kind enough to give me some on the following points of construction of the gneto machine as used for producing the t?—1. The diameter, width, and thickness of armature, or rings, if more than one? 2. nd amount of wire wound on same, together ount of wire contained in each segment, and of layers one over another? 3. The gauge of wire wound on the exciting electro-mag- hat proportion of current passes through the l how is the shunting effected?—NEW SOUTH

Plants.—If any reader will kindly answer queries I should be exceedingly obliged, and further information they choose to volunteer ect. 1. Would the ferns Selaginella Wider- mnogramma chrysophylla, Adiantum formo- nother variety of maidenhair fern, live and room that has a coal fire in it every day? 2. ferns flourish far better in a shady position window that is somewhat sunny? 3. Will s live and be healthy through a winter's itting room where a coal fire is kept by day? t that plants have a very injurious influence (with some ventilation) because of the gases them? I have seen this confuted. 5. Would ecommend me a book on gardening—to in- r, greenhouse, hothouse, and fern gardening— re on those subjects not being sufficiently ILDA T., Cornwall.

Rifling Machine for Guns.—Any reader y giving a sketch of a rifling machine for s or rifles, say, for making 2 to 8 grooves, with of the same, and how fixed and used? Also re published on the subject?—F. W. P.

Sale of Stock (Consols).—Some reader informing me the readiest and quickest way he calculations for sale of stock at market 5 10s. stock at 95⅛? During the late Russian ck, 3 per cent., produced about £87 on its sale ENER.

Photography.—Will any reader give me ation about collodion transfers and opalo- ., 2, Rice-street, Liverpool.

Making Small Flag.—Will some reader e how to make a flag, about 1ft. × 1ft. 6in., ack crest on white or yellow ground? The rest would make it difficult to cut it out in d ink shows through, which will not do.—

Map of English Canals.—Is there such hed? I wish, if possible, to take a 14ft. boat n the Thames to the south coast, say Ports- this be done?—FABER.

Yacht Engine.—I have heard it stated e small launches in England which have a r into which the small one exhausts, like a gine without the condenser. Is this so, and vantage is gained thereby?—FIREFLY, Mel-

Towns by Steam.—A company has l in Auburn, New York, to carry out the eating the city by steam on the Holly people of Toronto are thinking of trying eme. A company, called "The Toronto bination Company," has been formed, ing for incorporation, for the purpose of t the system. The proposed capital stock

o Siberia.—Besides Professor Norden- dition in the Vega for the forcing of the assage, which left Gothenburg on July d now be well on its way in the Polar host of vessels have been sent out this Siberia for trading purposes. The ser, Captain Nilsson, left on July 14, amer Lena, Captain Johannesen, June n Gothenburg to the Yenisei and back; sailing vessel Express, Captain Gun- eft London with coal for the Vega and o steamers. All three have been sent ibiriakoff, and the Lena will accompany d's vessel to the mouth of the river of hich it will ascend to Jakutsk as a per- ing river steamer. Besides these Baron oscow, sent out the two small steamers oscow, and three lighters, on July 21, ven to Yenisei, to exchange various ain; and on July 14 the steamer Nep- spatched from Hamburg to open up he River Obi. There seems no doubt permanent trading route has been the north coast of Europe and Asia to the voyage seems so comparatively easy is apt to wonder why such a route had s advantage of long ago.

CHESS.

◆

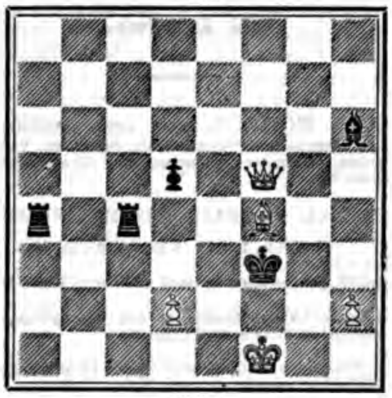
ALL Communications intended for this department must be addressed to J. PIERCE, Copthill House, Bedford.

PROBLEM CCCCXXXVII.

BY BELA SZERENGI, OF PESTH.

(From "Chess Gems," just published.)

Black.



White.

White to play and mate in three moves.

SOLUTION TO 435.

White.	*Black.*
1. Q to K 3.	1. Anything.
2. Mates.	

NOTICES TO CORRESPONDENTS.

CORRECT SOLUTIONS to 435 by J. G. F. and H. M. Prideaux (an extremely pretty problem); to 434 by J. G. F.

J. G. F.—The problem has been mislaid; but, if we remember right, the construction was considered awkward.

J. M.—Thanks for your kind permission, of which we shall certainly avail ourselves.

⁂ We beg to remind our readers that a copy of the new edition of "Chess Gems," just published, will be presented to the contributor of the best and most numerous problems to the ENGLISH MECHANIC at the close of this year. There appears to be only one gentleman trying for the prize at present. The work will be found to be of great value, containing, as it does, the best problems of ancient and modern masters of all countries. We shall from time to time quote some from its pages.

A Self-adjusting Watch Key.—Mr. Morris Cohen, of Leeds, has sent for inspection one of his new self-adjusting watch keys, which will be found handy and durable. It adjusts itself firmly to any-sized winding post, without wearing off the angles or conveying dust to the movement. By simply placing the forefinger on the push-pin at the top of the key the jaws open, and the key at once adjusts itself to a post of any size. The forefinger is then released, and the watch wound—a very slight pressure retaining the key on the post. When wound, pressure on the push-pin opens the jaws, and the key is at once released. The design of the key is neat, and in the better makes it forms a capital substitute for the bar usually worn at the end of the watch-chain.

Tic-Doloreux.—A patient who for several years had suffered from an intense neuralgia facialis came under the treatment of Professor Peters, of Paris, who put him under a treatment of six grains of bromide of potassium, the dose repeated thrice daily for the first month, four grains thrice daily in the second month, two grains thrice daily in the third month. The result is reported as being astonishing. Great success is claimed by Professor Gubler in the use of aconitum napellus for the ordinary form of facial neuralgia, particularly when congestion is present. Professor Lee, of the "Hôtel Dieu," Paris, relates a case where a patient of his, after 30 years of suffering from the tic-doloreux, got quickly rid of his pain after a few daily administrations of eight-grain doses of salicylate of soda.—*Correspondens Blatt.*

Strawberries and Constipation.—Professor F. H. Storer, of Harvard University, in a communication to the *Journal of Pharmacy*, calls attention to the fact, not generally known (and which certainly would scarcely be expected), that ripe strawberries are very apt to induce constipation. He remarks that in the United States particularly, "where an immense and well-nigh universal consumption of this fruit is coincident with the setting in of hot weather, the constipating action of the berry is complicated, and, as it were, increased by the excessive waste of water from the body, by perspiration, which occurs at this period; and there can be little doubt that, taking the two causes together, the strawberry season—though perhaps beneficial to some constitutions—is the occasion of much ill-health among the American people."

ANSWERS TO CORRESPONDENTS.

◆

⁂ *All communications should be addressed to the* EDITOR *of the* ENGLISH MECHANIC, 31, *Tavistock-street, Covent Garden, W.C.*

HINTS TO CORRESPONDENTS.

1. Write on one side of the paper only, and put drawings for illustrations on separate pieces of paper. 2. Put titles to queries, and when answering queries put the numbers as well as the titles of the queries to which the replies refer. 3. No charge is made for inserting letters, queries, or replies. 4. Commercial letters, or queries, or replies are not inserted. 5. No question asking for education or scientific information is answered through the post. 6. Letters sent to correspondents, under cover to the Editor, are not forwarded; and the names of correspondents are not given to inquirers.

The following are the initials, &c., of letters to hand up to Tuesday evening, August 6, and unacknowledged elsewhere:—

J. GLEAVE AND SON.—E. C. Mee.—F. Calvert.—R. J. Allen.—E. R. Norman.—A. J. Compton.—N. G. W.—J. C. Clough.—G. T. Burnett.—J. and H. Grace.—F. d'Alquen.—Langden and Co.—Douglas Scoffern.—Jan.—E. E. L.—Alexander.—Jack of All Trades.—W. Morshead. — Firefly, Melbourne. — Diapason.—Hugh Clements.—Charles Robinson.—T. B. Y.—E. L. P.—Joseph Green.—W. H. B.—O. E. W.—H. J. Burton.—Hawks.—Novus Homo. — Anxious. — Cynocephalus.—Medical Practitioner.—A. B. Biggs.—Joseph Jewsbury.—L. J. H.—A. Sells.—R. N. C.—Tottenham.—Faber.—W. Dockray.—Hesper.—Photo.—T. Mitcheson.—Looker on.—Borrowdale.—W. H. W.—Kneecap.—Steamship.—Boxwook.—Pains.—Cook's Shop.—T. A.—P. O. Tele.—Autos.—J. S.—Darkness.—Wear Engineer.—J. E. F.—J. E. Floyd.—Verax.—Artist.—Benjamin Bolt.—Hilda.—W. H. R.—Geo. Tommy.—Oilman.—W. Bourne.—A. B. H.—Varnish.—F. B. K.

YOUNG MUSICIAN. (The cost will be from three to six pounds, according to style and number of pages. We cannot recommend individual printers.)—J. K. P. (The quotation was ours, not Mr. Edison's, and was not intended to apply as you understand it.)—T. W. (Instructions for making a dulcimer were given on pp. 46 and 126 of Vol. XXI.)—MODUS OPERANDI. (Of any wholesale chemist; we cannot name firms in this column.)—GAS. (Hughes' "Treatise on Gasworks," 4s., Lockwood and Co., Stationers' Hall-court, is a cheap and useful work.)—W. DOCKRAY. (We do not forward letters, and all such communications go at once to the waste paper basket. The book has been long out of print—the correspondent mentioned has repeatedly stated this in these columns—and an overture made by us some two years since to republish it, with such additions as modern improvements might demand, was not met favourably.)—L. T. D. (It is often done where a considerable amount of compression is required, as in high speed engines. The exhaust is closed early by the action of a link motion, or in stationary engines by a lap on the exhaust side of slide-valve. Such an addition delays the exhaust port opening and accelerates its closing.)—OPERA. (You have omitted to take the great expansibility of the metal into account. Zinc expands as much as [illegible] part of its length when heated from 32° Fahr. to 212° Fahr.)—NOT PROVEN. (We think the charcoal burners of the Ardennes use a mixture of one-fourth beech and oak, one-fourth poplar and willow, and one-half elm. The yield is about 140lb. of charcoal from about 660lb. of mixed wood. There is no doubt much of the substance of the wood is lost, which by a better process would be yielded as charcoal.)—T. R. (When the breadth of the tooth of a wheel is just twice its whole length, its ultimate resistance to transverse stress is approximately equal to its resistance to diagonal stress applied at one corner. A greater breadth than twice the length, therefore, is not reckoned to add to the transverse resistance of the tooth, but is necessary for durability.)

THE Kew Gardens Defence Association contemplate asking Parliament to sanction the formation of a public School of Botany at Kew, so as to make Kew a teaching centre for botany and its allied sciences. Lectures open to all, somewhat after the fashion of those in the Garden of Plants, Paris, is, we apprehend, what they contemplate.—*Garden.*

Florida.—A writer to the Tampa *Tribune* states that Florida is rich in minerals. He says that coal, hard and soft, iron, petroleum, and bi-sulphuret of iron certainly exist there, and he considers that the legislature could not do better than make a liberal grant for a thorough geographical survey of the State.

Brine as a Preservative.—At a recent meeting of the Geneva Society of Physics and Natural History, Prof. Alph. de Candolle presented a glass jar containing fruits of the coffee plant collected before maturity in Mexico, preserved in a liquid which chemical analysis proved to be salt water. It is fifty years since the jar thus filled was hermetically sealed, under the eye of Aug.-Pyr. de Candolle, and to-day the coffee-beans which it contains are in a thoroughly satisfactory state of preservation. The water contains a solution of chloride of sodium and very small quantities of other chlorides or salts. No gas was found in solution; the water must then have been boiled, and introduced while hot into the jar. This experiment may give valuable hints as to the substitution of salt water for alcohol (of which every one knows the inconvenience) for the preservation of organic substances.—*Nature.*

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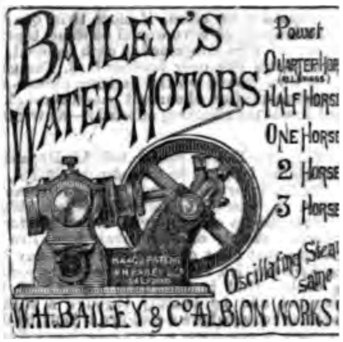

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FRANCIS RAVENSCROF

he English Mechanic
AND
ORLD OF SCIENCE AND ART.

FRIDAY, AUGUST 16, 1878.

ARTICLES.

ILWAY ACCIDENTS AND THE BRAKE EXPERIMENTS.

HE return of railway accidents in 1877
is so far satisfactory that it shows a
ainution on the average of previous
rs, but we suspect that if an examina-
n were made into the details of each so-
led accident, it would soon be discovered
t most, if not all, of these railway
astrophes were brought about by negli-
nce, either direct or indirect. Many
rsons might be induced to think that,
cause, during the last thirty years, the
ality amongst passengers has been
luced from 1 in, say, 5,000,000 to 1 in
000,000, which is about the figure for
t year, there was little reason to complain,
d small hope of still further reducing
mortality. Those, however, who are
uainted with the working of railways
ow that the great majority of train acci-
nts are preventible, and that they arise
inly from negligence, or from a want of
se appliances which would render them
possible. The number of passengers in-
red last year shows a remarkable fall from
returns of the previous year, and we are
lined to think that, on the whole, greater
e has been exhibited by the companies
n at any previous time. The action of
Board of Trade has doubtless had some
ect in producing this result, and, if a
tle more pressure is brought to bear, it
not impossible that we may ultimately
uce railway disasters to *bonâ-fide* acci-
nts. In his report, Mr. Calcraft says
t greater security for life and limb may
attained if the companies will only avail
mselves of the means placed at their
posal, more especially by providing a
neral system of continuous brakes, by
eloping the block and the interlocking
stems, by fitting properly-arranged foot-
ards, and by better considered and
forced regulations as to the couplings of
aches and waggons. With the introduc-
n of the block system and its gradual
elopment, in company with the inter-
king of points and signals, a gratifying
uction in the number of collisions has
n effected; and all railwaymen will agree
t, with a properly arranged system of
nts and signals, collisions ought to be-
me practically impossible, except on the
pposition of culpable negligence, or the
eaking down of the apparatus at the
itical moment. On last Bank holiday, the
siest day in the year, two accidents
curred on lines near London—happily,
thout any serious results; but in the one
e with much inconvenience and annoy-
ce to the passengers, and in the other
h a considerable loss in money to the
pany. Many of the visitors to the
ystal Palace and other places on the
ndon-bridge lines did not return to their
mes until four and five in the morn-
g, and the Great Eastern and Southend
mpanies must have lost a considerable
m by the blocking of the line during the
rly part of the day. Both accidents
pear to have been caused by defective
nalling and interlocking arrangements,
t an examination of the latter will serve
point the moral. From Fenchurch-street
Stepney the traffic is worked on two up-
es and one down line—the three branching off into four at the junction, an up and down on the Bow extension, and an up and down on the Blackwall line. Trains coming up on the Bow extension for either of the up lines must cross the down line at one point or another, and as they are necessarily going at slow speed, having only just started, there is little possibility of a serious collision; but owing to the absence of interlocking points and signals there is every possibility of a "pitch in," as it is called, which may, as on this occasion, result in serious loss of traffic. A North Woolwich up train was crossing the down line just as a Southend down train was entering the station, and the result was a collision, much excitement and some injury to the passengers, and a block of about three hours during the busiest part of the day. Now, this accident could not have happened had the points been interlocked with the signals, the cost of which arrangement would probably have been covered by the fares the company were obliged to return and refuse. For, assuming the up train to have started against its signal, it would have gone to the left instead of the right, and would have crossed the down line at a point clear of the incoming train. Similarly, had the down train run against the signal, the points would have been so set that it would have taken the wrong road, but it would have been left clear of the outcoming train, and in either case the delay would have been slight, and no damage would have been done. The lesson is easily learnt, and possibly the loss of revenue will in this case lead to an alteration that should have been made long ago, if the "penny wise" policy had not the lead of the "pound foolish." Third-class passengers will thank Mr. Calcraft for calling attention to the want of padding in the carriages allotted to them. He appropriately points out that third-class coaches are defective as regards comfort and safety when compared with first and even second-class carriages. The first-class passenger is, in slight collisions, saved from any severe contusion by the well-stuffed and padded linings of his carriage, but the third-class passenger has nothing but hard boards to bump against. It is true that some companies—for instance, the North-western—do give their third-class passengers a comfortable seat and a padded back rest, but the majority of third-class coaches are nothing but varnished wood, and some—the South Western Richmond line, for instance—little better than cattle-trucks. Why this should be so is a puzzle, for third-class passenger traffic pays best, and the first financier in the world, Mr. Gladstone, long ago advised railway companies to stick to the democracy. It cannot be the cost, for that is merely nominal, but it may be that some vague idea floats in the minds of the directors that the travelling public will be driven from the third into the second and first-class coaches by the want of comfort in those set apart for them. By this time they have lived long enough to know better, and, with the Midland and the North-western taking the lead, we may yet hope to see a universal improvement.

Capt. Galton and Mr. Westinghouse have been continuing their experiments upon the Brighton line, and we await the official returns of their results before commenting on them at length. The general result is to show that, while it is always an advantage to bring the maximum retarding force upon the wheels as speedily as possible, any brake apparatus, claiming to be the best must be capable of reducing the force as the speed slackens. At 60 miles an hour it was found practically impossible to skid the wheels with the maximum force of the brakes applied instantaneously, but skidding took place as the speed decreased. At 50 miles skidding occurred when the brakes were applied with a force equal to 1·64 of the weight on the wheels; but, in these experiments, the value of the reducing valve was clearly exemplified, as the pressure was reduced as the speed decreased, and it was found possible to prevent skidding by a judicious use of the brake-power at command. The experiments also demonstrated the superiority of cast iron over wrought iron brake blocks, for at the moment of skidding with the latter the shock was tremendous, and even dangerous—the wrought-iron blocks wearing the tires in a remarkable way, to the extent of tearing small pieces out of them, and roughing the surfaces in a very destructive if not dangerous manner. On the contrary, the cast-iron blocks left the tires clean and smooth. Further experiments are to be made, and the London and Brighton Company deserve the thanks of the community, and, above all, of the railway world, for the public spirit they have shown in placing the means of making them at the disposal of Capt. Douglas Galton and Mr. Westinghouse. We hope still to see the brake question set at rest by a competitive trial, carried out at the same time on parallel lines of rail, for we believe it is the only way to convince those who still doubt.

HIGHWAYS BILL & LOCOMOTIVES.

THE restrictive legislation that has prevented the development of the road locomotive still prevails, and the Highways Bill of 1878 does little more than modify the almost prohibitive enactments of 1861 and 1865. Certain sections of the Acts passed in those years are repealed by the new bill, which has become, or will doubtless soon become, law, and in their place we have the following rules and regulations. By the new bill it is proposed to make it unlawful to use, on any turnpike road or highway, locomotives that do not comply with the following provisions:—A locomotive weighing not more than three tons, providing it is not employed to draw a carriage or waggon, may have tires of not less than three inches in width, but for every ton, or fraction of a ton, above that weight the width of the tire must be increased by one inch. A ten-ton locomotive must, then, in future have wheels with tires 10in. wide; and, so far, there is, bearing in mind the usual character of country roads, nothing of which to complain. But, if the locomotive is employed to draw a waggon or carriage, the next provision declares that it must have driving wheels the tires of which are not less than 2in. for every ton that the locomotive weighs; a 10-ton engine would therefore require wheels 20in. broad in the tread. Except under special circumstances, no locomotive, the width of which exceeds 9ft., or weighing more than 14 tons, can be legally worked over common roads; and the driving-wheels of all locomotives must be cylindrical and smooth-soled, or shod with diagonal bars not less than 3in. wide, nor more than ¾in. deep. These cross-bars must extend over the whole width of the tire, and they must be placed so close that not more than 3in. of space shall intervene between any two bars. The exact weight of the engine, including that of the necessary coal and water, must be legibly marked on some conspicuous part in letters not less than 1in. in length. Those are the principal provisions of a bill prepared by Mr. Sclater Booth and Mr. Salt, which a body of gentlemen, few of whom are practical engineers, are requested to criticise into a suitable Act, that shall protect the interests involved without hindering the utilisation of road locomotives. No one supposes that the Houses of Parliament would designedly prevent or restrict the introduction of any useful invention; but, while so much power—all power, in fact—is placed in their hands, is it too much to expect that, on technical matters of this nature, they should call to their aid the evidence of experts. The limit of 3in. for the width of tires, and of 1in. for each ton in the weight of locomotive, is a rule that can be easily understood, and is probably as good a measurement as could have been decided upon by any committee of experts, but why should it be doubled when the locomotive is required to draw a waggon? The answer is, of course, that, with a load behind, the wheels of the locomotive are more likely to tear up the surface of the road, and at first sight the rule appears to be a good one; but a little examination into details will, we think, put another face on the matter. The wheels of the traction engine are, it will be observed, to be cylindrical, and in a 10-ton locomotive will be 20in. across the tire, the outside edges of the two driving wheels not being more than 9ft. apart. We have thus what we may regard as two cylinders, the centres of the circumferences of which are between, say, 6 and 8 feet apart. Now, if it is absolutely necessary that the tires should be 20in. wide, it is equally necessary that the road should be level; but we know that all roads must, for the sake of carrying off rain, have a rounded contour, and we see at once that it is practically impossible for the 20in. tread of the wheel to bear over its whole surface, except perhaps when the road is in a soft state, and then the kneading action of the broad wheel will probably do more damage than the narrower tread of a smaller wheel. Such legislation is, therefore, a blunder, for the simple reason that makers of traction engines are not likely to construct machines having wheels with too narrow tires, but they will, on the contrary, in proportioning their locomotives, adopt those dimensions which, from practical experience, they know to be best. The duration of the machine is of as much importance as that of the road, and, though the maker will naturally give the machine the first place, the road on which it is to run is so much a part and parcel of it that he is compelled to take it into consideration in working out his design. As it is, the heavier examples of road locomotives, with tires of 20 and 24in. width, will be subjected to severe strains when running over high-pitched roads, and the road itself will, we believe, be more seriously damaged than it would have been by the passage of narrower wheels. The permission to use diagonal bars across the tires reads strangely in a bill that insists on extra wide tires; and the manner in which that permission is granted is evidence of the absence of technical skill in those who drafted the bill. Instead of stipulating that the faces of the bars should present a certain area within given dimensions, no definition of diagonal is offered, and the spaces between the bars may be anything from, say, ½in. up to 3in. It is obvious that the bars, to be diagonal, need only be very slightly out of the line of the axis, so that, practically, the permission to use them savours very much of the "meddling and muddling" that has always characterised legislation in connection with steam carriages. Even in so simple a matter as framing a clause stipulating that the weight of the engine shall be marked in plain characters, those who drafted the bill, those who "amended" it in committee, and those who permitted it to pass its third reading, are alike incapable of putting the provision into language that cannot be misunderstood. According to the clause, the "exact and true weight of a locomotive, including necessary water and coals, shall be legibly written in letters of not less than 1in. in length;" but we need scarcely point out to our readers that what is wanted is that every road locomotive should have its maximum weight indicated in large figures. The "exact and true" weight, if correct at the time of starting, cannot be "exact and true" when half the journey is completed, unless the engine is frequently stopped to take in fuel and water. The "exact and true" weight will doubtless be understood to mean the weight in running order, and the point is scarcely worth commenting upon if it did not serve to expose the want of knowledge of those who are called upon to make Acts of Parliament. Credit is due, however, for the repeal of the absurd regulation that a man should precede the engine by 60 yards, and carry a red flag. He was also to help timid horses and timid riders past the locomotive, and was yet liable to be summoned if he was not 60 yards in front of the engine. Doubtless, some latitude would have been allowed, but if the letter of the law had been adhered to, the flagman must either give up his 60 yards' limit or refuse to assist riders past the engine. A little practical experience demonstrated the absurdity of the provision; the red flag was probably a greater source of alarm to horses than the engine, and, moreover, when the man was called upon to assist in leading horses he had only one hand for the work, for he could not drop his flag. The most amusing feature of the clause, however, was the manner in which horses and riders following the engine were ignored. The flagman was to give notice of its approach, but those who wanted to pass it in the same direction were left to their own devices, as it was scarcely possible to attract the attention of a flagman more than 60 yards ahead of them. According to the new bill, an attendant must always accompany the locomotive on foot while it is in motion, and, if required, must assist horses, and carriages drawn by horses, in passing the engine. There is nothing positively objectionable in that clause, though it is difficult to see why the attendant should be compelled to walk. As a matter of fact, he will ride during the greater part of the time, and walk only when some one is looking. Bearing in mind for what purposes road locomotives are used, and the scenes of the greater part of their labours, it seems a needlessly troublesome provision to insist that "every locomotive used on any turnpike road or highway shall be constructed on the principle of consuming its own smoke." The meaning of the clause is not very definite, unless it may be taken literally. It is easy enough to construct a locomotive on the "principle of consuming its own smoke," but it is not always possible to work it without giving off smoke. If it is intended that all locomotives, when working upon roads, shall consume their smoke, and we suspect that is the meaning of the clause, a quite unnecessary restriction will be placed upon them. The designer of an engine, for the sake of economy, will so arrange his furnace, and the driver will so regulate his fire, that the smoke given off unconsumed will be a very small quantity, which cannot possibly be a nuisance in a country road, and is of small moment in a town; but it would surely be sufficient if the clause were made compulsory only when the locomotive is, say, within 50 yards of a dwelling. An odoriferous and pestiferous ditch is permitted to widely distribute disease, it may be death; but a little smoke because it is visible, must be put down—no matter at what expense and at what inconvenience. The smoke might possibly help to destroy the disease-germs of the ditch, but that is a consideration not yet appreciated by our legislators. There are signs of better things in the future, for more than one noble lord has ventured to express the opinion that the dangers of steam carriages in the streets have been much exaggerated, and such expressions of opinion filter rapidly downwards. The law relating to locomotives, and to steam on common roads, has now been amended and patched in so many places that it is time a brand-new Act was passed. The present bill, or rather the clauses added to the new Highways Bill, is evidence that the question is not regarded with so much distrust as formerly characterised the Acts relating to road locomotives; while the importance and value of the latter are steadily becoming more widely known. They will soon be regarded as necessities of the times, but, we suspect, until that is the general opinion, no satisfactory Act regulating the employment of steam on common roads will be passed.

THE ORGAN: A COMPREHENSIVE TREATISE ON ITS MANUFACTURE, PROCURAL, AND LODGMENT.*

By John Watson Warman,

Associate of the College of Organists, London.

PART I.—GENERAL TREATMENT IN MANUFACTURE.

c. AGAINST all these advantages the cutting of the Slider has nothing to offer, except—1; *Insuring* always the same amount of wind to the Pipes. 2; Making the show of an additional Knob. The first is always secured if the Pipe be sufficiently winded from each Slider (*see Dep.* of SOUNDBOARDS); the second is a piece of sham unworthy of any true Builder.

c. c. It may be mentioned that some have objected to this continuation of an Incomplete or Short Stop by Grooving into the Bass of another one which is complete, giving as a reason that the Stop-Handle is then made to convey a false statement. Among these may be mentioned Mr. W. H. Clarke, the well-known Organist and Organ-builder of Indianapolis, Ind., U.S.; see page 52 of his "Outline of the Pipe Organ." That such scruples are held is only honourable, but it is sufficient to observe that only two parties are concerned—the purchaser and the player; the former can be and should be supplied with the number of Pipes in each Register, the latter will soon find them out for himself, and the convenience of the diminished number of Handles will *remain* with him.

d. I think, therefore, that without any further expenditure of words, we may safely lay down that Borrowing by Groove for a short or incomplete Stop is not only *permissible*, but decidedly *advisable*.

d. d. It may be mentioned here that on the Choir Organ the finishing of the Open 8ft. at Ten C, and borrowing the remainder from the Stopped Diap. is, in some cases, actually *preferable*, even for effect (*see Dep.* of SPECIFICATIONS).

e. In some cases the bottom of the Double has been *partly* borrowed from some 8 feet Stop in frequent use, by making the actual Pipes of the former merely a Quint, the 16 feet sound therefore obtained by *resultant* tone. An Example occurs in the North Congregational Church, Westfield, Mass., U.S.; by Johnson, Westfield, U.S.

The species of Borrowing that consists in obtaining two or more notes from one Pipe will be treated of in *Depart.* of PIPES.

e. e. The only other form of *Auxiliary*-borrowing necessary to notice here is that of completion of an entire Manual, which is short in its downward compass. This, too, is exceedingly valuable in the case of cheap Instruments, if done with discretion; thus, in even a low-priced two-Manual Organ, the Great will, of course, go through; but there is really no necessity whatever for the Swell to do so, provided only that it go as far as Gam. G.: the Swell is, in many respects, essentially unfit to supplement the Pedale (*see* 127, t.); the usual great expense of the 7 bottom notes is here much added to by the *Boxing*, the presence of at least one *Double* (*see* SPECIFICATIONS) still further increasing cost; *the Vocal range practically finishes at Gam. G*, and the shortening of the Swell as this note will allow of a good addition to Pedale.

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The completion, therefore, of the Swell in cases by borrowing from the Choir, or if r not present on a *suitable* portion of it, furnishes a most valuable expedient.

Examples of borrowing the bottom of a ier are too numerous to require here any icularisation. It is only within the last 20 s that the necessity of having the Swell Org. nple range has been fairly realised; consetly, almost all our old Instruments borrow ower portion of some one Section. The on most usually shortened was, of course, Swell, and where a Choir Organ was also ent the effect of the break was not, obsly very offensive, for the Swell borrowed Choir; but where the Manuals were Great *Swell*, as was, and will in the future be still the case, the usual method was to borrow the entire Great. It need hardly be ted out how very offensive a treatment this th a Swell descending no lower than Ten. C, he Vocal range is constantly passing below note, and unless great caution be observed dreadful *progressions* often result.

As, however, the importance of the Swell me better recognised this truly barbarous dient was abandoned; and when a Choir an did not exist, either the Stopt Diap. ie Swell was continued (sometimes with the ition of the Principal) throughout, geney outside the Swell Box, or a *portion only* of Great was used, by being provided with a ll separate Pallet. Strange to say, however, importance of this point seems to have been ome cases seen and felt sooner by the lesswn Builders than by those who would claim igher position. The Instrument built for Parish Church, Ashford, Kent, somewhere ut 40 years ago, by (if I rightly recollect) ington, had its Swell Stopt Diap. and cipal both continued to bottom outside the ; while the Instruments in St. John's, Mar-, and St. Margaret's, Canterbury, both y beautiful specimens by Gray and ison, are yet each disfigured with this truly sive break. The former has just been delled, but I do not know whether this cular part has received attention. Both ns are, comparatively speaking, new.

In the much smaller and less pretentious ument lately erected by the same firm in tgate Church, Canterbury, the defect has remedied, the Swell below Ten C acting on the Great Stopt Diapason. The same od is constantly adopted by Hill; an nce is furnished by St. John's, Longside.

It now remains to consider the plan of ᴀʀʏ Bᴏʀʀᴏᴡɪɴɢ—that is, when the porborrowed is an essential one. This plan rder may itself be divided into two:—1st, n the borrowing is from one Clavier to her; 2nd, when it is from the same Clavier. he first-named the borrowing may obviously n unison, or some octave or other note at sure. In the second it will be apparent the borrowing must be at a different pitch ize of tone.

It will now, perhaps, be well to give some nples of each Variety.

stances of borrowing from different Clavier.

By *Cav.-Coll.* Abbey of St. Denis, near : entire Clavier des Bombardes borrowed Great.

Clarke, Indianopolis, Ind., U.S. Jarvis Baptist Church, Toronto: Violoncello and oct. of Pedale can be at pleasure placed on uals.

By *Elliott and Hill.* York Minster: is portion of Pedale borrowed from bottom vell.

Gern. St. John the Baptist, Kensington, on: Contra Fagotto of Pedale borrowed same stop in Swell.

By *Gray and Davison.* City Hall, Glasgow: heaviest Stops of the Great can be layed from the Swell Manual. Town Leeds: the Echo of six Stops can be either on Solo or Choir Clavier; also Great can be at pleasure placed on Swell. *Harris (René).* St. Andrew's, Undershaft, n: Two lowest octaves of Choir borrowed Great. St. Peter, Mancroft, Norwich: Open and St. Diap. and Prin. borrowed Great below Ten. D. Salisbury Cathedral: ond Great, really almost a duplicate Manual, as every Stop, except one Open Diap. and a Cornet, was borrowed from true Great.

o. By *Hill.* Town Hall, Birmingham: whole of Solo borrowed from Choir and Swell.

By *Jones, H., London.* Parish Church, Bridgenorth (Specific. by the Organist, Mr. Skeffington): two Swell Reeds borrowed from Great St. Peter's Wes. Chapel, Canterbury: lower portion of Great Double borrowed from Pedal Pipes (I have called this *Primary* because of the great importance of the Double).

p. By *Radcliff and Sagar, Leeds.* St. Jude's, Leeds: bottom oct. of Choir Dulciana borrowed from Ped. Violoncello. The Dulciana being a chief stop of the Choir, this comes theoretically under the division of Primary borrowing.

By *Schulze, Paulinzelle.* Exchange Room, Northampton: Pedale Bourdon and Flute borrowed from Manual Great.

q. By *Smith, Bristol.* St. James, Bristol (Specific. by Mr. Hodges): nearly the whole of Choir is borrowed from Great.

r. By *Snetzler.* Lynn Regis, Norfolk: Swell below Ten. F borrows Choir St. Diap., Dulciana, and Flute, which are kept distinct for that purpose.

s. By *Walcker, Ludwigsburg.* Ulm Cathedral: whole of Solo borrows from various parts of remainder of Instrument.

By *Warman, J. W., Faringdon.* Organ for Mr. M. Bradley: Pedale Principal borrowed from Great Open Diap.

t. By *Whiteley, Chester.* Chester Cathedral: Solo Tromba, Diap. Harmonic, and Flute Harmonic borrowed from Great.

u. *Instances of borrowing from same Clavier.* This treatment, which, for a variety of reasons to be presently pointed out, is really the best, and indeed perhaps the only legitimate variety of Primary-borrowing, has, strange to say, been comparatively little attended to; only one example of real importance, so far as author is aware, existing at the present time: one reason, doubtless, being that many of the effects of Borrowing on a single Clavier can be as effectively and more simply obtained by those very useful expedients, Octave Couplers.

v. The example in question is furnished in the large Organ by Gray and Davison, in the Town Hall, Leeds. It is confined to the Solo, and the method is as follows:—The Solo Organ proper has 9 Registers, but 7 additional Knobs give combinations of particular Stops of the said 9; thus, No. 10 gives Clarinet and 8ft. Flute, but the latter in its super octave, the effect being, of course, of an 8ft. Clarinet and 4ft. Flute combined; and No. 15 gives Flute, Clarinet, and Bassoon, but the first-named in the 4ft. pitch, and last-named in the 16ft. pitch, the effect being that of Flute 4ft., Clarinet 8ft., and Contra Fagotto 16ft.

w. As the Leeds Instrument is one of considerable size and importance; and furnishes, as just said, almost the only existing noteworthy instance of borrowing on a single Clavier or Section: considering also the somewhat peculiar circumstance under which the Organ came into existence, and the very strong terms of eulogium in which its Solo Section has been spoken of—it will perhaps be as well to give this example of Borrowing a more extended examination.

w.w. The Solo proper of the Leeds Instrument, then, consists of the following 8 Registers: Bourdon (8ft.), Concert Flute Harmonic (8), Piccolo Harmonic (4), Ottavina Harmonic (2), Clarinet (8), Cor Anglais and Bassoon, *Free Reed* (8), Tromba (8), Ophicleide (8).

x. The combinations by Borrowing are as follows:—10. Clarinet and Flute in octaves; 11. Oboe and Flute in do.; 12. Clarinet and Bassoon in do.; 13. Clarinet and Oboe in do.; 14. Oboe and Bassoon in do.; 15. Flute, Clarinet, and Bassoon in double octaves; 16. Flute, Oboe, and Bassoon in do.

y. The design and effect of the treatment will be sufficiently apparent and clear on referring to Nos. 10 and 15 just described; and it cannot be denied that the scheme possesses both novelty, ingenuity, and a certain amount of effectiveness. But it can hardly fail that its merit, whatever it may be, will be really lessened by the most faulty and injudiciously laudatory notice or description put forward by the authorities, and from which—inserted into the "Choir"—the foregoing list is taken: it will be only necessary here to notice the portion referring to the Solo Organ.

z. This writer, after making the extremely questionable statements that the Pipes of the Organ gain from 20 to 30 per cent. in intensity by being placed horizontally (see full analysis, Gᴇɴ. Aʀʀ.), and that the Cor Anglais is the best imitative Bassoon that has been yet achieved by the Organ-builder—proceeds (it must be understood that the present author has not the least knowledge as to who he is) to make the perfectly astounding assertion that the effect of Stops combined in this way is very different from that produced by the union of ordinary ones of different size of tone. Will that describer be kind enough to explain how? The example he gives shows conclusively how his enthusiasm has obscured such faculties as he may possess; he instances a Cremona of 8ft. combined with a 4ft. Flute, as giving as different an effect from the No. 10 of the Leeds Solo Organ as two ordinary *dissimilar* Stops, one 8 and one 4 feet, will, from a simple octave struck with only a single Stop drawn.

[23, a.] A more absurd and erroneous comparison was probably never instituted; it is incredible that the describer should not have seen that the No. 10 and the Choir instance he gives are *exactly identical in effect*, except as the Choir differs from the Solo. The Cremona (or Cromorne, as it by rights ought to be written) will, of course, not sound like a Clarinet, nor the Flute if an ordinary one like the Harmonic species; also it is quite certain that a Choir on a 3in. wind will not give such an effect as with 6 or 7; but with these reservations, which are entirely incidental, and have nothing to do with the question, the effect is, as already observed, *identical*, except that in the latter case it is obtained in a *superior* because a more *simple* and *direct* way (*see* further in Tʀᴇᴀᴛᴍᴇɴᴛ, 24, m.). It is lamentable that a person possessing no more critical acumen than is displayed in this description of the Leeds Organ should attempt or be intrusted with the task of placing fairly before the public so large, and, in many respects, so fine an Instrument.

b. As a fact, however, the Solo arrangement of the Leeds Organ will not bear even a slender analysis. First and foremost Nos. 10 and 11 are useless, and serve only to additionally elaborate an already too complicated Instrument; a 4ft. Flute of *same* kind (Harmonic) being already present, the simple drawing of this will, obviously, give the effect desired, without the roundabout way of borrowing the 8ft. Flute in the octave above; the same thing applies to Nos. 15 and 16 so far as the Flute is concerned. There remain only the exceptional Reed effects, and each of these might have been obtained by the simple disposition on the Solo Organ of a Contra Fagotto, 16ft., and a Super Clarinet, 4ft.; both of which Registers may be regarded as simply *indispensable* in any Concert Organ containing as many Sounding Stops as does the Leeds Instrument—viz., 93.

c. It may possibly be thought that I have in the foregoing been unnecessarily critical or severe, that the Organ is a really fine one, that these things are matters of opinion, &c., &c.—all very well, but not altering the case here one iota. The Leeds Organ was designed under very peculiar, not to say questionable circumstances; the acceptance of a scheme prepared by persons who can, after all, be regarded only as amateurs, in preference to that proposed by one who had (and that, too, while yet little more than a youth in years) shown himself a veritable giant in Organ construction; the natural indignation of the latter person, the controversy that followed (vide *Musical Gazette* of 1857), the bitter feeling that gradually arose, the recommendation about "noiseless Throttle-valves to own (personal) lingual organ,"—all these combine to render it not only justifiable, but desirable, that the Instrument itself be carefully, strictly, and exhaustively examined. In a future *Part* the entire scheme will therefore come fully under notice.

d. It may be laid down that the Leeds Solo scheme, though undoubtedly ingenious and effective (as has been already said), can, on the whole, only be cited as an example of what ought to be avoided. Granting that the mechanism is (as it doubtless is) of the most simple and effective kind possible, yet still mechanism there must be; and this even with the very best construction, will inevitably amount to almost, if not quite, the cost of the two Registers named (b, *ante.*); and when all is done the Solo possesses no more actual Stops than it did before, whereas the addition of the aforesaid two Registers would give a most valuable increase.

(*To be continued.*)

SOLUBLE COTTON FOR PHOTOGRAPHERS.

AN ammoniacal solution of a salt of copper has been known for some time to impart extraordinary qualities to paper, and it has also been used for dissolving cotton. For some reason or other this property of acting as a solvent of cotton has not been utilised so fully as it might be, and it is remarkable that greater use has not been made of it in the work of photography. M. Ernest Boivin calls attention to this subject, and tells us that in his operations in carbon photography with dry collodion, in which films of normal collodion are employed, he has frequently used with advantage a solution of ordinary cotton in ammonia liquor, containing 15 per cent. of hydrated carbonate of copper. In the rapid albumen dry process it is necessary, before applying the albumen to the plate, to cover it with collodion, which forms a kind of spongy felt, capable of retaining a greater quantity of albumen, and of equalising the film. The soluble cotton prepared by M. Boivin, according to the directions of Major Turainne, has given satisfactory results. It is not so easily used as the alcoholised ether collodion, but it costs much less. He prepares it in the following manner:—In ammonia at 22° Baumé, containing 15 per cent. of hydrated carbonate of copper, after the reaction has ended he adds to the liquid (in small quantities) ordinary cotton, free from greasy matter, such as is used for the preparation of pyroxylin; it is agitated, and after solution filtered through asbestos, or decanted after repose in a glass-stoppered bottle, as the product is highly caustic. If we desire to obtain a cotton adhering more strongly to the plate, or opaline films, add to the caustic solution a little resin. To cover a plate collodionise in the ordinary manner, and when the coating is thoroughly dry immerse the plate in a dish of water acidulated with nitric acid. The blue print produced by the copper salt disappears rapidly, and a few washings will be found to leave on the surface of the plate, after thorough drying, an adherent coating of pure cotton. This coating, whilst still wet from the last washing, may be covered with albumen, or the plates may be set aside and wetted where it is required to albumenise them. After the final washing the plates may be covered with iodo-bromide solution, drained merely or allowed to thoroughly dry, when on dipping into the silver bath they will be found to be very sensitive. The microscope does not disclose any difference between the tissue thus formed by ordinary cotton, and that obtained from emulsions.

HOW TO MAKE A PIANOFORTE.—V.

THE action frame consists of two end pieces or standards, and two rails—viz., the lever rail and the hammer rest. The standards are made of 1in. hard wood—generally bay wood—3in. wide, resting at the bottom on a block 1in. square, and are kept in position by dowels. The top of the treble standard is cut so as to allow it to pass freely under the wrest-pins, and the bass to match; a ¾in. block 2in. long is then glued to the part leaning against the plank, A, Fig. 1. The hammer rail is first squared across at the ends of the brasses, this line forming a shoulder to a 2in. tongue at each end, let into the standard, so that a ¼in. slip placed over them shall be flush at the edge. (See diagram B, Fig. 1). The tongues are then blackleaded, to ascertain the position of the rail. Put the treble standard in its place, and mark the height of the top *bridge pin on it.* 4in. below this mark is the *position of the centre* wire. The lever rail is of 1in. pine, ¼in. longer between the standards than the hammer rail, and giving it that much play. ⅜in. laps are cut at each end, and dovetailed into the standards, (C, Fig. 1). The height of this rail is regulated by that of the hopper. For a 2½in. hopper it will be 4¾in. from the key bottom to the top of the rail. An action spring is then screwed outside the treble standard, pressing against the tongue of the hammer rail. The blocks are glued to the key-bottom, their position indicated by adjusting the hammer butts to their respective strings, the same distance (about 16½in.) being everywhere between the back of the rail and inside the lockboard. A dowel is then put in the top blocks, projecting ⅜in. beyond them; a slight tap at the front of the standards will mark their place on the wrest plank, the holes being bored slightly below. To get the length of the hammer stems fit a treble hammer until the nose just clears the bridge pins, and cut the remainder to the same outside measurement. The key-frame can now be screwed to its place, taking care that its bass key is at the same distance from the standard as the hammer butt. The levers are usually put in to a scale fixed between the standards; but

FIG. 1

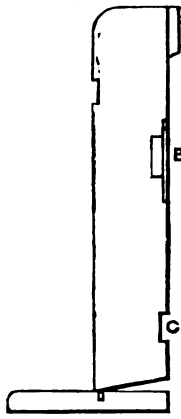
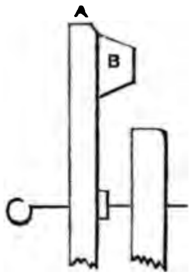


FIG. 3



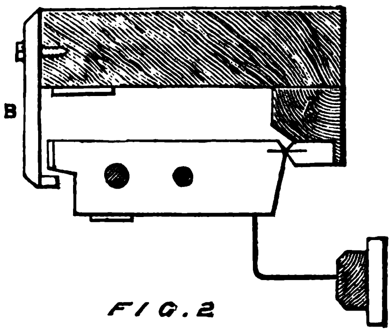


FIG. 2

it will, perhaps, be a readier method to first put in the hoppers, carefully spacing them, and set the levers in to match them. The damper rail is of the same wood and dimensions as the standards, and 3ft. long. It is centred at the treble end in a "damper rail eye," screwed into the plank, and at the bass, with a "side centre" sunk in the rest. This is a piece of 1in. wood, 2in. deep, fitted between the wrest plank and the projecting front of the end. At the back of the rail is a square length of ¾in. pine, on which the dampers are hung (A, Fig. 2). The front is clothed with soft baize. The height of the rail is ascertained by trying dampers at each end, allowing a working space of ½in. between them and the hammers. They are finally hung by the hammer scale. To obtain the length of stickers, measure between the levers and the hammer butts, and deduct ¼in. for thickness of hinge and play of sticker; or if the measurement is required before fitting the action, deduct 8½in. from the space between the top bridge pin and key-bottom. To mark for the damper wires: Bend about 1½in. from the bottom or plain end of a wire to a right angle, and screw a button on the top. Place this just under the damper, and mark where the bent end touches the left si stickers, Nos. 1 and 60. The damp are then placed sides up, and a l between these marks. A small ho bored ¼in. from the front, and the wi through and cut close to the side of t when they will be ready for fix hammer rest is a duplicate of the bevelled at the inside of the top ed the slant of the hammer, and clo soft baize. It is placed so that the when resting on it are from 2in. from the strings. The next task cutting the tops of the hoppers— conducted with extreme care, suffici taken off to allow the hammers to on the rest, without any space or pla the lever and the hopper. The back taken off (A, Fig. 3), so as to let down gradually on to the check, an as much as possible the double blo hammer—that bane of single act giving to the tone a most unpleasa as may be readily understood when sidered that this second contact hammer with the string is at a ti the latter is at its fullest vibrati hopper checks are cut so as to a hammer to fall about ⅜in. from the and with a slight backward slant (B, The whole are then blackleaded and bu The damper wires are then adjusted they stand perfectly free between the h The socket rail is slipped over them, in its place by the props, which are into the back of the hammer rail. The or damper lifts are put on, leaving of a card between them and the The rail shade (which is a slip of ¼in. wo a shelf for the dampers to rest on w rail is raised by the loud pedal)—see dia Fig. 2—is fastened to the front of the rail, and concludes the finishing. The ing portion, including the pedaling an the various blocks, &c., is called fly-fi the last of all being the regulating a ing the keys; but as these directions w equally to a check action, I will firs how this is to be fitted together.

W. H. I

NATURAL HISTORY OF CYI

ACCORDING to MM. Unger and the numbers of the genera and plants in Cyprus are as follows:—

	Genera.	S
1. Compositæ	70	...
2. Papilionaceæ	32	...
3. Gramineæ	37	...
4. Labiatæ	25	...
5. Umbelliferæ	34	...
6. Cruciferæ	29	...
7. Caryophyllaceæ ...	13	...
8. Liliaceæ	13	...
9. Boraginaceæ	12	...
10. Ranunculaceæ ...	9	...
11. Scrophulariaceæ ...	9	...
12. Orchidaceæ	7	...

And the list of those special to the considerable.

Amongst the most useful trees culti the olive and the mulberry. The ma of oil from the former was at one time tensive, as is proved by the great reser Larnaka, but over-speculation in the times ruined the trade, and the culti olives was abandoned for that of cott cotton seed is sown as early as possible to push it on rapidly, and not, as is some, that it may be well grown be grasshoppers arrive—a point to be re again. Three or four seeds are placed and when the shoots have come abov the strongest is left and the others are So far from the fear of grasshoppers, sometimes turned in to eat off the you The plants are hoed in June and July crop is gathered in October and Novem cotton of Cyprus is esteemed more hi that of any other part of the Levant, of its superior whiteness and the le thickness of its thread.

The cultivation of the mulberry tre greatly abandoned, though there are still existing where silkworms are rai climate is well adapted for this

f the fineness and evenness of the
fter the winter has passed. Locality
affect the colour of the silk. The
whitest kind is found in the neigh-
of Famagousta and Karpasso, the
sulphur-coloured near Citherea and
r part of the northern villages, and
surrounding places produce that of
yellow. Saffron, rhubarb, and other
roductions were also cultivated. An
acted from the seeds of the jujube
phus jujuba), and also from oil of
These were used when olive oil was

t the trees specially noticeable are
ritima, with which the mountain
anta Croce is covered, the cork oak,
it, and many others yielding good
imber; and some very valuable orna-
oods—oak, palm, cypress, orange,
l fig trees—are abundant. When the
s first went to the island it was
th forests, which they began to clear
ation and smelting the copper ore.
e still abundant in the S.W. district,
xist in the north. The Carob tree
siliqua), otherwise called the locust
t. John's Bread, from an idea that
Baptist used the pods for food in the
, is a source of profit, the pods being
exported. Ferula græca is abun-
applied to domestic purposes.
produced to some extent from the
d much comes from the neighbour-
unt Olympus. A very absurd myth
some books as to the production of
It is said to descend as a dew during
pon the foliage of a species of small-
, and in the morning, before the sun
country people drive their goats
ese plants, and the opium is collected
r of the animals, from which it is
washed and prepared for the market.
plants are very numerous, and drugs
ed from them, as colchicum, colo-
aparilla, and many others. There
variety of grasses, and flowers are
it that the island seems one vast

etians raised great quantities of
but these and the sugar works were
on the invasion of the Ottomans.
r is still produced, but only to a
ent. Vegetables of all kinds are
lant, and this island is the native
e cauliflower, which was obtained
on from Brassica oleracea. Amongst
ucts of Cyprus are cassia, cinnamon,
me, nutmegs, kermes, barley, wheat,
, and other odoriferous plants.
pists will find plenty to occupy them
eat of the day confines them in-
mongst the diatomaceæ named are
elegans, Fragilaria ungariana, Navi-
, N. elliptica, N. crytocephala, Am-
ilis, and Rhabdomena adricaticum;
æ, Palmella ungariana, Oscillaria
Protoderma irride, and Vaucheria
nd of Phyceæ, Dictiola implexa,
onia, and Sargassum Donati. Fungi
are very numerous, and many of
al to the island. There is a great
rasses.
is the great object of attention to
ts. It grows in great perfection.
rich, and produces most luscious
syrupy nature. The three principal
Commandery, Muscadine, which are
, and Mavro, or black. All red wines
black, but this is particularly dark
od, and I never perceived the pitchy
ch Cyprus wine is said to acquire
placed in pitched skins. Many of
ilies have wine two, and even four,
ars old in their cellars.
a of the island embraces snakes,
ot venomous, as in the other islands,
by the children catching and play-
em. The natives think it very un-
l one. There are also scorpions and
but here, as in the other islands of
rranean, their bite is not deadly.
a centipede alleged to be about a
half long, has no existence, neither
ode, an enormous venomous reptile,
is supposed to have been certain

Game, as the partridge, hare, pheasant, quail, are abundant in the island. The fox and a few pigs are the only wild quadrupeds. Deer formerly existed. If any still remain they are very rare. All the birds passing the winter in Africa frequent the island. As regards grasshoppers and locusts migrating from the continent, they are incapable of flying the distance. All that are found are indigenous, and are said to have been greatly reduced by the efforts of one of the Turkish governors.

John J. Lake.

A PARALLEL VICE.

AN improved form of parallel vice has been recently patented by Mr. W. Riley, of Keighley, the construction of which will be easily understood by a reference to the engravings.

The object of the invention is to arrange a parallel vice in such a manner that when the vice lever is held in a certain position the loose jaw will be free, and can be slid towards or from the fast jaw, the distance required to take in the material the workman is operating upon, and when the jaws are in contact with the material the workman can instantly apply pressure to the jaws, and secure the material therein quite firm.

The long flange of the fast jaw casting is fixed to the bench in the ordinary manner. At one end of this flange, and perpendicular to the same, is the fast jaw, and at the under side of the long flange are projections forming a groove, into which is fitted the slide of the loose jaw casting. Through this loose jaw casting, in a longitudinal direction, passes a bar, supported by journals formed at each end of the loose jaw slide. The bar is fitted with a lever at the end next the loose jaw, and near to the other end is fitted a scrolled cam. By actuating the lever the scrolled cam raises a block having a ratchet formed on one side, the teeth of which are forced into the teeth of a longitudinal ratchet fixed to the under side of the long flange, and by further actuating the lever the scrolled cam will draw the loose jaw towards the fast jaw, and thus secure the material between the jaws quite firm.

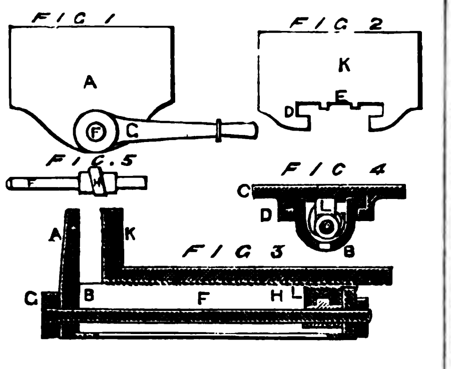


Fig. 1 is a front elevation of the vice; Fig. 2, a front elevation of the fast jaw; Fig. 3, a longitudinal section; Fig. 4, a transverse section taken near the cam; and Fig. 5 represents the scrolled cam.

A represents the loose jaw which is cast to the slide, B. At the under side of the long flange, C, forming part of fast jaw casting, are two projections, D, into which is fitted the loose jaw slide, B. At the top side of the groove is a rack, E, which may be cast to the fast jaw casting, or otherwise secured thereon. Through the loose jaw casting, B, a bar or vice spindle, F, is carried by journals formed in each end of the casting. At one end of this spindle, next the loose jaw, is a lever, G. Near the other end of the spindle is a scrolled cam, H. On the top of this scrolled cam, and fitting between the projections on the under side of the fast jaw casting, rests a block, L, the top side of which is formed with a number of ratchet teeth, corresponding in pitch and form to the teeth in rack, E. When the lever, G, is held in a certain position, the loose jaw is at liberty to slide to or from the fast jaw, K; and when material is put between the fast and loose jaws, and the loose jaw moved so as to bring the jaws in contact, the material is secured by actuating the lever, G, which causes the scrolled cam, H, to raise the block, L, until the ratchet teeth in the same fit into the rack, E. The centre line of the scrolled cam, H, is at an angle with the axis of the spindle, F, and thus the circumference of the cam keeps the teeth of the block, L, imbedded in the teeth of the rack, E, and at the same time the side of the cam presses against the groove formed in the block, L, and draws the loose jaw towards the fast jaw.

RESTORATIVE AND MEDICINAL BEVERAGES.

AN invention of improvements in the manufacture of aërated and other beverages for restorative and medicinal purposes has been patented by Mr. D. Johnson, of Wrexham. The liquids are termed "zoedone" or "life-giver," for the reason that they contain substances highly valuable as nerve tonics, and very effectual in supplying the waste of nervous power consequent upon mental and physical labour and sickness. The invention consists in the combination of certain chemical substances or preparations with water, wine, spirit, malt-liquor, syrup, or other liquids used as beverages, which beverages may or may not contain any desirable bitter or tonic substances. The chemical substances are the soluble phosphates of lime, iron, potash, and soda; also the lacto-phosphates of lime and iron, and unoxidised phosphorus. The chief object of the invention is the production of aërated beverages prepared by the addition of the said phosphates, or lacto-phosphates, or unoxidised phosphorus (or all or any of them combined), to a suitable liquid, which may in some instances contain such substances as quinine, sarsaparilla, taraxacum, podophyllin, pepsine, lacto-pepsine, gentian, hops, cardamoms, and the like, or any of the various forms of salicine.

In carrying out his invention, the patentee prefers to proceed as follows:—He first makes a phosphorised or phosphuretted syrup by combining the soluble phosphates in the manner ordinarily adopted by chemists, and then mixes them with about ten times their bulk of strong saccharine liquid or syrup, which may be flavoured or medicated as desired, and coloured with cochineal or other harmless pigment. It is important that this order of mixture should be observed, as if the flavouring or medicaments are added before the syrup is mixed with the phosphates, the iron will be precipitated, and, therefore, much of the restorative or medicinal value of the beverage will be lost, whereas when the above order or method of proceeding is observed, the beverage will keep perfectly clear, and the full strength of the phosphates will be retained. The bottles or other vessels for containing the improved beverage are dosed with a suitable quantity, say from one to three ounces of this phosphorised or phosphuretted syrup, which is then aërated in the manner usually employed in aërating liquids, by the use of water charged with carbonic acid gas. The patentee prefers that the aërated water used for this purpose should be perfectly free from alkalinity, as gaseous alkaline water tends to make the beverage turbid after it has been kept a short time.

In the addition of the aforesaid phosphorised syrup to wine, spirits, fruit syrup, or fruit juice, care must be taken that these substances are at the time entirely free from acetous fermentation. The patentee, therefore, mixes with them for their preservation a small quantity of any suitable substance prior to the addition of the phosphorised syrup—salicylic acid being very advantageous for this purpose. The phosphorised syrup is added to or mixed with the wine, syrup, or juice in the proportion of from one to two fluid drachms of the phosphorised syrup to every wineglassful of the liquid to be phosphorised.

THE BEE SHOW.

THE fourth show of the British Beekeepers' Association was held last week at the Royal Horticultural Gardens, South Kensington. The objects of the Association are the advancement of bee-keeping as a means of bettering the condition of cottagers, and the advocacy of humanity to the honey bee. The most important part of the Bee

Show is the exhibition of those methods of "driving" and manipulation by which the bees are induced to leave their hives. A competition for prizes in driving was on Tuesday held in a tent which had an inner enclosure of netting, so that the process could be observed without the spectator having to fear the stilettos of the enraged insects. The bees are first made drunk with sugar, or have their senses dulled a little with smoke, and are then drummed out of the hive into a straw skep, from which they are shaken into the new hive. Mr. Abbott obtained a prize this year for the use of a metal instead of a straw skep. The prize for driving was awarded to Mr. W. Martin, a cottager and chairmaker, of High Wycombe. Many improved bar and frame hives were exhibited which make the skill of the driver unnecessary, since the bees can be easily shaken out of them. In these a thin plate of wax is inserted to guide the bees in making their cells. They take advantage of the wall thus provided and build against it. Their time is saved, and the combs are regularly built. A machine to produce these guiding walls by rapidly passing wax under a roller was exhibited this year. Supers are also shown. These are placed above the hives, and are removed as soon at they are filled with honey. Mr. John Hunter, the well-known apiarian, shows little American supers, just large enough to hold a pound of honeycomb. "Slingers," or "extractors," in which the comb is placed, and turned rapidly round till the honey is expelled by centrifugal force, were also shown. Mr. Knight's (first prize) and Messrs. Neighbour's (third) appear to be the best. Mr. Brice Wilson took a first prize for an observatory hive, Messrs. Abbott for a combination hive, Mr. Lee for a cottager's. Splendid honey comes from Dumfries and Herts. It is shown in all colours—light, if the bees have fed on white clover in Ayrshire, darker if their pasturage has been upon the lime blossoms of Highgate, and so on. The early summer was too cold for much honey to have been gathered this year, but the bees have not been widely accused of preying upon the fruit trees, as they were in the bad season of 1876.

Among curiosities is a Portuguese hive of bark, exhibited by the Rev. F. T. Scott, and a quantity of honey produced on an upper floor in the Strand by bees belonging to Mr. Thurston, which were partly fed on syrup, and partly foraged on the flowers of the Embankment, or flew across the Thames to the learned shades of Lambeth. An interesting collection is that of the flowers from which bees chiefly gather their food—the spiked teasle, the meadowsweet, the thyme which gave its flavour to the honey of Hymettus, the white nettle, the fragrant mignonette and lavender, with borage, good also in claret cup.

The exhibition was enlivened on the first day by a discussion, opened by the Rev. J. D. Glennie, on questions interesting to bee-masters. One of these was, "How far is the process which leads to swarming initiated by and carried out with the goodwill of the old queen." The prevalent opinion was that the queen did not leave the hive willingly; one apiarian, indeed, had seen her forcibly led out between two resolute advisers.

BRITISH v. AMERICAN TOOLS.*

THE importation into this country of American-made tools is becoming a somewhat noticeable feature in Transatlantic trade. We have been accustomed for many years past to get our notions from across the water, and very ingenious and very useful many of these little contrivances were. Yankee mousetraps enable our cats to live in dignified idleness. But for Yankee egg-flippers forks would still do duty in this necessary process. Yankee apple-parers and peashellers, carpet sweepers and ash shifters have saved not a little labour, and contributed not a little to our comfort. (The future historian, with characteristic logic, will probably conclude that a nation so addicted to saving labour must have been extremely lazy.) Although, however, the introduction here of most of these and similar articles is due to American enterprise, it is probable that British industry has succeeded in producing them at prices under those at which they can be imported, so that much of the work sold as American is really of British manufacture. And it would appear as though in the future importations from America will become more and more confined to novelties, and continue for given articles only so long as the novelty lasts. In other words, so soon as any considerable demand for a novelty is created here, home manufacturers will supply the demand on terms leaving little scope for importation. In the matter of cutting tools, it is an undoubted fact that American manufactures have gained a very appreciable footing in Russian, Australian, and Canadian markets, hitherto supplied almost wholly by British manufacturers. But, according to the *Engineer*, the late reductions in the prices of English houses have considerably checked the success of American competitions, and there are indications that by the employment of improved machinery foreign enterprise will be yet more effectually met. The *Engineer* proceeds to say:—"An examination of certain tools obtained by a Midland hardware merchant from an American firm, to the order of certain Australian customers, has convinced us that they would have been sent out by no tool-making firm in this country, having other than the very lowest trade standing; they would most certainly not have been issued by our leading toolmakers. It could hardly have been with goods of this quality that the Americans succeeded in getting the position in the Antipodean markets which led to the preference indicated in the order."

This country may justly be considered the birthplace and home of what are known as machine tools—such as lathes, shaping, drilling, and other machines used in mechanical operations. It is, therefore, somewhat disquieting to find American-made machine tools competing here with tools of home make. Having occasion some time since to buy a number of light machine tools, the writer thought it advisable to carefully examine the American productions of that class, with a view of getting the best tools, whether British or American. The result was not favourable to the American machines. The impression produced by the examination was—first, that the American tools were all too light, much lighter than British tools of same nominal capacity. In a machine tool it is difficult to err on the side of solidity. Mass, indeed, is essential to steady, hard cutting. Secondly, that the workmanship was in no case up to our British standards. It was wanting in that absolute accuracy which characterises the workmanship of our first-rate toolmaking firms. Thirdly, the prices were anything but low. No lower than (if as low as) those of Whitworth, or other firms of the highest standing in this country. The writer concluded that those who required first-rate tools should not go to America for them, whilst those who require cheap tools could procure the cheapest here at home.

American machine tools are not often met with in our engineering workshops proper, but are chiefly found in manufactories devoted to the production of bicycles, sewing machines, and in other such light mechanical industries. Chiefly also in the smaller establishments of this kind. In short, American machine tools are in most favour amongst those who know least about tools. Amateur mechanics are recommended to think twice before investing in them.

ON THE ARTIFICIAL FORMATION OF PYROLUSITE.*

IN a paper read before the Chemical Society I gave a detailed account of a curious reaction of manganese salts, and showed that manganese dioxide resembling pyrolusite could be obtained by the reaction. I have since made many samples, and have obtained nodules so like the natural mineral that I thought that an account of the method might have some interest for mineralogists. When manganous nitrate is dissolved in strong nitric acid and warmed, and a few chips of potassic chlorate added, there is precipitated in the liquid black oxide of manganese in the form of flat plates which, when very thin, are of a beautiful purple, but when thicker are of a red colour. The whole of the manganese is precipitated in this form, but when the strength of the acid and the temperature are made to vary, the distribution of the plates may be changed. When the acid is very concentrated and the temperature only about 20°, and the mixture allowed to stand for some days, the dioxide of manganese is precipitated in plates (and sometimes needles), radiating from a centre, and arranged so that when fractured, and viewed with a low microscopic power, they look exactly like natural pyrolusite. The specific gravity is also the same, being 4·935. When the reaction is allowed to proceed more rapidly, loose plates are always formed. When a salt of iron is present it is partially precipitated in the form of a double manganate of manganese and iron, but it contains too much oxygen to be identical with any of the forms of Wad.

THE APPLICATION OF PHOTOGRAPHY TO THE PRODUCTION OF PRINTING SURFACES AND PICTURES IN PIGMENT—IV.†

By Thomas Bolas, Esq., F.C.S.

Printing of half-tone subjects from Metal. Application of Asser's process. Talbot's Photo-engraving. Woodbury's methods of engraving and printing.

WHEN treating of photozincography I gave details of Asser's process, and I showed you a zincplate bearing the fatty image. Since then I have etched that zinc plate, so as to convert it into a high printing block, suitable for the typographic press. Here it is; here is an electrotypic cast of it, and yonder is a proof from it, hanging side by side with a proof from the unetched plate. In comparing these proofs, you will see that a little of the detail has been lost during the etching; but this is not due to any defect in the process, but to the fact that I etched the plate too rapidly. In etching a plate of this kind, the re-inkings must be done with great caution, and the acid used for the earlier etchings must be very dilute—say, one part of acid to one hundred of water.

I hope to see Asser's process come into use for large and comparatively rough work, it being well adapted for this. Mr. Dallas has brought the manufacture of typographic blocks, for the representation of half tone, to great perfection, and he has kindly lent me some of these, and also prints from them. Although we do not know what method Mr. Dallas employs in making his "tint" blocks, we can all appreciate the excellence of the results.

The illustrious Talbot discovered a method of printing in half tone by means of etched copper or steel plates, and very beautiful results have been obtained by this method, which I now intend to illustrate to you.

Here is a copper plate which has been carefully cleaned and charcoaled. I slightly warm this, and fix it on the turn-table. I next pour on it a warm solution containing six parts of gelatine, one hundred of water, and one of ammonium bichromate. The table being now rotated, all excess of the gelatine solution is thrown off, and a thin even film is left on the copper plate. The plate must next be dried at a gentle heat, after which it is ready for exposure to light under a transparency. Here is a plate which has been so exposed, and you will notice that, where the light has acted, the coating has become brown, and at the same time it has become insoluble in aqueous liquids, the degree of insolubility depending on the extent to which the light has acted. The next problem is to etch through the soluble parts of this film without destroying its continuity. This cannot be done by nitric acid, as the acid destroys the gelatine film at once, but a strong solution of iron perchloride will answer the purpose. The plate being now put into this solution of perchloride of iron, the etching has commenced. Those parts of the gelatine film which have not been acted on at all by the light remain very soluble, and allow the etching to take place rapidly, while those parts where much light has acted resist the solution altogether, and those parts which have been acted on by a small proportion of light allow a proportionate amount of the iron perchloride to penetrate. Thus all degrees of light and shade are represented by corresponding amounts of etching. The plate is now sufficiently etched. I take it out, clean off the gelatine; and now it is ready for the press. Here is a proof from a similar plate.

The next process to which I direct your attention is one discovered, perfected, and carried out on a large scale by Mr. Woodbury. The Woodbury-type process consists in casting coloured gelatine pictures in a metal mould. Here is a metal mould—the method of making it I will describe directly—in which the image is hollowed out, the depth of the hollow being greatest in those parts corresponding with the dark parts of the picture, and everywhere deep in proportion to the intensity of the shade. I place this mould in a dish containing blackened water, so that the water just runs over its face. You now see no picture or anything approaching to a picture. Now notice the effect of pressing a piece of plate-glass down on the surface of the mould. The excess of blackened water is forced out, and the hollows of the mould alone are filled up with the blackened water. Now, as these hollows vary in depth, varying degrees of shade are produced, and a perfect picture is produced. I take the glass off, and the picture disappears; put it on once more, and it re-appears. Instead of coloured water, I pour on this mould a little coloured gelatine, and press a piece of plate-glass down on the surface. The excess is forced out, and the mould filled with coloured gelatine. In a few seconds the gelatine will have set, and I shall be able to lift off the glass which will carry with it the gelatine image. Here it is; it forms a transparency suitable for the magic lantern. If, after having flooded the mould with coloured gelatine, a piece of paper is laid on, and the excess of gelatine is forced out with a plate of glass, a picture composed of coloured gelatine is moulded on the paper, and can be removed as soon as the mould is set. When removed, it is dipped into a solution of alum, in order to render the gelatine image insoluble in water.

So much for the general principles of Woodbury type; and now let me show you how you can work this process yourselves.

The first thing is to dissolve about six parts of easily soluble gelatine, and two parts of lump sugar, in fifteen parts of warm water. Here is the warm mixture already strained through muslin, and here is a waxed glass plate, set level, and bordered with a little ledge of wood. The warm gelatine solution being poured on, spreads itself over the plate, forming an even layer, which, in the course of one hour, rill dry, forming a uniform sheet. Well, here is a ry sheet of the gelatine on another piece of glass, nd you see that the introduction of a penknife under ne corner of the gelatinous sheet brings it off the lass at once. The next thing is to make this elatine sensitive to light, and for this purpose it is oaked in a solution of potassium bichromate, ontaining 3½ per cent. of the salt. You see that it as now become quite flaccid by absorbing the olution, and I now lay it on a sheet of glass, and renove the excess of solution by means of the queegee. The bichromated gelatine adheres to the lass, but when dry it will be easily removable.

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* By W. H. N., in the *Journal* of the Amateur Mechanical Society.

* By J. B. Hannay, F.R.S.E., F.C.S., Assistant Lecturer on Chemistry, Owen's College, Manchester; from the *Mineralogical Magazine*.

† Being the Cantor Lectures delivered before the Society of Arts.

Here is a glass plate, with a dry sensitive film on t. I take the film off, and place it under a negative. t is now ready for exposure to light, and would require about two hours of such light as we had to-day t noon. Here is a printing frame containing three uch films, which have had the necessary exposure nder their negatives. I put these films in water, nd let them get moderately soft, but not so soft as he film became during the sensitising. One of hese I take out and lay face downwards on a piece f finely ground glass, another is similarly placed on piece of glass covered with gold-beaters' skin, and he remaining one is put down on a sheet of ollodionised glass. The squeegee is now applied to ach, and adhesion takes place. In order to enable he gelatine films to firmly fix themselves to the supports, they should remain at rest during a period of bout half an hour; but as we cannot wait that me, I have provided a duplicate set, previously prepared. Mr. Barker will now put these into warm ater, and the gelatine soon begins to dissolve. Now, emember that certain parts of the bichromated elatine have been made insoluble by the action f light shining through the negative, and these nsoluble parts will remain undissolved on the pports (ground glass, gold beaters' skin, and ollodionised glass). It will take some little time r Mr. Barker to wash away all the soluble gelatine, nt towards the end of the lecture you will see his esults in the shape of gelatinous reliefs; thick here corresponding to the blacks of the picture, ery thin in those parts representing the whites, and nely graduating between these extremes. When he reliefs have been sufficiently developed, they ust be dried, and here is a finished and dry set. ou see that, having only one hour, it is necessary o get continually in advance of the work, and to ake fresh materials which have been previously orked up to a certain stage. Let me begin with he relief on finely-ground glass. This being gently armed, I put a border of wood round it, and pour n some fusible metal, made by melting together one art of cadmium, two parts of tin, four parts of lead, nd seven parts of bismuth. Well now, if I left this o cool in the ordinary way, the top would solidify irst, and the lower layers of metal in contracting ould leave small vacant spaces next to the surface f the gelatine, thus rendering the cast imperfect. o obviate this, I place the glass on this cold block f metal, and cover the top of the fluid fusible alloy with warm sand. The rest explains itself—the portion of fusible alloy next the face of the mould ecomes solid first. Here is a fusible metal mould made in the way I have just illustrated to you; I il it slightly, pour some coloured gelatine solution n it, and force away the excess by means of flat lass; and when the gelatine has set, the glass can e removed, carrying with it the moulded transparency.

Here is the relief on gold-beaters' skin, and here s the one which was developed on collodion. These an easily be stripped from their glass suppports, as I now show you—one corner being liberated, off they ome; I will pass them round for you to look at. Now, in the actual commercial practice of Woodbury-type printing, a film relief, such as you are now passing round, is forced into a plate of lead by means of the hydraulic press, and the leaden mould thus obtained is used for printing. I now lay a film relief on the smooth steel base of this screw press, place a piece of lead on the top, and apply pressure. You see the result—the lead has become an exact counterpart of the gelatine relief, which you will notice is in no way damaged.

Here is a leaden mould, together with the corresponding relief, kindly supplied by Messrs. Braun & Co., of Dornach, and here is a very fine mould made by Mr. Woodbury himself. I will make a cast in this, and you see that the result is one of Mr. Woodbury's magnificent lantern slides, which are now so popular. It is now projected on the screen, and you can all see it. I take it out, or the heat would melt the wet gelatine, and I pass it round for you to examine, but remember that it is not yet dry, so do not touch the face of it.

I think I explained to you that, in order to get a Woodbury-type picture on paper, it is merely necessary to interpose paper between the gelatine, as poured on the mould, and the plate-glass cover, which forces out the excess. To illustrate the matter, I will print one from this mould. Now, notice the paper I use. It is thin, hard paper, surfaced with shellac, to prevent the gelatine from penetrating it, and heavily rolled, to make it even in thickness. There is much more which I should like to tell you about the Woodbury-type process, but I have not time. You will not fail to notice the admirable collection of prints and illustrative specimens kindly lent me by the Woodbury-type Company, Messrs. Goupil and Co., Braun and Co., Bruckmann, and others, who are working the process on a large scale, not forgetting these very fine specimens lent by Mr. Woodbury himself.

I may mention that, in actual practice, one Woodbury-type printer can attend to several moulds, and by the time he has filled the last of the series, the first is ready to give up its picture. The moulds are arranged on a circular table, which revolves in front of the operator.

Mr. Woodbury has modified his process so as to obtain copper-plates suitable for deep printing in the ordinary copper-plate press, and this modification has been worked with the greatest success by Messrs. Goupil and Co., of Paris, who have kindly lent me these magnificent specimens of their work.

A gritty powder is added to the gelatinous mixture employed for making the relief, and, when the relief is made, it is found to be more or less rough, from the projection of the gritty particles. The relief is then rolled against a sheet of lead, so as to make a perfect reverse in this metal. As far as form is concerned, this plate of lead is perfectly adapted for printing in the copper-plate press, the hollows left by the projecting particles of grit holding the ink to perfection. But as lead is much too soft to be used as a deep-printing plate, the leaden plate is reproduced in copper by the electrotype process, two electrotypings being, of course, necessary—one to make a reverse mould, and a second to make a cast of this mould, or a duplicate of the original leaden plate.

BRITISH ASSOCIATION.—ADDRESS OF THE PRESIDENT.

At the 48th meeting of the British Association for the Advancement of Science, the third held in Dublin, the President, William Spottiswoode, Esq., M.A., D.C.L., LL.D., F.R.S., F.R.A.S., F.R.G.S., delivered an address, which he divided under two heads—the purposes and prospects of the association, and the external aspects and tendencies of the science he represented—mathematics. After a few remarks on what a president's address should be, the second and real subject of the address was reached, Dr. Spottiswoode pointing out that one thing appears clear from a retrospect of past experience—viz., that first or last, either at the outset in his choice of subject or in the conclusions ultimately drawn therefrom, the president, according to his own account at least, finds himself on every occasion in a position of "exceptional or more than usual difficulty." And your present representative, like his predecessors, feels himself this moment in a similar predicament. The reason which he now offers is that the branch of science which he represents is one whose lines of advance, viewed from a mathematician's own point of view, offer so few points of contact with the ordinary experiences of life or modes of thought, that any account of its actual progress which he might have attempted must have failed in the first requisite of an address—namely, that of being intelligible.

Mathematical Science.

Now if this esoteric view had been the only aspect of the subject which he could present to his hearers, he might well have given up the attempt in despair. But although in its technical character Mathematical Science suffers the inconveniences, while it enjoys the dignity, of its Olympian position, still in a less formal garb, or in disguise, if you are pleased so to call it, it is found present at many an unexpected turn; and although some of us may never have learnt its special language, not a few have, all through our scientific life, and even in almost every accurate utterance, like Molière's well-known character, been talking mathematics without knowing it. It is, moreover, a fact not to be overlooked that the appearance of isolation, so conspicuous in mathematics, appertains in a greater or less degree to all other sciences, and perhaps also to all pursuits in life. In its highest flight each soars to a distance from its fellows. Each is pursued alone for its own sake, and without reference to its connection with, or its application to, any other subject. The pioneer and the advanced guard are of necessity separated from the main body, and in this respect mathematics does not materially differ from its neighbours. And, therefore, as the solitariness of mathematics has been a frequent theme of discourse, it may be not altogether unprofitable to dwell for a short time upon the other side of the question, and to inquire whether there be not points of contact in method or in subject-matter between mathematics and the outer world which have been frequently overlooked; whether its lines do not in some cases run parallel to those of other occupations and purposes of life; and lastly, whether we may not hope for some change in the attitude too often assumed towards it by the representatives of other branches of knowledge and of mental activity.

In his preface to the "Principia," Newton gives expression to some general ideas which may well serve as the key-note for all future utterances on the relation of mathematics to natural, including also therein what are commonly called artificial, phenomena:—

"The ancients divided mechanics into two parts, rational and practical; and since artisans often work inaccurately, it came to pass that mechanics and geometry were distinguished in this way, that everything accurate was referred to geometry, and everything inaccurate to mechanics. But the inaccuracies appertain to the artisan and not to the art, and geometry itself has its foundation in mechanical practice, and is in fact nothing else than that part of universal mechanics which accurately lays down and demonstrates the art of measuring." He next explains that rational mechanics is the science of motion resulting from forces, and adds: "The whole difficulty of philosophy seems to me to lie in investigating the forces of nature from the phenomena of motion, and in demonstrating that from these forces other phenomena will ensue." Then, after stating the problems of which he has treated in the work itself, he says, "I would that all other natural phenomena might similarly be deduced from mechanical principles. For many things move me to suspect that everything depends upon certain forces in virtue of which the particles of bodies, through forces not yet understood, are either impelled together so as to cohere in regular figures, or are repelled and recede from one another."

Newton's views, then, are clear. He regards mathematics, not as a method independent of, though applicable to, various subjects, but as itself the higher side or aspect of the subjects themselves; and it would be little more than a translation of his notions into other language, little more than a paraphrase of his own words, if we were to describe the mathematical as one aspect of the material world itself, apart from which all other aspects are but incomplete sketches, and, however accurate after their own kind, are still liable to the imperfections of the inaccurate artificer. Mr. Burrowes, in his preface to the first volume of the "Transactions of the Royal Irish Academy," has carried out the same argument, approaching it from the other side. "No one science," he says, "is so little connected with the rest as not to afford many principles whose use may extend considerably beyond the science to which they primarily belong, and no proposition is so purely theoretical as to be incapable of being applied to practical purposes. There is no apparent connection between duration and the cycloidal arch, the properties of which have furnished us with the best method of measuring time; and he who has made himself master of the nature and affections of the logarithmic curve has advanced considerably towards ascertaining the proportional density of the air at various distances from the earth. The researches of the mathematician are the only sure ground on which we can reason from experiments; and how far experimental science may assist commercial interests is evinced by the success of manufactures in countries where the hand of the artificer has taken its direction from the philosopher. Every manufacture is in reality but a chemical process, and the machinery requisite for carrying it on but the right application of certain propositions in rational mechanics." So far your academician. Every subject, therefore, whether in its usual acceptation, scientific or otherwise, may have a mathematical aspect; as soon, in fact, as it becomes a matter of strict measurement, or of numerical statement, so soon does it enter upon a mathematical phase. This phase may, or it may not, be a prelude to another in which the laws of the subject are expressed in algebraical formulæ, or represented by geometrical figures. But the real gist of the business does not always lie in the mode of expression, and the fascination of the formulæ or other mathematical paraphernalia may after all be little more than that of a theatrical transformation scene. The process of reducing to formulæ is really one of abstraction, the results of which are not always wholly on the side of gain; in fact, through the process itself the subject may lose in one respect even more than it gains in another. But long before such abstraction is completely attained, and even in cases where it is never attained at all, a subject may to all intents and purposes become mathematical. It is not so much elaborate calculations or abstruse processes which characterise this phase as the principles of precision, of exactness, and of proportion. But these are principles with which no true knowledge can entirely dispense. If it be the general scientific spirit which at the outset moves upon the face of the waters, and out of the unknown depth brings forth light and living forms, it is no less the mathematical spirit which breathes the breath of life into what would otherwise have ever remained mere dry bones of fact, which reunites the scattered limbs and re-creates from them a new and organic whole.

And as a matter of fact, in the words used by Professor Jellett at our meeting at Belfast—viz., "Not only are we applying our methods to many sciences already recognised as belonging to the legitimate province of mathematics, but we are learning, to apply the same instrument to sciences hitherto wholly or partially independent of its authority. Physical science is learning more and more every day to see in the phenomena of nature modifications of that one phenomenon (namely, motion) which is peculiarly under the power of mathematics." Echoes are these, far off and faint perhaps, but still true echoes, in answer to Newton's wish that all these phenomena may some day "be deduced from mechanical principles."

If, turning from this aspect of the subject, it were my purpose to enumerate how the same tendency has evinced itself in the arts, unconsciously it may be to the artists themselves, I might call as witnesses each one in turn with full reliance on the testimony which they would bear. And, having more special reference to mathematics, I might confidently point to the accuracy of measurement, to the truth of curve, which according to modern investigation is the key to the perfection of classic art. I might triumphantly cite not only the architects of all ages, whose art so manifestly rests upon mathematical principles, but I might cite also the literary as well as the artistic remains of the great artists of Cinquecento, both painters and sculptors, in evidence of the geometry and the mechanics which, having been laid at the foundation, appear to have found their way upwards through the superstructure of their works. And in a less ambitious sphere, but nearer to ourselves in both time and place, I might point with satisfaction to the great school of English constructors of the 18th century in the domestic arts, and remind you that not only the engineer and the architect, but even the cabinetmakers devoted half the space of their books to perspective and to the principles whereby solid figures may be delineated on paper, or what is now termed descriptive geometry.

Nor perhaps would the sciences which concern themselves with reasoning and speech, nor the kindred art of music, nor even literature itself, if thoroughly probed, offer few points of dependence upon the science of which I am speaking. What, in fact, is logic but that part of universal reasoning; grammar but that part of universal speech; harmony and counterpoint but that part of universal music, "which accurately lays down," and demonstrates (so far as demonstration is possible) precise methods appertaining to each of these arts? And I might even appeal to the common consent which speaks of the mathematical as the pattern form of reasoning and model of a precise style.

The Principle of Measurement.

Taking, then, precision and exactness as the characteristics which distinguish the mathematical phase of a subject, we are naturally led to expect that the approach to such a phase will be indicated by increasing application of the principle of measurement, and by the importance which is attached to numerical results. And this very necessary condition for progress may, I think, be fairly described as one of the main features of scientific advance in the present day.

If it were my purpose, by descending into the arena of special sciences, to show how the most various investigations alike tend to issue in measurement, and to that extent to assume a mathematical phase, I should be embarrassed by the abundance of instances which might be adduced. I will therefore confine myself to a passing notice of a very few, selecting those which exemplify not only the general tendency, but also the special character of the measurements now particularly required—viz, that of minuteness, and the indirect method by which alone we can at present hope to approach them. An object having a diameter of an 80,000th of an inch is perhaps the smallest of which the microscope could give any well-defined representation, and it is improbable that one of 120,000th of an inch could be singly discerned with the highest powers at our command. But the solar beams and the electric light reveal to us the presence of bodies far smaller than these. And, in the absence of any means of observing them singly, Professor Tyndall has suggested a scale of these minute objects in terms of the lengths of luminiferous waves. To this he was led, not by any attempt at individual measurement, but by taking account of them in the aggregate, and observing the tints which they scatter laterally when clustered in the form of actinic clouds. The small bodies with which experimental science has recently come into contact are not confined to gaseous molecules, but comprise also complete organisms; and the same philosopher has made a profound study of the momentous influence exerted by these minute organisms in the economy of life. And if, in view of their specific effects, whether deleterious or other, on human life, any qualitative classification, or quantitative estimate be ever possible, it seems that it must be effected by some such method as that indicated above.

Again, to enumerate a few more instances of the measurement of minute quantities, there are the average distances of molecules from one another in various gases and at various pressures; the length of their free path or range open for their motion *without coming into collision;* there are movements causing the pressures and differences of pressure under which Mr. Crookes' radiometers execute their wonderful revolutions. There are the excursions of the air while transmitting notes of high pitch, which through the researches of Lord Rayleigh appear to be of a diminutiveness altogether unexpected. There are the molecular actions brought into play in the remarkable experiments by Dr. Kerr, who has succeeded, where even Faraday failed, in effecting a visible rotation of the plane of polarisation of light in its passage through electrified dielectrics, and on its reflection at the surface of a magnet. To take one more instance, which must be present to the minds of us all, there are the infinitesimal ripples of the vibrating plate in Mr. Graham Bell's most marvellous invention. Of the nodes and ventral segments in the plate of the telephone which actually converts sound into electricity and electricity into sound, we can at present form no conception. All that can now be said is that the most perfect specimens of Chladni's sand figures on a vibrating plate, or of Kundt's lycopodium heaps in a musical tube, or even Mr. Sedley Taylor's more delicate vortices in the films of the phoneidoscope, are rough and sketchy compared with these. For notwithstanding the fact that in the movements of the telephone-plate we have actually in our hand the solution of that old-world problem, the construction of a speaking machine; yet the characters in which that solution is expressed are too small for our powers of decipherment. In movements such as these we seem to lose sight of the distinction, or perhaps we have unconsciously passed the boundary between massive and molecular motion.

Through the phonograph we have not only a transformation but a permanent and tangible record of the mechanism of speech. But the differences upon which articulation (apart from loudness, pitch, and quality) depends, appear from the experiments of Fleeming Jenkin and of others, to be of microscopic size. The microphone affords another instance of the unexpected value of minute variations—in this case of electric currents; and it is remarkable that the gist of the instrument seems to lie in obtaining and perfecting that which electricians have hitherto most scrupulously avoided—viz., loose contact.

Once more, Mr. De La Rue has brought forward as one of the results derived from his stupendous battery of 10,000 cells strong evidence for supposing that a voltaic discharge, even when apparently continuous, may still be an intermittent phenomenon; but all that is known of the period of such intermittence is, that it must recur at exceedingly short intervals. And, in connection with this subject, it may be added that, whatever be the ultimate explanation of the strange stratification which the voltaic discharge undergoes in rarefied gases, it is clear that the alternate disposition of light and darkness must be dependent on some periodic distribution in space or sequence in time which can at present be dealt with only in a very general way. In the exhausted column we have a vehicle for electricity not constant like an ordinary conductor, but itself modified by the passage of the discharge, and perhaps subject to laws differing materially from those which it obeys at atmospheric pressure. It may also be that some of the features accompanying stratification form a magnified image of phenomena belonging to disruptive discharges in general; and that consequently, so far from expecting among the known facts of the latter any clue to an explanation of the former, we must hope ultimately to find in the former an elucidation of what is at present obscure in the latter. A prudent philosopher usually avoids hazarding any forecast of the practical application of a purely scientific research. But it would seem that the configuration of these striæ might some day prove a very delicate means of estimating low pressures, and perhaps also for effecting some electrical measurements.

Now, it is a curious fact that almost the only small quantities of which we have as yet any actual measurements are the wave-lengths of light; and that all others, excepting so far as they can be deduced from these, await future determination. In the mean-time, when unable to approach these small quantities individuality, the method to which we are obliged to have recourse is, as indicated above, that of averages, whereby, disregarding the circumstances of each particular case, we calculate the average size, the average velocity, the average direction, &c., of a large number of instances. But although this method is based upon experience, and leads to results which may be accepted as substantially true; although it may be applicable to any finite interval of time, or over any finite area of space (that is, for all practical purposes of life), there is no evidence to show that it is so when the dimensions of interval or of area are indefinitely diminished. The truth is that the simplicity of nature which we at present grasp is really the result of infinite complexity; and that below the uniformity there underlies a diversity whose depths we have not yet probed, and whose secret places are still beyond our reach.

The present is not an occasion for multiplying illustrations, but I can hardly omit a passing allusion to one all-important in[illegible] application of the statistical method. Without its aid social life, or the history of life and death, could not be conceived at all, or only in the most superficial manner. Without it we could never attain to any clear ideas of the condition of the poor, we could never hope for any solid amelioration of their condition or prospects. Without its aid sanitary measures, and even medicine, would be powerless. Without it the politician and the philanthropist would alike be wandering over a trackless desert.

It is, however, not so much from the side of science at large as from that of mathematics itself that I desire to speak. I wish from the latter point of view to indicate connections between mathematics and other subjects to prove that here is not after all such a far-off region, nor so undecipherable an alphabet, and to show that even at unlikely spots we may trace under-currents of thought which having issued from a common source fertilise alike the mathematical and the non-mathematical world.

Three Modern Mathematical Methods.

Having this in view, I propose to make the subject of special remark some processes peculiar to modern mathematics; and, partly with the object of incidentally removing some current misapprehensions, I have selected for examination three methods in respect of which mathematicians are often thought to have exceeded all reasonable limits of speculation, and to have adopted for unknown purposes an unknown tongue. And it will be my endeavour to show not only that in these very cases our science has not outstepped its own legitimate range, but that even art and literature have unconsciously employed methods similar in principle. The three methods in question are, first, that of Imaginary Quantities; secondly, that of Manifold Space; and thirdly, that of Geometry not according to Euclid.

First it is objected that, abandoning the more cautious methods of ancient mathematicians, we have admitted into our formulæ quantities which by our own showing, and even in our own nomenclature, are imaginary or impossible; nay, more, that out of them we have formed a variety of new algebras to which there is no counterpart whatever in reality; but from which we claim to arrive at possible and certain results. On this head it is in Dublin, if anywhere, that I may be permitted to speak. For to the fertile imagination of the late Astronomer Royal for Ireland we are indebted for that marvellous Calculus of Quaternions, which is only now beginning to be fully understood, and which has not yet received all the applications of which it is doubtless capable. And even although this calculus be not co-extensive with another which almost simultaneously germinated on the Continent, nor with ideas more recently developed in America; yet it must always hold its position as an original discovery, and as a representative of one of the two great groups of generalised algebras (viz., those the squares of whose units are respectively negative unity and zero), the common origin of which must still be marked on our intellectual map as an unknown region. Well do I recollect how in its early days we used to handle the method as a magician's page might try to wield his master's wand, trembling as it were between hope and fear, and hardly knowing whether to trust our own results until they had been submitted to the present and ever-ready counsel of Sir W. R. Hamilton himself.

To fix our ideas, consider the measurement of a line, or the reckoning of time, or the performance of any mathematical operation. A line may be measured in one direction or in the opposite; time may be reckoned forward or backward; an operation may be performed or be reversed, it may be done or may be undone; and if having once reversed any of these processes we reverse it a second time, we shall find that we have come back to the original direction of measurement or of reckoning, or to the original kind of operation.

Suppose, however, that at some stage of a calculation our formulæ indicate an alteration in the mode of measurement such that, if the alteration be repeated, a condition of things, not the same as, but the reverse of the original, will be produced. Or suppose that, at a certain stage, our transformations indicate that time is to be reckoned in some manner different from future or past, but still in a way having definite algebraical connection with time which is gone and time which is to come. It is clear that in actual experience there is no process to which such measurements correspond. Time has no meaning except as future or past; and the present is but the meeting point of the two. Or, once more, suppose that we are gravely told that all circles pass through the same two imaginary points at an infinite distance, and that every line drawn through one of these points is perpendicular to itself. On hearing the statement, we shall probably whisper, with a smile or a sigh, that we hope it is not true; but that in any case it is a long way off, and perhaps, after all, it does not very much signify. If, however, as mathematicians we are not satisfied to dismiss the question on these terms, we ourselves must admit that we have here reached a definite point of issue. Our science must either give a rational account of the dilemma, or yield the position as no longer tenable.

Special modes of explaining this anomalous state of things have occurred to mathematicians. But, omitting details as unsuited to the present occasion, it will, I think, be sufficient to point out in general terms that a solution of the difficulty is to be found in the fact that the formulæ which give rise to these results are more comprehensive than the signification assigned to them; and when we pass out of the condition of things first contemplated they cannot (as it is obvious they ought not) give us any results intelligible on that basis. But it does not therefore by any means follow that upon a more enlarged basis the formulæ are incapable of interpretation; on the contrary, the difficulty at which we have arrived indicates that there must be some more comprehensive statement of the problem which will include cases impossible in the more limited, but possible in the wider view of the subject.

A very simple instance will illustrate the matter. If from a point outside a circle we draw a straight line to touch the curve, the distance between the starting point and the point of contact has certain geometrical properties. If the starting point be shifted nearer and nearer to the circle the distance in question becomes shorter, and ultimately vanishes. But as soon as the point passes to the interior of the circle the notion of a tangent and distance to the point of contact cease to have any meaning; and the same anomalous condition of things prevails as long as the point remains in the interior. But if the point be shifted still further until it emerges on the other side, the tangent and its properties resume their reality, and are as intelligible as before. Now the process whereby we have passed from the possible to the impossible, and again repassed to the possible (namely, the shifting of the starting point) is a perfectly continuous one, while the conditions of the problem as stated above have abruptly changed. If, however, we replace the idea of a line touching by that of a line cutting the circle, and the distance of the point of contact by the distances at which the line is intercepted by the curve, it will easily be seen that the latter includes the former as a limiting case, when the cutting line is turned about the starting point until it coincides with the tangent itself. And further, that the two intercepts have a perfectly distinct and intelligible meaning whether the point be outside or inside the area. The only difference is that in the first case the intercepts are measured in the same direction; in the latter in opposite directions.

The foregoing instance has shown one purpose which these imaginaries may serve—viz., as marks indicating a limit to a particular condition of things, to the application of a particular law, or pointing out a stage where a more comprehensive law is required. To attain to such a law we must, as in the instance of the circle and tangent, reconsider our statement of the problem; we must go back to the principle from which we set out, and ascertain whether it may not be modified or enlarged. And even if in any particular investigation, wherein imaginaries have occurred, the most comprehensive statement of the problem of which we are at present capable fails to give an actual representation of these quantities; if they must for the present be relegated to the category of imaginaries, it still does not follow that we may at some future time find a law which will endow them with reality, nor that in the meantime we need hesitate to employ them, in accordance with the great principle of continuity, for bringing out correct results.

If, moreover, both in geometry and algebra we occasionally make use of points or of quantities, which from our present outlook have no real existence, which can neither be delineated in space of which we have experience, nor measured by scale as we count measurement; if these imaginaries, as they are termed, are called up by legitimate processes of our science; if they serve the purpose not merely of suggesting ideas but of actually conducting us to practical conclusions; if all this be true in abstract science, I may perhaps be allowed to point out, in illustration of my argument, that in art unreal forms are frequently used for suggesting ideas, for conveying a meaning for which no other seems to be suitable or adequate. Are not forms unknown to biology, situations incompatible with gravitation, positions which challenge not merely the stability but even the possibility of equilibrium—are not these the very means to which the artist often has recourse in order to convey his meaning and to fulfil his mission? Who that has ever revelled in the ornamentation of the Renaissance, in the extraordinary transitions from the animal to the vegetable, from faunic to floral forms, and from these again to almost purely geometric curves, who has not felt that these imaginaries have a claim to recognition very similar to that of their congeners in mathematics? How is it that the grotesque paintings of the Middle Ages, the fantastic sculpture of remote nations, and even the rude art of the prehistoric past, still impress us, and have an interest over and above their antiquarian value, unless it be that they are symbols which, although hard of interpretation when taken alone, are yet capable from a more comprehensive point of view of leading us mentally to something beyond themselves, and to truths which, although reached through them, have a reality scarcely to be attributed to their outward forms?

Again, if we turn from art to letters, truth to nature and to fact is undoubtedly a characteristic of sterling literature; and yet in the delineation of outward nature itself, still more in that of feelings and affections, of the secret parts of character and motives of conduct, it frequently happens that the writer is driven to imagery, to an analogy, or even to a paradox, in order to give utterance to that of which there is no direct counterpart in recognised speech. And yet, which of us cannot find a meaning for these literary figures, an inward response to imaginative poetry, to social fiction, or even to those tales of giant and fairyland written it is supposed, only for the nursery or schoolroom? But in order thus to reanimate these things with a meaning beyond that of the mere words, have we not to reconsider our first position, to enlarge the ideas with which we started? Have we not to cast about for some thing which is common to the idea conveyed and to the subject actually described, and to seek for the sympathetic spring which underlies both? Have we not like a mathematician, to go back as it were to some first principles, or, as it is pleasanter to describe it, to become again as a little child?

Manifold Space.

Passing to the second of the three methods—viz., that of manifold space, it may first be remarked that our whole experience of space is in three dimensions—viz., of that which has length, breadth, and thickness; and if for certain purposes we restrict our ideas to two dimensions as in plane geometry, or to one dimension as in the division of a straight line, we do this only by consciously and of deliberate purpose sitting aside, but not annihilating the remaining one or two dimensions. Negation, as Hegel has justly remarked, implies that which is negatived, or, as he expresses it, affirms the opposite. It is by abstraction from previous experience, by a limitation of its results, and not by any independent process, that we arrive at the idea of space whose dimensions are less than three.

It is doubtless on this account that problems in plane geometry which, although capable of solution on their own account, become much more intelligible, more easy of extension if viewed in connection with solid space, and as special cases of corresponding problems in solid geometry. So eminently is this the case, that the very language of the more general method often leads us almost intuitively to conclusions which, from the more restricted point of view, require long and laborious proof. Such a change in the base of operations has, in fact, been successfully made in geometry of two dimensions, and although we have not the same experimental data for the further steps, yet neither the modes of reasoning, nor the validity of its conclusions, are in any way affected by applying an analogous mental process to geometry of three dimensions; and by regarding figures in space of three dimensions as sections of figures in space of four, in the same way that figures in plano are sometimes considered as sections of figures in solid space. The addition of a fourth dimension to space not only extends the actual properties of geometrical figures, but it also adds new properties which are often useful for the purposes of transformation or of proof. Thus it has recently been shown that in four dimensions a closed material shell could be turned inside out by simple flexure, without either stretching or tearing; and that in such a space it is impossible to tie a knot.

Again, the solution of problems in geometry is often effected by means of algebra; and as three measurements, or co-ordinates as they are called, determine the position of a point in space, so do three letters or measurable quantities serve for the same purpose in the language of algebra. Now, many algebraical problems involving three unknown or variable quantities admit of being generalised so as to give problems involving many such quantities. And as, on the one hand, to every algebraical problem involving unknown quantities or variables by ones, or by twos, or by threes, there corresponds a problem in geometry of one or of two or of three dimensions; so, on the other, it may be said that to every algebraical problem involving many variables there corresponds a problem in geometry of many dimensions.

There is, however, another aspect under which even ordinary space presents to us a fourfold, or indeed a manifold character. In modern physics space is regarded, not as a vacuum in which bodies are placed and forces have to play, but rather as a plenum with which matter is co-extensive. And from a physical point of view the properties of space are the properties of matter, or of the medium which fills it. Similarly from a mathematical point of view, space may be regarded as a locus in quo, as a plenum filled with those elements of geometrical magnitude which we take as fundamental. These elements need not always be the same. For different purposes different elements may be chosen; and upon the degree of complexity of the subject of our choice will depend the internal structure or manifoldness of space.

Thus, beginning with the simplest case, a point may have any singly infinite multitude of positions in a line, which gives a onefold system of points in a line. The line may revolve in a plane about any one of its points, giving a twofold system of points in a plane; and the plane may revolve about any one of the lines, giving a threefold system of points in space.

Suppose, however, that we take a straight line as our element, and conceive space as filled with such lines. This will be the case if we take two planes—*e.g.*, two parallel planes, and join every point in one with every point in the other. Now, the points in a plane form a twofold system, and it therefore follows that the system of lines is fourfold; in other words, space regarded as a plenum of lines is fourfold. The same result follows from the consideration that the lines in a plane and the planes through a point are each twofold.

Again, if we take a sphere as our element, we can through any point as a centre draw a singly infinite number of spheres, but the number of such centres is triply infinite; hence space as a plenum of spheres is fourfold. And, generally, space as a plenum of surfaces has a manifoldness equal to the number of constants required to determine the surface. Although it would be beyond our present purpose to attempt to pursue the subject further, it should not pass unnoticed that the identity in the fourfold character of space, as derived, on the one hand, from a system of straight lines, and, on the other, from a system of spheres, is intimately connected with the principles established by Sophus Lie in his researches on the correlation of these figures.

If we take a circle as our element we can around any point in a plane as a centre draw a singly infinite system of circles; but the number of such centres in a plane is doubly infinite; hence the circles in a plane form a threefold system, and as the planes in space form a threefold system, it follows that space as a plenum of circles is sixfold.

Again, if we take a circle as our element, we may regard it as a section either of a sphere, or of a right cone (given except in position) by a plane perpendicular to the axis. In the former case the position of the centre is threefold; the directions of the plane, like that of a pencil of lines perpendicular thereto, twofold; and the radius of the sphere onefold; sixfold in all. In the latter case the position of the vertex is threefold; the direction of the axis twofold; and the distance of the plane of section onefold; sixfold in all, as before. Hence space as a plenum of circles is sixfold.

Similarly, if we take a conic as our element we may regard it as a section of a right cone (given except in position) by a plane. If the nature of the conic be defined the plane of section will be inclined at a fixed angle to the axis; otherwise it will be free to take any inclination whatever. This being so, the position of the vertex will be threefold; the direction of the axis twofold; the distance of the plane of section from the vertex onefold; and the direction of that plane onefold if the conic be defined, twofold if it be not defined. Hence, space as a plenum of definite conics will be sevenfold, as a plenum of conics in general eightfold. And so on for curves of higher degrees.

This is in fact the whole story and history of manifold space. It is not seriously regarded as a reality in the same sense as ordinary space; it is a mode of representation, or a method which, having served its purpose, vanishes from the scene. Like a rainbow, if we try to grasp it, it eludes our very touch; but like a rainbow, it arises out of real conditions of known and tangible quantities, and if rightly apprehended it is a true and valuable expression of natural laws, and serves a definite purpose in the science of which it forms part.

Again, if we seek a counterpart of this in common life, I might remind you that perspective in drawing is itself a method not altogether dissimilar to that of which I have been speaking; and that the third dimension of space, as represented in the picture, has its origin in the painter's mind, and is due to his skill, but has no real existence upon the canvas which is the groundwork of his art. Or again, turning to literature, when in legendary tales, or in works of fiction, things past and future are pictured as present, has not the poetic fancy correlated time with the three dimensions of space, and brought all alike to a common focus? Or once more, when space already filled with material substances is mentally peopled with immaterial beings, may not the imagination be regarded as having added a new element to the capacity of space, a fourth dimension of which there is no evidence in experimental fact?

Non-Euclidean Geometry.

The third method proposed for special remark is that which has been termed non-Euclidean geometry, and the train of reasoning which has led to it may be described in general terms as follows:—Some of the properties of space which, on account of their simplicity, theoretical as well as practical, have, in constructing the ordinary system of geometry, been considered as fundamental, are now seen to be particular cases of more general properties. Thus a plane surface and a straight line may be regarded as special instances of surfaces and lines whose curvature is everywhere uniform or constant. And it is perhaps not difficult to see that, when the special notions of flatness and straightness are abandoned, many properties of geometrical figures which we are in the habit of regarding as fundamental will undergo profound modification. Thus a plane may be considered as a special case of the sphere—viz., the limit to which a sphere approaches when its radius is increased without limit. But even this consideration trenches upon an elementary proposition relating to one of the simplest of geometrical figures. In plane triangles the interior angles are together equal to two right angles; but in triangles traced on the surface of a sphere this proposition does not hold good. To this other instances might be added.

Further, these modifications may affect not only our ideas of particular geometrical figures, but the very axioms of the science itself. Thus the idea, which in fact lies at the foundation of Euclid's method—viz., that a geometrical figure may be moved in space without change of size or alteration of form, entirely falls away, and becomes only approximate in a space wherein dimension and form are dependent upon position. For instance, if we consider merely the case of figures traced on a flattened globe like the earth's surface, or upon an eggshell, such figures cannot be made to slide upon the surface without change of form, as is the case with figures traced upon a plane or even upon a sphere. But, further still, these generalisations are not restricted to the case of figures traced upon a surface; they may apply also to solid figures in a space whose very configuration varies from point to point. We may, for instance, imagine a space in which our rule or scale of measurement varies as it extends, or as it moves about in one direction or another; a space, in fact, whose geometric density is not uniformly distributed. Thus we might picture to ourselves such a space as a field having a more or less complicated distribution of temperature, and our scale as a rod instantaneously susceptible of expansion or contraction under the influence of heat; or we might suppose space to be even crystalline in its geometric formation, and our scale and measuring instruments to accept the structure of the locality in which they are applied. These ideas are doubtless difficult of apprehension, at all events at the outset; but Helmholtz has pointed out a very familiar phenomenon which may be regarded as a diagram of such a kind of space. The picture formed by reflection from a plane mirror may be taken as a correct representation of ordinary space, in which, subject to the usual laws of perspective, every object appears in the same form and of the same dimensions whatever be its position. In like manner the picture formed by reflection from a curved mirror may be regarded as the representation of a space wherein dimension and form are dependent upon position. Thus in an ordinary convex mirror objects appear smaller as they recede laterally from the centre of the picture; straight lines become curved; objects infinitely distant in front of the mirror appear at a distant only equal to the focal length behind. And by suitable modifications in the curvature of the mirror representations could similarly be obtained of space of various configurations.

The diversity in kind of these spaces is of course infinite; they vary with the mode in which we generalise our conceptions of ordinary space; but upon each as a basis it is possible to construct a consistent system of geometry, whose laws, as a matter of strict reasoning, have a validity and truth not inferior to those with which we are habitually familiar. Such systems having been actually constructed, the question has not unnaturally been asked, whether there is anything in nature or in the outer world to which they correspond; whether, admitting that for our limited experience ordinary geometry amply suffices, we may understand that for powers more extensive in range or more minute in definition some more general scheme would be requisite? Thus, for example, although the one may serve for the solar system, is it legitimate to suppose that it may fail to apply at distances reaching to the fixed stars, or to regions beyond? Or again, if our vision could discern the minute configuration of portions of space, which to our ordinary powers appear infinitesimally small, should we expect to find that all our usual geometry is but a special case, sufficient indeed for daily use, but after all only a rough approximation to a truer although perhaps more complicated scheme? Traces of these questions are in fact to be found in the writings of some of our greatest and most original mathematicians. Gauss, Riemann, and Helmholtz have thrown out suggestions radiating as it were in these various directions from a common centre; while Cayley, Sylvester, and Clifford in this country, Klein in Germany, Lobatcheffsky in Russia, Bolyai in Hungary, and Beltrami *in Italy, with many others, have* reflected kindred *ideas with all the modifications* due to the chromatic *dispersion of their individual minds.* But to the main question the answer must be in the negative. And, to use the words of Newton, since "Geometry has its foundation in mechanical practice," the same must be the answer until our experience is different from what it now is. And yet, all this notwithstanding, generalised conceptions of space are not without their practical utility. The principle of representing space of one kind by that of another, and figures belonging to one by their analogues in the other, is not only recognised as legitimate in pure mathematics, but has long ago found its application in cartography. In maps or charts, geographical positions, the contour of coasts, and other features, belonging in reality to the Earth's surface, are represented on the flat; and to each mode of representation, or projection as it is called, there corresponds a special correlation between the spheroid and the plane. To this might perhaps be added the method of descriptive geometry, and all similar processes in use by engineers, both military and civil.

Utility of Pure Mathematics.

It has often been asked whether modern research in the field of pure mathematics has not so completely outstripped its physical applications as to be practically useless; whether the analyist and the geometer might not now, and for a long time to come, fairly say, "hic artem remumque repono," and turn his attention to mechanics and to physics. That the pure has outstripped the applied is largely true; but that the former is on that useless is far from true. Its utility often crops up at unexpected points; witness the aids to classification of physical quantities, furnished by the ideas (of Scalar and Vector) involved in the calculus of quaternions; or the advantages that have accrued to physical astronomy from Lagrange's equations, and from Hamilton's principal of varying action; on the value of complex quantities, and the properties of general integrals, and of general theorems on integration for the theories of electricity and magnetism. The utility of such researches can in no case be discounted, or even imagined beforehand; who, for instance, would have supposed that the calculus of forms or the theory of substitution would have thrown much light upon ordinary equations; or that Abelian functions and hyperelliptic transcendents would have told us anything about the properties of curves; or that the calculus of operations would have helped us in any way towards the figure of the earth? But upon such technical points I must not now dwell. If, however, as I hope, it has been sufficiently shown that any of these more extended ideas enable us to combine together, and to deal with as one, properties and processes which from the ordinary point of view present marked distinctions, then they will have justified their own existence; and in using them we shall not have been walking in a vain shadow, nor disquieting our brains in vain.

These extensions of mathematical ideas would however be overwhelming if they were not compensated by some simplifications in the processes actually employed. Of those aids to calculation I will mention only two—viz., symmetry of form, and mechanical appliances; or say mathematics as a fine art, and mathematics as a handicraft. And, first, as to symmetry of form. There are many passages of algebra in which long processes of calculation at the outset seem unavoidable. Results are often obtained in the first instance through a tangled maze of formulæ, where at best we can just make sure of our process step by step, without any general survey of the path which we have traversed, and still less of that which we have to pursue. But almost within our own generation a new method has been devised to clear this entanglement. More correctly speaking, the method is not new, for it is inherent in the processes of algebra itself, and instances of it, unnoticed perhaps or disregarded, are to be found cropping up throughout nearly all mathematical treatises. By Lagrange, and to some extent also by Gauss, among the older writers, the method of which I am speaking was recognised as a principle; but beside these perhaps no others can be named until a period within our own recollection. The method consists in symmetry of expression. In algebraical formulæ combinations of the quantities entering therein occur and recur; and by a suitable choice of these quantities the various combinations may be rendered symmetrical, and reduced to a few well-known types. This having been done, and one such combination having been calculated, the remainder, together with many of their results, can often be written down at once, without further calculations, by simple permutations of the letters. Symmetrical expressions, moreover, save as much time and trouble in reading as in writing. Instead of wading laboriously through a series of expressions which, although successively dependent, bear no outward resemblance to one another, we may read off symmetrical formulæ, of almost any length, at a glance. A page of such formulæ becomes a picture: known forms are seen in definite groupings; their relative positions, or perspective as it may be called, their very light and shadow, convey their meaning almost as much as through the artistic faculty as through any conscious ratiocinative process. Few principles have been more suggestive of extended ideas or of new views and relations than that of which I am now speaking. In order to pass from questions concerning plane figures to those which appertain to space, from conditions having few degrees of freedom to others which have many—in a word, from more restricted to less restricted problems—we have in many cases merely to add lines and columns to our array of letters or symbols already formed, and then read off pictorially the extended theorems.

Next as to mechanical appliances. Mr. Babbage, when speaking of the difficulty of insuring accuracy in the long numerical calculations of theoretical astronomy, remarked, that the science which is itself is the most accurate and certain of all had, through these difficulties, become inaccurate and uncertain in some of its results. And it was doubtless some such consideration as this, coupled with his dislike of employing skilled labour where unskilled would suffice, which led him to the invention of his calculating machines. The idea of substituting mechanical for intellectual power has not lain dormant; for beside the arithmetical machines whose name is legion (from Napier's bones, Earl Stanhope's calculator, to Schultz and Thomas's machines now in actual use) an invention has lately been designed for even a more difficult task. Prof. James Thomson has in fact recently constructed a machine which, by means of the mere friction of a disc, a cylinder, and a ball, is capable of effecting a variety of the complicated calculations which occur in the highest application of mathematics to physical problems. By its aid it seems that an unskilled labourer may, in a given time, perform the work of ten skilled arithmeticians. The machine is applicable alike to the calculation of tidal, of magnetic, of meteorological, and perhaps also of all other periodic phenomena. It will solve differential equations of the second and perhaps of even higher orders. And through the same invention the problem of finding the free motions of any number of mutually attracting particles, unrestricted by any of the approximate suppositions required in the treatment of the lunar and planetary theories, is reduced to the simple process of turning a handle.

When Faraday had completed the experimental part of a physical problem, and desired that it should thenceforward be treated mathematically, he used irreverently to say, "Hand it over to the calculators." But truth is ever stranger than fiction; and if he had lived until our day, he might with perfect propriety have said, "Hand it over to the machine."

Had time permitted, the foregoing topics would have led me to point out that the mathematician, although concerned only with abstractions, uses many of the same methods of research as are employed in other sciences, and in the arts, such as observation, experiment, induction, imagination. But this is the less necessary because the subject has been already handled very ably, although with greater brevity than might have been wished, by Prof. Sylvester in his address to Section A. at our meeting at Exeter.

Origin of Mathematical Ideas.

In an exhaustive treatment of my subject there would still remain a question which in one sense lies at the bottom of all others, and which through almost all time has had an attraction for reflective minds—viz., what was the origin of mathematical ideas? Are they to be regarded as independent of, or dependent upon, experience? The question has been answered sometimes in one way and sometimes in another. But the absence of any satisfactory conclusion may after all be understood as implying that no answer is possible in the sense in which the question is put; or rather that there is no question at all in the matter, except as to the history of actual facts. And, even if we distinguish, as we certainly should, between the origin of ideas in the individual and their origin in a nation or mankind, we should still come to the same conclusion. If we take the case of the individual, all we can do is to give an account of our own experience; how we played with marbles and apples; how we learnt the multiplication table, fractions, and proportions; how we were afterwards amused to find that common things conformed to the rules of number; and later still how we came to see that the same laws applied to music and to mechanism, to astronomy, to chemistry, and to many other subjects. And then, on trying to analyse our own mental processes, we find that mathematical ideas have been imbibed in precisely the same way as all other ideas—viz., by learning, by experience, and by reflection. The apparent difference in the mode of first apprehending them and in their ultimate cogency arises from the difference of the ideas themselves, from the preponderance of quantitative over qualitative considerations in mathematics, from the notions of absolute equality and identity which they imply.

If we turn to the other question, How did the world at large acquire and improve its idea of number and of figures? How can we span the interval between the savage who counted only by the help of outward objects, to whom 15 was "half the hands and both the feet," and Newton or lace? The answer is the history of mathematics . its successive developments—arithmetic, geo- ry, algebra, &c. The first and greatest step in this was the transition from number in the crete to number in the abstract. This was the inning not only of mathematics but of all tract thought. The reason and mode of it was same as in the individual. There was the same eral influx of evidence, the same unsought-for erimental proof, the same recognition of general s running through all manner of purposes and tions of life. No wonder than if, under such umstances, mathematics, like some other sub- s and perhaps with better excuse, came after a s to be clothed with mysticism; nor that, even nodern times, they should have been placed upon *à priori* basis, as in the philosophy of Kant. nber was so soon found to be a principal common nany branches of knowledge that it was readily umed to be the key to all. It gave distinctness xpression, if not clearness of thought, to ideas ch were floating in the untutored mind, and n suggested to it new conceptions. In "the ," "the all," "the many in one" (terms of ely arithmetic origin), it gave the earliest utter- e to men's first crude notions about God and world. In "the equal," "the solid," "the ight," and "the crooked," which still survive gures of speech among ourselves, it supplied a bulary for the moral notions of mankind, and kened them by giving them the power of expres- . In this lies the great and enduring interest he fragments which remain to us of the Pytha- an philosophy.

he consecutive processes of mathematics led to consecutive processes of logic; but it was not l long after mankind had attained to abstract s that they attained to any clear notion of their nection with one another. In process of time leading ideas of mathematics became the leading s of logic. The "one" and the "many" passed the "whole" and its "parts;" and thence the "universal" and the "particular." The cies of logic, such as the well-known puzzle of illes and the tortoise, partake of the nature of sciences. And perhaps the conception of the nite and the infinitesimal, as well as of negation, have been in early times transferred from logic athematics. But the connection of our ideas of ber is probably anterior to the connection of of our other ideas. And, as a matter of fact, netry and arithmetic had already made con- rable progress when Aristotle invented the ogism.

eneral ideas there were, besides those of mathe- ics—true flashes of genius which saw that there t be general laws to which the universe conforms, which saw them only by occasional glimpses, through the distortion of imperfect knowledge; although the only records of them now remain- are the inadequate representations of later ters, yet we must still remember that to the tence of such ideas is due not only the concep- but even the possibility of physical science. these general ideas were too wide in their grasp, in early days at least were connected to their jects of application by links too shadowy to be ughly apprehended by most minds; and so it e to pass that one form of such an idea was n as its only form, one application of it as the itself; and philosophy, unable to maintain itself he level of ideas, fell back upon the abstractions nse, and, by preference, upon those which were t ready to hand—namely, those of mathematics. o's ideas relapsed into a doctrine of numbers; hematics into mysticism, into neo-Platonism, the like. And so, through many long ages, ugh good report and evil report, mathematics always held an unsought-for sway. It has pened to this science, as to many other subjects, ; its warmest adherents have not always been best friends. Mathematics have often been ght into matters where their presence has been loubtful utility. If they have given precision to ary style, that precision has sometimes been ied to excess, as in Spinoza and perhaps cartes; if they have tended to clearness of ex- sion in philosophy that very clearness has etimes given an appearance of finality not ays true; if they have contributed to definition in ology that definiteness has often been fictitious, has been attained at the cost of spiritual mean- . And, coming to recent times, although we y admire the ingenuity displayed in the logical chines of Earl Stanhope and of Stanley Jevons, the "Formal Logic" of De Morgan, and in the alculus" of Boole; although as mathematicians may feel satisfaction that these feats (the possi- ty of which was clear *à priori*) have been nally accomplished; yet we must bear in mind t their application is really confined to cases re the subject-matter is perfectly uniform in racter, and that beyond this range they are le to encumber rather than to assist thought.

ot unconnected with this intimate association deas and their expression is the fact that, which- r may been the cause, whichever effect, or ether both may not in turn have acted as cause and effect, the culminating age of classic art was contemporaneous with the first great development of mathematical science. In an earlier part of this discourse I have alluded to the importance of mathematical precision recognised in the technique of art during the Cinquecento; and I have now time only to add that on looking still further back it would seem that sculpture and painting, architecture and music, nay even poetry itself, received a new, if not their first true, impulse at the period when geometric form appeared fresh chiselled by the hand of the mathematician, and when the first ideas of harmony and proportion rang joyously together in the morning tide of art.

Whether the views on which I have here insisted be in any way novel, or whether they be merely such as from habit or from inclination are usually kept out of sight, matters little. But whichever be the case, they may still furnish a solvent of that rigid aversion which both literature and art are too often inclined to maintain towards science of all kinds. It is a very old story that, to know one another better, to dwell upon similarities rather than upon diversities, are the first stages towards a better understanding between two parties; but in few cases has it a truer application than in that here discussed. To recognise the common growth of scientific and other instincts until the time of harvest is not only conducive to a rich crop, but it is also a matter of prudence, lest in trying to root up weeds from among the wheat we should at the same time root up that which is as valuable as wheat. When Pascal's father had shut the door of his son's study to mathematics, and closeted him with Latin and Greek, he found on his return that the walls were teeming with formulæ and figures, the more congenial product of the boy's mind. Fortunately for the boy, and fortunately also for science, the mathematics were not torn up, but were suffered to grow together with other subjects. And all said and done, the lad was not the worse scholar or man of letters in the end. But, truth to tell, considering the severance which still subsists in education and during our early years between literature and science, we can hardly wonder if, when thrown together in the afterwork of life they should meet as strangers; or if the severe garb, the curious implements, and the strange wares of the latter should seem little attractive when contrasted with the light companionship of the former. The day is yet young, and in the early dawn many things look weird and fantastic which in fuller light prove to be familiar and useful. The outcomings of science, which at one time have been deemed to be but stumbling-blocks scattered in the way, may ultimately prove stepping-stones which have been carefully laid to form a pathway over difficult places for the children of "sweetness and of light."

The instances on which we have dwelt are only a few out of many in which mathematics may be found ruling and governing a variety of subjects. It is as the supreme result of all experience, the framework in which all the varied manifestations of nature have been set, that our science has laid claim to be the arbiter of all knowledge. She does not, indeed, contribute elements of fact, which must be sought elsewhere; but she shifts and regulates them: she proclaims the laws to which they must conform if those elements are to issue in precise results. From the data of a problem she can infallibly extract all possible consequences, whether they be those first sought, or others not anticipated; but she can introduce nothing which was not latent in the original statement. Mathematics cannot tell us whether there be or be not limits to time or space; but to her they are both of indefinite extent, and this in a sense which neither affirms nor denies that they are either infinite or finite. Mathematics cannot tell us whether matter be continuous or discrete in its structure; but to her it is indifferent whether it be one or the other, and her conclusions are independent of either particular hypothesis. Mathematics can tell us nothing of the origin of matter, of its creation or its annihilation; she deals only with it in a state of existence; but within that state its modes of existence may vary from our most elementary conception to our most complex experience. Mathematics can tell us nothing beyond the problems which she specifically undertakes; she will carry them to their limit, but there she stops, and upon the great region beyond she is imperturbably silent.

Conterminous with space and co-eval with time is the kingdom of mathematics; within this range her dominion is supreme; otherwise than according to her order nothing can exist; in contradiction to her laws nothing takes place. On her mysterious scroll is to be found written for those who can read it that which has been, that which is, and that which is to come. Everything material which is the subject of knowledge has number, order, or position; and these are her first outlines for a sketch of the universe. If our more feeble hands cannot follow out the details, still her part has been drawn with an unerring pen, and her work cannot be gainsayed. So wide is the range of mathematical science, so indefinitely may it extend beyond our actual powers of manipulation, that at some moments we are inclined to fall down with even more than reverence before her majestic presence. But so strictly limited are her promises and powers, about so much that we might wish to know does she offer no information whatever, that at other moments we are fain to call her results but a vain thing, and to reject them as a stone when we had asked for bread. If one aspect of the subject encourages our hopes, so does the other tend to chasten our desires; and he is perhaps the wisest, and in the long run the happiest among his fellows, who has learnt not only this science, but also the larger lesson which it indirectly teaches—namely, to temper our aspirations to that which is possible, to moderate our desires to that which is attainable, to restrict our hopes to that of which accomplishment, if not immediately practicable, is at least distinctly within the range of conception. That which is at present beyond our ken may, at some period and in some manner as yet unknown to us, fall within our grasp; but our science teaches us, while ever yearning with Goethe for "Light, more light," to concentrate our attention upon that of which our powers are capable, and contentedly to leave for future experience the solution of problems to which we can at present say neither yea nor nay.

It is within the region thus indicated that knowledge in the true sense of the word is to be sought. Other modes of influence there are in society and in individual life, other forms of energy beside that of intellect. There is the potential energy of sympathy, the actual energy of work; there are the vicissitudes of life, the diversity of circumstance, health, and disease, and all the perplexing issues, whether for good or for evil, of impulse and of passion. But although the book of life cannot at present be read by the light of science alone nor the wayfarers be satisfied by the few loaves of knowledge now in our hands, yet it would be difficult to overstate the almost miraculous increase which may be produced by a liberal distribution of what we already have, and by a restriction of our cravings within the limits of possibility.

In proportion as method is better than impulse, deliberate purpose than erratic action, the clear glow of sunshine than irregular reflection, and definite utterances than an uncertain sound; in proportion as knowledge is better than surmise, proof than opinion; in that proportion will the mathematician value a discrimination between the certain and the uncertain, and a just estimate of the issues which depend upon one motive power or the other. While on the one hand he accords to his neighbours full liberty to regard the unknown in whatever way they are led by the noblest powers that they possess; so on the other he claims an equal right to draw a clear line of demarcation between that which is a matter of knowledge and that which is at all events something else, and to treat the one category as fairly claiming our assent, the other as open to further evidence. And yet, when he sees around him those whose aspirations are so fair, whose impulses so strong, whose receptive faculties so sensitive, as to give objective reality to what is often but a reflex from themselves, or a projected image of their own experience, he will be willing to admit that there are influences which he cannot as yet either fathom or measure, but whose operation he must recognise among the facts of our existence.

Equivalent of Gallium. — M. Lecocq Boisbaudran has estimated the value of the equivalent of gallium:—(1) By calcining gallo-ammoniacal alum. (2) By calcining the nitrate of gallium which is formed by a known weight of metal. The small losses of materials during these two operations affect the value of the equivalent inversely, so that the mean is not perceptibly changed. His investigations lead to a maximum value of 69·97, and a minimum of 69·66, giving a mean of 69·82. After making various comparisons among the spectra of aluminium, gallium, and indium on the one side, and sodium, rubidium, and caesium on the other, he deduces the value 69·86, which is a little greater than that which was given by Mendelejeff for the body which he predicted, in his theoretical classification of the elements.

Simple Tangent Galvanometer.—M. Louis Schwendler has lately introduced a simple form of tangent galvanometer. The apparatus is contained in a small box of about 6in. sides. The galvanometer has two coils—one of thick wire and few convolutions, offering no more than 1 ohm resistance; another of thin copper wire, having a greater number of convolutions, and a resistance of 100 ohms. Two sets of resistance coils for use with the above coils, respectively, one of 20 and 200 ohms, the other of 1,000 and 2,000 ohms. A simple reverser allows the readings of the galvanometer to be taken from either side of zero. In order that the strength of the currents passing through the coils may be as nearly as possible proportional to the tangents of the deflections, the magnet has a length of less than one fifth of the diameter of the deflecting coil. The small magnetic needle carries a thin aluminium pointer fixed in right angle of the needle. In order that the needle after each deflection may come sooner to rest, the aluminium point carries small wind fans of the same metal. When closing the box the needle is taken off its pivot.

SCIENTIFIC NEWS.

In spite of what a correspondent of the *Athenæum* says, there is little doubt but that a cordial and hospitable greeting is being enjoyed by the members of the British Association at Dublin. According to the correspondent named the reception cannot be so good as at the last meeting held in Dublin; for first a stranger was appointed president, then an Englishman has been offered the presidency next year, and there is a great paucity of Irish among the presidents, vice-presidents, and other officers of sections. An eminent scientific man has proposed, we are told, to receive the strangers with all hospitality, but to withhold all the Irish papers. That is a novel method of showing displeasure. However, even the lugubrious correspondent thinks it likely, as the Irish are very forgiving, that they may change and give a thoroughly hearty welcome. We expect so. It is twenty-one years since the Association met in Dublin, and the president then was Dr. Lloyd, the aged Provost of Trinity College. The President of the present session is also distinguished as a mathematical physicist, and, as will be seen in another column, his address deals mainly with the influence of mathematics upon science. If we may judge from the list of excursions and entertainments already proposed, the savants will have little to complain of as regards their reception in Ireland. Amongst the eminent visitors who have promised to be present are Cornu, Chevalier, Brown-Séquard, Vogel, Cope, Sylvester, Draper, H. M. Stanley, and Captain Burnaby.

The Paris Academy of Sciences has at last elected Mr. Darwin a corresponding member in the section of zoology. Prof. Asa Gray has also been elected in the section of botany.

The Astronomer-Royal points out that the position of θ Cancri agrees very well with that sent by telegram as the place of the suspected intramercurial planet. The magnitude of the star is, however, smaller than the magnitude assigned to the body seen by Prof. Watson. Further particulars of the eclipse observations are awaited with interest.

Two processes for the preservation of iron by coating it with a film of magnetic oxide are now fairly competing for public favour. That of Prof. Barff is well known, and Mr. Bowers's, of which we gave an account on p. 182 *ante*, will soon be appreciated when the results of certain experiments recently made at Dudley become known. There, at the works of Messrs. Cochrane, his apparatus has been erected, and he has demonstrated the possibility of coating various articles with the preservative oxide. An iron chamber is set in a furnace in such a manner that it can be heated to a dull red, very much in the same manner as a retort for making coal-gas is arranged. A tight fitting lid, perforated with two holes—one for the admission of a pipe by which air is conveyed to the back end of the chamber, and one for its exit when deoxidised, closes the front end; and is opened only when it is required to withdraw the articles to be coated. Any description of the plant is, however, premature, because, although designs exist, the present chamber is merely a temporary arrangement employed to demonstrate the practical value of the invention, which so far as cast iron is concerned has now been done. To produce the magnetic oxide on wrought iron and steel will necessitate some modification, but as the invention is now known castings can be effectually protected from rust at a cost of about £1 per ton, with this advantage, that the coat put on them is so pleasing that in many cases paint will be dispensed with.

The death of the Rev. W. B. Clarke, an eminent geologist, who died at Sydney, on June 16, in his 81st year, was announced by telegram, and particulars are now to hand by the Australian mail. The deceased gentleman emigrated in 1839, and retired from his clerical duties eight years ago. The *Sydney Morning Herald* says:—"His contributions to the science of geology and mineralogy would alone fill a library. Perhaps his largest and best known work was that entitled '*The Southern Gold-fields*,' *which contains an exhaustive* description of the auriferous deposits throughout Australia. This work was written in consequence of Mr. Clarke having been commissioned by the Government to visit and report upon the principal gold-producing localities in the colony. Some two or three years ago Mr. Clark was elected a Fellow of the Royal Society of England—an honour which has been so rarely conferred upon colonial savants that Mr. Clarke valued it perhaps more than all the other distinctions he had won, especially as the honour was conferred upon him by the unanimous and spontaneous action of the society."

The death is also announced, at the early age of 47, of Mr. R. Daintree, formerly Government geologist of Queensland.

Further trials have been made with screw-propellers on the Iris. At the previous trial, which gave the very satisfactory result of 18·572 knots with 7,734·85 horse-power, the Iris was propelled by new experimental four-bladed screws, having each a diameter of 16ft. 3in. and a pitch of 20ft. The latest trial was mainly for the purpose of ascertaining the comparative efficiency of an experimental two-bladed screw, having a diameter of 18ft. 1¼in., and a pitch of 21ft. 5$\frac{5}{16}$in. The full speed trial over the measured mile gave as the average of four full-power runs:—Steam at engines, 61·5lb. starboard and 65·5 port; vacuum in condensers, 27in.; revolutions, 94 and 92; indicated horse-power, 7,463·38; mean speed of vessel, 18·587 knots. Thus, a better result was obtained at a less expenditure of power; notwithstanding, it has been determined to fit the vessel with the four-bladed propellers, because the two-bladed screws produced so much vibration. The maximum amount, strange to say, was not produced when the ship was going at full speed, but when the engines were making about 80 revolutions, and the speed was 16 knots.

The Walsall Town Council have determined to offer two premiums of 100 guineas each for the two best schemes for disposing of the sewage of the town.

The death is announced of Mr. Thomas Whitwell, of the Thornaby Ironworks. Accompanied by the chief fitter he entered a Belgian heating furnace, for the purpose of thoroughly examining it as it was undergoing tests. By some means the damper at the top of the flue was closed, and the confined gases immediately burst into flame and enveloped the experimenters. They made the best of their way out, but during the time occupied in ascending the ladder they were so fearfully burnt that death followed in both cases. Mr. Whitwell was only 40 years of age, and was one of the ablest of the ironmasters of Cleveland.

The effects of mining are beginning to make themselves apparent in the Midland and Northern counties, and recently the west side of Lord Dudley's Wren's Nest subsided along a length of nearly 50 yards.

The Clothworkers' Company have voted a special donation of £2,000 in aid of the building fund of the Bradford (Yorks) Weaving and Design School.

The "breech-loading" question is coming into prominence again, and one of the three experimental breech-loading guns made at the Royal Gun Factories, Woolwich, has been sent to the Ordnance Stores on service, and will probably undergo further trials at Shoeburyness. This is a 32-pounder cast-iron gun converted into a breech-loader on the French screw relieve system, and is intended for the flank defence of ditches and other positions where showers of case shot at short ranges are likely to be of service. The other two guns have not yet passed final proof. One of these is a 40-pounder Armstrong breech-loader, which has simply been turned on its side by shifting the trunnions, so that the vent piece is removed at the side instead of the top; and the third is one of the old 61cwt. wedge guns (64-pounders), transformed into a breech-loader similar in principle to the guns manufactured by Herr Krupp.

A party of English geologists, under the leadership of Prof. Morris, arrived at Boulogne on Aug. 5, and were met in a cordial manner by the maire, M. Huguet, and a number of distinguished French geologists and scientific men. The object of the party was a verification of ascertained facts, and the inspection of a famous geological country.

The Giffard captive balloon has been making ascents with regularity and safety, but on some days when the wind pressure was great no attempt was made. The experiment is watched with considerable interest, and the result will probably be that in future balloons intended for frequent service will be made of stronger materials, and filled with hydrogen instead of coal gas.

Haeckel has published his reply to Virchow, in time for the savants to digest it before they meet at Cassel. It is entitled "Freie Wissenschaft und freie Lehre," and bears the motto, "Impavidi progrediamur." The descent of man is closely reasoned out, but there is too much personal matter in it.

We are informed that a course of six lectures on meteorology will be given under the auspices of the council of the Meteorological Society, commencing in October next. The subjects of the lectures will be:—"The Nature and Physical Properties of the Atmosphere;" "Air Temperature — its Distribution and Range;" "Atmospheric Pressure—Wind and Storms;" "Clouds and Weather Signs;" "Rain, Snow, Hail, and Electricity;" and "The Nature, Methods, and General Objects of Meteorology." It is intended that these lectures shall give a concise account of the present state of knowledge on the above subjects. The lectures will be open to the public, admission being by ticket, to be obtained at the office of the society, 30, Great George-street, Westminster, S.W. Further particulars, giving full information as to the time, place, &c., will be duly announced.

SCIENTIFIC SOCIETIES.

THE INSTITUTION OF COLLIERY ENGINEERS.

At the monthly meeting of the members of the North of England Institution of Colliery Engineers, held on Saturday last, at Newcastle-on-Tyne, the president (Mr. Hare) in the chair, a paper on "Boilers and Boiler Explosions" was read by Mr. W. O. Johnson, Seghill. Mr. Johnson, having narrated the circumstances connected with the explosion of boilers under his charge, went on to say that every care ought to be taken that boilers were frequently visited by those in charge. It was well enough to have boilers fitted with safety-valves, water gauges, steam gauges, &c., but it was a great error to depend upon these safeguards doing their duty at all times. Having seen exploded boilers that were thoroughly repaired, he decidedly objected to a boiler being extensively repaired; and, rather than do so, he would renew it. No doubt expansion and contraction had their doubtful share in explosions. He was of opinion that boilers should be made of one class of iron; and, although it was a fine point, he thought that iron from different makers did not expand and contract alike. He next proceeded to speak of the different kind of boilers, and said there were several things to be taken into account in adopting boilers—the duty they had to perform, the water that had to be used, the chimney power that was at command as to size and height, and the class or kind of coal that would be used. At Seghill they had adopted boilers 28ft. long, 5ft. 6in. diameter, with a tube 3ft. in diameter, built with the bridge rings. They had given every satisfaction, but from them no more steam was got than was got from the ordinary cylinder boiler, 6ft. in diameter, and 30ft. long. He was deceived in that; but still they got the same quantity of steam with one-third the amount of coal. For 24 hours the consumption was 6 tons per boiler, and now it was under 3 tons, and the engines were much better supplied with steam, thus proving that in adopting Galloway's tubes there was a saving of coal. There were various kinds of self-acting mechanical stokers, and seven mechanical stokers, patented by Butcher, had been adopted at Seghill. They were adopted not so much to save labour as to enable duff coal to be used; and it was found that with these stokers and using duff coal steam was got a great deal better than with a rougher class of coal and hand-firing. There was no doubt that the more regularly coals were put on to a fire the better it was, and if they used large coal no benefit was got from the internal part of it, but simply from the outside. Duff coal was used at Seghill, and there was a reduction of something like 5cwt. a day, and the boilers, seven in number, were now raising the same quantity of steam with a less quantity of coal, which was a great consideration.

ITTERS TO THE EDITOR

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lo not hold ourselves responsible for the opinions of spondents. The Editor respectfully requests that all ications should be drawn up as briefly as possible.]

nmunications should be addressed to the Editor of the ɪ MECHANIC, *31, Tavistock-street, Covent-garden,*

eques and Post-office Orders to be made Payable to MORE EDWARDS.

ɪ order to facilitate reference, Correspondents, when ɪ of any Letter previously inserted, will oblige by ing the number of the Letter, as well as the page on appears.

ould have everyone write what he knows, and as ɪ he knows, but no more; and that not in this it in all other subjects: For such a person may me particular knowledge and experience of the of such a person or such a fountain, that as to ings, knows no more than what everybody does, to keep a clutter with this little pittance of his, ertake to write the whole body of physicks: a vice ence great inconveniences derive their original." *igne's Essays.*

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?HINI—PORTABLE EQUATOREAL E PLANET JUPITER—THE HAR- T MOON—THE SATELLITES OF ɪS—ANTIQUITY OF MAN—THE 'D QUESTION—THUNDER AND HTNING—"NAVIGET ANTICY- ɪ."

7.]—As I do not possess a copy of the . C. of Stars," which is Mr. Proctor's y for the star magnitudes employed by him 'Atlas," I am unable to inform "Twenty ' (query 33604, p. 535) whether θ Delphini pears as of the 4th magnitude or not. If, , it does, it is certainly erroneously estimated, h as it is really a small 6th magnitude star, so designated by Argelander, and in the wich Seven-Year Catalogue." Its insertion Proctor's "Atlas" as a 4th magnitude is due stake; but whether such mistake was made author, or whether it is referable to his authority, I am unable (for the reason I ven above) to say. I may add that ever since earance of "Twenty Hours'" query, a week have made a nightly attempt to see Del- —but in vain; a dense mass of cloud having ntly covered the sky before it became dark to see small stars. Verily, practical astro- pursued under difficulties in our charming climate!

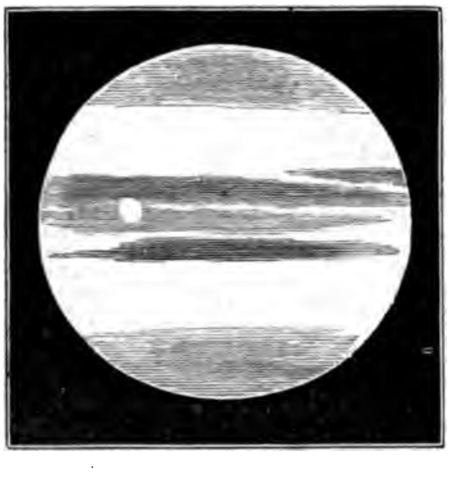
thelstan" (query 33641, p. 535) will take the to hunt through the indices of back volumes NGLISH MECHANIC he will obtain a mass of tion on the construction and use of nearly rm of Equatorial Mounting there is. As to and adjustment of the Equatoreal, if your ndent will refer to Vol. XV., pp. 551 and will find a couple of articles, in which I of them in as simple and perspicuous a man- I was capable of doing, and by the aid of would fain hope he would succeed in adjust- own instrument with all needful accuracy.

writing paragraph one above I have suc- in getting a glimpse of the heavens, and myself of the opportunity to scrutinise the upiter, of which I append a sketch. I have for the purpose of inviting the attention of ther astronomical correspondents to a bly sharp, clear, and well-defined white , like a satellite, at present visible on the disc. The drawing was made on the night st 8th at 11h. 40m., G.M.T., with a power a 4¼in. achromatic.

Ir. Lecky (letter 14682, p. 547) forgive me ɪg that he is mistaken with reference to the of any mention in astronomical works of the the Moon rises nearly at the same hour for lays during one part of every lunation? For , needless to be specified, I am writing this ven more hurriedly than usual, and have no time to hunt systematically through my ks; but, taking a few from their shelves at I find a description of the phenomenon onsideration in Christie's "Astronomy" .), p. 49; Loomis's "Treatise on Astro- p. 115; Sir Edmund Beckett's "Astronomy Mathematics" (5th edition), p. 134; 's "Astronomy" (by Stubbs and Brün- 111; "Chambers's Descriptive Astronomy," ind's "Solar System," p. 44; and Proctor's " p. 156. If my memory serves me, the fact oned in several other books, but I have y not an instant to consult them just now.

k that Mr. Symes (letter 14683, p. 547) nd some easier and more plausible explana- he passage in Lecomte than that afforded supposition that the recently-discovered of Mars were really seen towards the end eventeenth (*not* "sixteenth") century. I ggest either that (1st) Mars may have been . when in a part of the sky full of small r (2nd) that because satellites were known ve round the Earth, Jupiter, and Saturn, therefore the author jumped to the conclusion that every member of the solar system was furnished with one or more of such attendants.

It is a pity that people rush into print without the most rudimentary acquaintance with the subjects on which they presume to give an opinion. "So far" (says "J. A.," in letter 14688, p. 550) "as our experience is capable of furnishing data for calculation, it is seen to be quite possible that man may not have been an inhabitant of the Earth for a longer period than the Bible assigns to him!" Is it possible, one is tempted to ask in wonder, that your correspondent can never have heard of the results of the explorations in the Caves of the Dordogne, at Settle, by Mr. Pengelly at Kent's Hole, near Torquay, of the excavations at Neanderthal, Engis, and Mentone? Does he, can he, be aware that Man *was contemporary in England with the Hippopotamus* at a time when as yet the English Channel was not, and when what are now Germany and Norfolk were conterminous? But I might multiply such questions almost ad infinitum without adding anything to the force of an appeal to a man who would seem never to have opened a single book on the subject on which he delivers so calm and confident an opinion.



The thoroughly plain, common-sense letter (14699) on p. 553, signed "Ruin," has sent me back to the one in which the controversy originated (I mean 14596, p. 470), and I am as much surprised as "Ruin" himself at the sophisms with which it is filled. When will "Pioneer" and others learn that most rudimentary fact in all political economy that when two men are bidding for one article—be it an acre of land, a cottage, a sheep, or a pair of scissors—the price of that article will go up; but that when one man has his choice of two articles then their price will go down? The demand for building lots in the neighbourhood of towns increases almost hourly, and, merely as a matter of course, their value rises. "If" (says "Pioneer") "the wages of the working classes are 40 per cent. better than they were some 40 years ago, while house rent, local taxation, and the more necessary articles of consumption have been advanced in the same proportion, where are the advantages gained by the wages-receiving portion of the community?" The naïveté of this would be amusing if it were not really pitiable. It amounts to nothing more nor less than a demand that the working man should be protected by special legislation, and that everybody else—be he landowner, butcher, or what not—should be compelled to sell whatever he may deal in and live by to this favoured class; which is itself to fix the rate at which it chooses to pay, as well as that of its own remuneration. "The old and well-established union of British landlords" exists only in the imagination of your correspondent. Twice within the last few years have I been outbidden in the auction-room for land adjoining my own, which I wished to buy; and, as it happens, in each case the purchaser could scarcely write his own name! In the case of one of the pieces of land (a 16 acre plot) I actually offered with my own lips one-third more than the value set upon it by two professional land agents, outbidding my own agent in the room, who dared go no further; and yet, as I have said, it fell to a man who could scarcely write or spell. There is nothing to hinder any working man from owning land of his own but the tyranny of his union and the necessity of muddling himself "for the good of the house" where it meets. To talk of a "monopoly in land" (in any other sense than that in which a monopoly exists in mutton, trousers, four-wheel cabs, or tea) is to utter childish nonsense.

"Observer" (query 33728, p. 560), may calculate the distance at which the electrical discharge has taken place by reflecting that at the freezing temperature (32° Fahr.) sound travels at the rate of 1,093ft. per second. Inasmuch, however, as this velocity augments at the rate of some 2ft. for every degree of the centigrade thermometer, he may, as a rough and ready rule, multiply the interval in seconds elapsing between the appearance of a flash of lightning and the sound of its concomitant thunder by 1,125. Thus suppose that we see a flash of lightning, and at the end of 6 seconds hear the thunder, then 1,125 yards × 6 = 6,750 yards, or rather more than a mile and a quarter.

The origin of the phrase, "Naviget Anticyram" (concerning which "H. P." puts query 33729, p. 560), was this. There were two towns called Anticyra in Greece, both famous for the hellebore which grew there; and it was an ancient superstition that hellebore was a specific for insanity. Hence the proverb which has recently acquired notoriety from the perfect taste with which it was quoted.

A Fellow of the Royal Astronomical Society.

NEBULAR HYPOTHESIS, AND LAND QUESTION.

[14708.]—IN reply to "J. A." (14688), I may say that I find the ratio of the moon's perigee to the apogee ought to be very nearly as 1 is to 7, instead of being nearly a ratio of equality, which, in fact, it is. Also, it may be remarked that, since the orbit of Encke's comet lies wholly within that of Jupiter, if the sun had ever extended as far as Jupiter, the comet must have formed part of it, or it would not be where it is now. Moreover, its eccentricity being very great, it is very easy to show that if it had been detached from the sun, it must have had an initial velocity less than that of Jupiter; or, in other words, that the sun in contracting from the size which it had when Jupiter was detached, diminished instead of increased its velocity of rotation.

"The monopoly of land ought to be for ever abolished in order to stimulate industry." So says "Pioneer" (14596). There is one branch of industry, however, which, instead of being stimulated, is neglected or prevented, and that is the cultivation of land. To occupy land at all is to monopolise it. The man who occupies the smallest cottage garden monopolises it as much as he who occupies a thousand acres. He will not let other people grow potatoes in it, or come to cut his cabbages; in short, he monopolises it, and small blame to him. As to the question, however, as to whether there ought to be a limit to the quantity of land which an individual should be allowed to monopolise, there is certainly much to be said on both sides; but however, desirable it may be in itself that a person should be prevented from holding more than a certain quantity of land, it has always been found, by the Romans and others who have tried it, to be practically impossible to do so. But as to those who practically act upon the suggestion of "Pioneer," and try to put a stop to all monopoly of land, they certainly are anything but desirable neighbours, especially when the pears are ripening. **W. G. P.**

THE LAND QUESTION.

[14709.]—Is "Ruin" (14699, p. 553) quite certain that he clearly conceives the question with which he deals? One thing is quite evident that he has not touched the question. Mr. Mayer asked a most pertinent and reasonable question. If it be true that the cost of erecting houses has been doubled in a certain period, and that the cause of this increase is the extra wages paid for labour and the less amount of work done by the labourers, it is surely possible to show the fact, and to indicate the directions in which this increased cost is expended. To say "it is simply a fact that a house of any given size does cost nearly twice as much as it did about 30 years ago" does not furnish this evidence. The offer of such a statement as proof does not justify the person who so misunderstands the nature of evidence in remarking as to the querist, "When he asks me to prove them by figures he simply does not know what proof is." The statement itself may be true or false; the fact that many builders have made it when fighting a question between masters and men does not make it either.

Suppose, on the other hand, some one asserts that landlords have increased their rentals so that the increased cost of living has necessitated a great increase in the wages on which to live, and in the price of materials, and that for this reason houses cannot be built for less than double the cost 30 years ago. One assertion is worth as much as the other till details and facts prove their relative worth. But I do not mean to take up that general question just now; I only mean to pull "Ruin's" letter to pieces a little.

I do not quite understand the train of thought which underlies the opening sentences comparing the stolen land and brooms, so I go straight to the question, "Did any human being make the materials for them (the brooms), or make horses and cows, oxen and sheep and corn?" To all this the answer is clear:- Man does make them all. They exist in their present numbers and conditions only because man's labour and intelligence have been expended in producing them. The land itself (except where retrieved from the sea) is in no manner of way the product of man's labour; its improved value is; but unfortunately the return for that is claimed and enjoyed mainly by those who have done nothing towards the creation of it.

The confusion of thought is very common which underlies the next question, in which the 3 per Cent. Consols are mixed up as on an equal footing with land, "for which they are continually being exchanged." This sort of argument is generally employed by people whose minds cannot pass from surfaces to foundations, or whose interests incline them to maintain existing class institutions. But the fact that a thing has been bought and paid for gives the buyer no perfect right to the thing bought. He buys nothing except the rights of the seller. This is obvious natural equity, and furthermore it is the general principle of law, except where, for general convenience, bonâ-fide purchase or a given duration of possession constitutes good title. In this particular matter, however, the idea of purchase is only used to confuse. The question really is, whether certain rights claimed by the possessors of land are just rights, are desirable to be maintained for the general benefit, or whether they are encroachments on the general rights of the community, and ought to be resisted and perhaps put an end to.

When "Ruin," on the faith of his own delusion as to the value of his buying and selling argument, ventures upon saying "such nonsense is beyond answering," he runs some risk that other people will conclude that he is unable to perceive what it is he has attempted to answer. Perhaps he does not know that his next question is likely to be worked out ere long; probably he thinks that the idea of passing a law that no one should hold more than a fixed quantity of land is a mere Utopian dream. At a day coming, and probably not so far off as most people suppose, these questions of land tenure will become the leading social and political subjects. At the other side of the world that day is at hand, and I think it nearly certain that before many years are passed this restriction will exist; at all events the way to it is entered upon, for in the colony of Victoria differential charges are now made upon holdings beyond certain limits, and it is the determination of the people to endeavour to keep the ownership of the land in the hands of its actual occupiers, on a principle similar to that aimed at in the distribution of the lands of Palestine amongst the ancient Israelites.

The work of any individual forms but a small part of the motive forces of the world, but I feel pleasure in the thought that I had something to do with sowing the seeds of this movement, for the same doctrines which I have set forth in these pages I did my best to spread in Victoria 25 or 30 years ago. It is very interesting to see how most of the great questions which are so vehemently debated here, and as to which we hear so many guesses and prognostications, are quietly put into working in a land peopled by our own race, but unencumbered, as we are, by the monstrous weight of the past, and the social system it has called into existence.

I should like to tackle "Ruin" on the Berlin peace, but it will not do. That peace, or rather the principles that led to it, is really a part of the great struggle of the age. We see in various ways vast efforts being made to maintain and restore old traditions and the might of the priest, the baron, and the throne—the old powers whose strength is passing away to the people—the power of the coming time. Now, too, as in the middle ages, these seek the aid of the lower strata of the people in their struggles to enslave the whole for the benefit of their class interests. Now, too, as of old, they will find the new and rising power too strong for them. The rising tide is made up of many a rushing wave, which appears to draw back and lose ground, so, whatever the momentary aspect of things, the steady course of history shows us the gradual growth of liberty and the progress of the general and individual rights of Man as against the class interests of those who represent his ancient enslavers.

Sigma.

[14710.]—With certain recent examples of "courtesy" in high places one cannot well complain that your correspondent "Ruin" (p. 553) should have measured out to us rather more invective than argument. For myself I should be quite content if your correspondent would only set out to reach the truth, for if our ways of reaching it differed, we might be able to agree when we arrived there. "Ruin" says that I "think it makes a difference between coveting and stealing land and brooms, that no human being made the land, but one did make the brooms;" and he asks whether I "maintain the right to steal?" It will be time enough to answer such a question when your correspondent points out where and when I have supported the idea that any one had a right to steal the land, or anything else. Such sentences do but serve to cloud the judgment of muddle-headed mortals.

Every landholder in the country is only a sort of *leaseholder from the State—a perpetual* leaseholder, if you will. How on earth can any one have any right to the land, which neither he nor anybody else made? It is true he might have bought it with his own money, and, to such an extent, he has a right to it, in the sense that a man who takes a lease of a house may be said to be the owner of the house; but the land belongs to the nation—the Romans, until the Saxons and others turned them out. Formerly the king did almost as he liked with it, but the people have altered that. Isn't it amusing to have a man tell you that you imagine people get land without paying for it, and then, with a clinching tap of a hammer—"Such nonsense as that is beyond answering!" "Ruin" asks whether any human being made the materials for the brooms? The materials would have been of very little use without the "subtle brains and lissom fingers" to utilise them, and I believe even corn won't grow unless the land is tilled. "Ruin" says that "God did not make the Three per Cent. Consols." No, neither did He make the land laws.

I am sorry that I misunderstood "Ruin" about the Berlin peace, though, as he has been amused, he will probably overlook it this time. I thought he meant that the Berlin peace was to do workmen good, whereas it seems all he meant was that it will stimulate trade. I am not a "defender of strikes," nor have I made the rash assertion that the depression in trade was due to the Russo-Turkish war, and I do not believe that the "peace" will benefit trade at all. Trade was already reviving before the secret treaties with which the Lion now does business were made known, and at any rate the war can have had nothing to do with depression in America, where it has been much worse than here. So trade will revive, as it has revived before after periods of depression, and if we do not recover it all, it will be simply because the Chinese, &c., have found out English cotton stuffs, and the Australians don't like the hardware that modern manufacturers send them.

Of course your correspondent "disdains figures," as I said he appeared to do, p. 522. He makes a statement that he cannot prove, and then when challenged he goes off at a tangent, with some such fine-sounding platitude as "things are not less true because they have been said before." "Ruin" stated on p. 500 that "everybody knows that the *chief reason* why houses cost twice as much as they did 30 years ago is that the workmen do less work for the same wages than they did then." To my request for proof in figures I get a reply from your correspondent, who is "amused at my anger," that when I ask for proof by figures I "do not know what proof is." I see that the "twice as much" is modified into "nearly twice as much." I neither covet my neighbour's house, nor his want of honesty; but I have a strong conviction that a house of any given size took no more bricks to build 30 years ago than it does now—unless the makers have reduced the size of bricks; it took no more timber, no more nails, so that it is an easy matter for any "builder or other person of experience" to demonstrate the truth of his assertions by the testimony of figures.

If a £300 house now costs £600 to build, it is certain that the men who make the bricks, the men who cut the timber, the men who fashion the nails give less work for the same money than they did 30 years ago, or the sellers of the bricks, timber, &c., get the £300 that has to be accounted for, and we cannot accept the mere ipse dixit of builders and others that it has been spent in wages. To help your correspondent I have taken the trouble to inquire as to bricks, and find that the maker was paid 30 years ago 4s. 6d. per 1,000, whereas he now gets 6s., and for best quality as much as 7s. 3d. per 1,000; but bricks are now considerably more than double the price prevailing about 30 years ago, and the "chief reason" is not that the workman does less work for the same money. The fact is, that wages have risen with the general rise in prices, and workmen know very well that they are no better off than they were before; but what your correspondent has lost sight of is the fact that prices rose before wages. The owner of the brick-earth gives less of it for the same money than he did 30 years ago, but no one thinks of blaming him or of calling him a fool; but when working men are asked to return to low wages they should have some security that low prices will immediately follow the reduction.

S. Mayer.

[14711.]—The true and sensible letter of "Ruin" (14638, p. 500) is not quite so easily proved to be a mistake as S. Mayer (14652, p. 522) seems to imagine. I can quite bear out from experience, and so can any one who has had any—and prove it, too—that buildings now cost twice what they did 30 years ago, and that entirely in consequence of higher wages for less work—directly or indirectly—and if the land could be had for nothing it would make no approachable difference in the country when either "Pioneer" or S. Mayer may get land to build a cottage almost as cheap as the brooms. I know and have bought land from one of the sneered-at-noblemen, who, to encourage building, has sold it for a merely nominal price, but his object was defeated by my having to pay more for the work than it was worth when done (now a usual thing), so I am not likely to repeat the experiment, as I shall lose less by letting the remaining land lie idle.

The short hours and high wages are, to most observant men, not only sending up house rent, but many other things to an unfair value; to the injury of the working men themselves, and sapping the very foundations of England's prosperity. Man did not make the land any more than he made many other things which he enjoys, but if he bought or came honestly by it, the possessor has the same right to it as "Pioneer" or S. Mayer have to anything they possess. If they want land there is plenty to be had any day in England or Scotland for a fair price, and if not cheap enough here there are still larger tracts in our colonies. When they have bought it I hope they will not live to see the time when some one else will share it with them without paying for it.

Looker On.

MONOPOLY OF LAND AND SCARCITY OF HOUSES.

[14712.]—"Pioneer" (14596) says that when the working classes were prosperous no class grudged that prosperity more than the land proprietors. There is a saying in the manufacturing districts of Lancashire and Yorkshire that those who most grudge the workman's prosperity are most often found amongst those employers who have risen from the condition of working men. I think such suppositions are purely matter of opinion, and as such "Pioneer" embraces that which best suits his views. I am surprised that there should be such grudging, for a little examination would show that the same cause determines the prosperity of the workman, the employer, and the landowner, and all are under the influence of that inexorable law of supply and demand. "Pioneer" laments that the price of building lots in the suburbs of thriving little towns in the north of Scotland is now more than three times the price paid during the past 80 years. If "Pioneer" had been the fortunate and undisturbed possessor of a few of the said lots I wonder whether his lamentations or his rejoicings would have preponderated? He says that Highland glens have been depopulated to make room for the red deer, with benefit in respect of rents to the proprietor. I think such a change would be attended with pecuniary loss.

On this and similar subjects much has been said that would have been better unsaid. Thus "Pioneer" speaks of "the old and well-established union of British landlords." Can he prove the existence of such union?

And I notice that S. Mayer (14652) advocates the making of a law limiting the amount of land to be held by any one person. How will he frame his law of limitation, and how will he enforce it? And, as land is only one form of wealth, he ought, in common justice, to likewise limit the acquisition of wealth in all its other forms. All such ideas are impracticable and mischievous so far as they distract the attention of working men from other more feasible and beneficial measures. I do not approve all the existing laws relating to land and other properties. I think if a penny receipt stamp be sufficient to legalise a £1,000 transaction in wool or other merchandise, it ought also to be sufficient for the same amount in land. Then, as to the law of primogeniture, I incline to the opinion that it operates unjustly, although I have been told by a gentleman who has resided in France (where the law gives the youngest daughter an equal right with the eldest son) that their system divides and subdivides the land into so many small portions that he regarded their system as worse than ours. On this point I wish for more information before forming a conclusive opinion. I cannot see that this land question affects the welfare of the working man to the extent that "Pioneer" thinks it does, nor can I see how any further land legislation can materially advance science, stimulate industry, or revive trade. Whatever tends to the revival and maintenance of trade is of the greatest importance to the working man, and the subject is one to which he and others will shortly have to devote their earnest attention. One of the great questions of the day is how to find markets for our goods. A certain class of men have for years back preached up that free trade was a panacea for all the ills that trade is liable to, and that if we adopted it, and set the example, other countries would follow. Has the result verified their predictions?

W. H. B.

THE PREPARATION OF BOTANICAL SPECIMENS FOR HERBARIUM.

[14713.]—So much misunderstanding often exists as to the proper method of collecting and drying specimens for an herbarium that perhaps a few words thereon may not be without interest.

The entire work may be divided into three parts—(i.) Collecting; (ii.) Drying and Pressing; (iii.) Mounting.

(i.) *Collecting the Specimens.*—Care should be taken, in selecting a plant, to choose a specimen as perfect as possible, those which show any deviations from the typical plant being avoided. When practi-able the whole plant, root and all, should be taken, o allow of its careful examination. Specimens hould not be gathered, if possible, while they are oist from dew or rain, as they cannot be so well reserved.

Instead of placing the specimens when gathered ito a loose tin case, it is better and more conenient to subject them at once to a slight pressure. 'or this purpose a light, strong portfolio is made of he size adopted for the specimens (14in. × 9in. rill be found convenient), and arranged so that it an be made larger or smaller in bulk, as desired, he ends being left open. It is provided with a light trap, so that it may be carried over the shoulder or ack. On starting for a day's excursion the portfolio ontains a number of simple sheets of common newsaper, cut to the requisite size, and a piece of thick ardboard, the object of which is simply to separate he sheets of paper which contain specimens from hose which are free. Having gathered a number of lants the portfolio is opened, a sheet of paper reoved to the other side of the pasteboard, a plant or lants placed between it, and this continued until all he plants are disposed of, when the whole is trapped up again. By this means the plant is nmediately subjected to some pressure in its reshest state, instead of being first pressed after a ong, and perhaps hot day's work.

(ii.) *Drying and Pressing.*—On returning home he specimens are properly arranged, and, if very oist, removed to a fresh sheet of newspaper, and hen placed in the press. Mistakes often arise with eginners as to the amount of pressure required. In eality a slight pressure suffices, it being as imporant to dry the plants thoroughly by exposure to he sun or air. The best kind of press is one known s the "wire press," and consists of stout wire etwork mounted on a stout wire frame. The size aust, of course be the same as that chosen for the pecimens, and it has been found that the network s best made of No. 14 or 16 iron wire, with ½in. aeshes. The frame must be stiff enough not to be asily bent, and two or three strengtheners of stout rire may be fastened across it to avoid twisting. The op and bottom of the press are made precisely the ame, and are wholly unconnected with each other. To absorb the moisture given out on pressing ommon blotting or filter-paper of the proper size is mployed, which is lightly sewn together in parcels f three sheets. The plants are to be placed in the ress between the sheets of newspaper, each sheet ying between two parcels of the blotting-paper, and he whole tightly bound together with a piece of mall cord kept for the purpose. If this is properly lone it will be found to give quite sufficient pressure. After staying in the press for 24 hours (more or ess) the specimens are to be taken out, and laid eparately in the sheets of newspaper in an airy oom for 12 hours to dry, the blotting-paper being lso hung out on a stretched string. This drying aust not last longer than about 12 hours, or the pecimens will become warped and cockled. They re then returned to the press as before, and the ressing and drying repeated. The smaller specinens will by this time be finished, the more succulent nes will require further treatment. The chief thing n the whole process is to observe regularly the change rom drying by pressure to drying by exposure to he sun and air, and that during the pressing free ccess is allowed to the air.

(iii.) *Mounting.*—The drying process having been inished the specimens are removed from the newsaper, the earth beaten from the roots, and then each pecimen mounted on a sheet of white paper of the hosen size, by placing little strips of paper over the tem or other unimportant parts. At one bottom orner the name may be written, as well as the date nd place of gathering.

This method of preparing botanical specimens has een used for some time by many eminent German otanists, and has been found to give far better pecimens than any other. Delicate tints, which rere nearly always lost by the older methods of ressing, may be preserved for years, and the plants ave a much more natural appearance than when ried by a stronger pressure and without access of ir.

Hofwyl. **V. V.**

ON THE APPLICATION OF THE GAS ENGINE AS A MOTOR FOR STREET TRAM-CARS.

[14714.]—"BEAVER" (No. 14669) somewhat dogmatically states that "the gas-engine in its present orm is anything but satisfactory;" that he has a otion that gas as a direct agent is a mistake, and, used at all, it must be as an agent to compress r; and, without having shown any proof of his atement, he proceeds to describe a somewhat comlex arrangement of three cylinders, for the sole urpose of compressing air to be used in the proelling engine. I am not practically intimate with e gas-engine, but I know of two cases where ationary steam-engines have been taken out and as-engines put in, to the satisfaction of the owners, eing found less troublesome and more economical han the steam engines taken out. And I notice that the new silent "Otto" is advertised as "always ready to start at full power at once on the gas being lit." These good qualities, together with the great advantage of dispensing with the boiler, &c., induced me to think that the gas-engine held out the prospect of its being pre-eminently adapted for the propulsion of street tram-cars. I shall be glad if "Beaver" will give more minutely his reasons for regarding the gas-engine in its present form as so unsatisfactory for tram-car work when it is so very satisfactory for stationary purposes? Perhaps others who have had practical experience with the "New Otto" will give their opinions for or against its use as a car motor.

Since writing 14595 I have noticed an article in the ENGLISH MECHANIC, No. 632, p. 173, which says that in 1869 a bill was presented to Parliament, proposing to supply Birmingham with heating gas at 6d. per 1,000ft. This shows that the gas-engine can be worked at a cheaper rate than I estimated.

W. H. B.

TELEPHONE AND LIGHTNING.

[14715.]—DURING the violent thunderstorm of last Sunday (August 4) I listened through the telephone expecting that I should hear something. I sat near a window so that I could see when there was a flash of lightning. After listening for a short time there was a flash and a distinct click of the telephone, and when there seemed to be a double flash there was a double click. To make sure that I was not mistaken, I asked some one else to listen, and he also heard the click. After some while the storm passed over, and I could no longer see the flashes; nevertheless I heard the click on the telephone, and after several seconds the thunder. I tried to find the distance of the storm by the number of seconds between the click and the thunder. One was 12 seconds, which would be about 2½ miles.

Oxford. **B. Snooks.**

"D. H. G.'s" CUTTER BAR AND DOUBLE-EDGE TOOLS.

[14716.]—SOME time since I sent a query to the ENGLISH MECHANIC asking for information respecting the above-named contrivances, but as no reply except a short one from "J. L." has yet appeared, I venture again to ask "D. H. G." for more light. Our kind contributor has given us some most valuable articles on what I may term the subordinate parts of a lathe, and I think a few papers on slide-rest tools would now be very acceptable. I have read very attentively the articles which "D. H. G." sent more than a year ago, and have endeavoured to put into practice the principles therein laid down, but the information is not sufficiently complete to enable any one to successfully apply the double-edge tool. No tables are given as to what angles the facets are to be ground, and I presume a special form of tool-holder is necessary to set the points with exactitude. I hope "D. H. G." will kindly send a sketch of the tool-holder he finds most convenient.

I think I remember having seen a table of angles in the "Lathe and its Uses," but I have not, at present, access to that work.

It is a long time since I first came across some remarks on the double-edge form of slide-rest tools; they were communicated to the ENGLISH MECHANIC in its earlier days by a correspondent, who, I think, wrote under the nom de plume of "Virginian." But I did not give the subject any particular attention until I met with the articles by "D. H. G." In common with many other readers of this journal, I should like to give the system a fair trial, and trust that our kind friend will give us another instalment of his "Principles of Slide-Rest Practice" as soon as possible. **Orderic Vital.**

CIRCULAR STEEL CUTTERS FOR MILLING MACHINES.

[14717.]—THESE are extensively used for facing or shaping iron and brass. The smaller sizes used for wheel cutting and other operations do not occasion much difficulty. They should be hardened in oil, as they are then less liable to crack and warp. They require to be frequently sharpened, for which they should be softened and annealed, and either dressed with a file or the teeth slightly recut in the machine in which the cutters were formed. When the cutters are made of one circular block of steel, exceeding 3in. in diameter, the risk of cracking and warping in the hardening becomes very great. This risk is somewhat lessened if the soft cutter is well annealed before the final or finishing cut for sharpening is given. This annealing will be found to have thrown the cutter a little out of truth, showing that cast steel, even when in a soft state, is under some degree of tension.

Circular cutters, upwards of 3in. in diameter, are sometimes made in segments, bolted either to a face plate or between two flanges; a broken or faulty segment may thus be replaced without sacrificing the whole cutter, which must be the case if made in one entire piece. An engineer, who made extensive use of rotary dentated cutters, explained to me his method of making them up, which was as follows:—The teeth were punched out of sheet steel of suitable size and form. In the larger blades or teeth a circular hole was also punched midway. The cutting edges of the teeth were next sharpened, all to the exact shape, and chamfered by means of a smooth file. The similarity of each edge being insured by clamping the blade between two hardened steel templates or guide blocks during the filing. The blades were then hardened, and afterwards polished on both the flat sides on a revolving tap. They were next tempered to a straw colour, and coated with tin in the following manner:—They were just dipped for a few seconds separately into dilute hydrochloric acid, and then plunged, while still wet with the acid, into a ladle of molten tin, the surface of which was covered with tallow. The acid was used to remove the film of oxide produced by the tempering, which would otherwise prevent the union of the tin. The blades were then all arranged in a mould, having notches or grooves to hold all the cutters in exact position. Hard pewter, type metal, or other alloy is next poured into the mould, which unites with the tinned surfaces of the cutters, and combines them in one solid block. The object of punching a hole in the larger blades was to obtain a continuity of metal near the circumference, serving as a tie for uniting them for heavy work. These cutters were thus made up with great facility, and in order to sharpen the series they were merely melted out of the block and applied separately to the grindstone or lap, the whole series then replaced in the mould and recast. **F. H. Wenham.**

DECOLOURING DIAMONDS.

[14718.]—CAN any of your readers give information as to the chemical agents used in decolouring diamonds? In the specification of a patent obtained this year by M. C. Riballier, of Paris, I find that the "invention" consists in excluding the air from the operations. The patentee says:—"It is known that the greater part of brilliants have a yellow or grey tint, which considerably diminishes their value White brilliants being the most *récherché* and the dearest, all means tending to decolour tinted diamonds have been considered of great interest. Several processes have been tried with this object; they have generally consisted in putting the diamond in an ordinary crucible with strong chemical agents, and heating them together to a high temperature. The decolouration has never been produced, but the surface of the brilliant only has been attacked. My invention has for its object a process of decolouring tinted diamonds, whereby I can obtain from coloured diamonds white brilliants, the surface of which is in nowise altered, and of which the brilliancy of the facets has lost nothing in the operation. My process consists only in operating in a closed vessel protected from the external air, contrary to what has been done up to the present time in treating these matters in an open crucible placed on a furnace heated by gas or charcoal, similar to those which are employed for heating precious metals. I place in a crucible the brilliant and the chemical agents used until now, protecting them from the air; then in a place equally deprived of air I cover up the crucible, and I lute it hermetically, heating the whole then in any furnace, and by one of the ordinary processes in use—gas or charcoal—the desired result is obtained. Lastly, it is indispensable to allow the whole to cool gradually and regularly."

I gather from the above that the process as hitherto carried out has not produced satisfactory results; but that M. Riballier has discovered a method of removing the objectionable colour from diamonds, simply by heating them, in company with certain agents, in receptacles from which the air can be excluded. I should like to know the names of the strong chemical agents alluded to.

H. Vandermat.

COMPOSITION AND WORKING OF ALLOYS — APHIDES — PATH FOLLOWED BY LIGHTNING.

[14719.]—MAY I suggest that the practical value of the articles on the composition and working of alloys would be much increased if the respective fusing temperatures of the different alloys mentioned were given?

I have just got some of the Aphides Suchus Lanigerus on the larch; they are not in large numbers, and as far as I can see, have not done the young shoots on which they are any harm, which surprises me, as they injure apple trees very much.

On a Sunday afternoon about a month or six weeks ago I saw during a thunderstorm the lightning three times strike upwards from the earth to a dark heavy cloud. On the last occasion on reaching the cloud the light became excessively brilliant and dazzling, and very white. I have seen this several times before. The lightning which is sometimes seen on fine winter's nights, and is unaccompanied by thunder, I have sometimes seen go upwards from the ground, and there is one place, where there is a clump of trees on a slight knoll in the middle of a field nearly surrounded by trees, where I have frequently seen this. The lightning seemed to go up from the trees, and I have often thought that if there were a long pole in the centre of the clump, or a sphere, that St. Elmore's fire would be probably visible on the top of it.

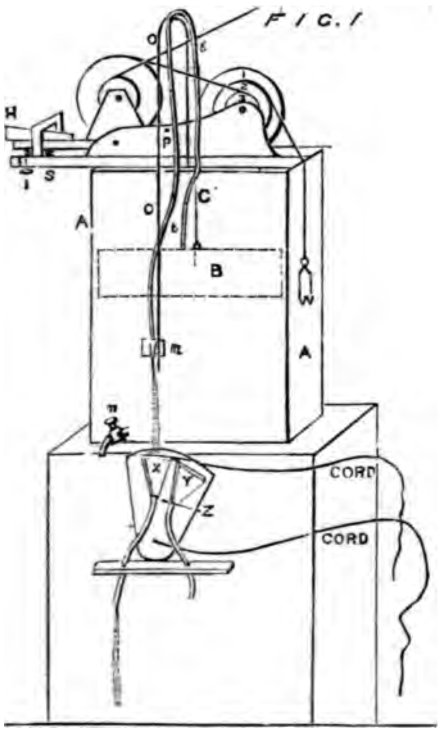
G. J. H.

TELESCOPES.

[14720.]—I FEEL diffident as to whether the jottings of a mere amateur telescopist in this far-off corner of the world will be deemed worth insertion in the columns of the ENGLISH MECHANIC, but the wide circulation of your paper will doubtless place it in the hands of many in the same situation as myself—that is, with large desires but small means, and moreover far removed from where almost anything can be procured for money.

My telescope is a 3in. achromatic, of 47in. focus, and, so far as I can judge, of very fair quality. It was at first mounted on an ordinary table tripod, which I very soon got dissatisfied with, and determined to supersede by an equatorial mounting, however rough, provided it were steady.

I have a couple of well-turned iron axes, which are mounted in wooden bearings. I have succeeded perfectly as to steadiness. I have also attached hour or declination circles, graduated with no great nicety, but nearly enough to bring any object that I want to pick up into the field.



My next want was a driving clock, and I set to work to carry out an idea of a water clock that had for some time been running in my head as a simple arrangement for it. This I will venture to describe. (See Fig. 1.) A is a rectangular cistern. I have used for this purpose what we call a "kerosene can," holding 4 gallons. B a float of wood, weighted at bottom until it will only just float. A siphon of small indiarubber tubing, *t*, has its end passed through a hole in the float into the water of the cistern. An arch of wire, *o*, is firmly fixed into the float, and is carried over to the outside of the cistern, rising to a sufficient height to allow the float to sink to the bottom of the cistern. The siphon tube is led round and supported by this arch. The outer and longer leg of the siphon is tipped with a conical nozzle of brass, the aperture of which is adjusted to give the correct rate of discharge. By this arrangement the point of discharge descends with the float, and consequently the flow is uniform. A cord, *c*, rises from the centre of the float, and gives motion to the pulleys which drive the telescope.

The pulley work is shown in detail in Fig. 2. D and E are two rollers of wood. The upper end of the cord, C, is fastened into the outer rim of D, and winds around it, the rim being grooved to receive the cord. The pulley, E, is driven by an endless band from the small rim, 3. As E revolves it winds on the small rim, 4, the cord, *k*, that drives the telescope. The bearings of the pulley, E, form, with the lever-arm, F, an L-lever, which is pivoted at *g*. The arm, F, being pressed down by a wedge, H, brings the pulley, E, back until it lies firmly against the endless band. A thumbscrew, I, regulates the pressure of the wedge. The cord, *k*, proceeds to, and passes partly round, a grooved pulley of 7in. *diameter, working loosely on the* polar axis under the hour circle, the end of the cord being fastened into this pulley. The pulley has a projecting ear, which carries a clamp to attach it to or detach it from the telescope.

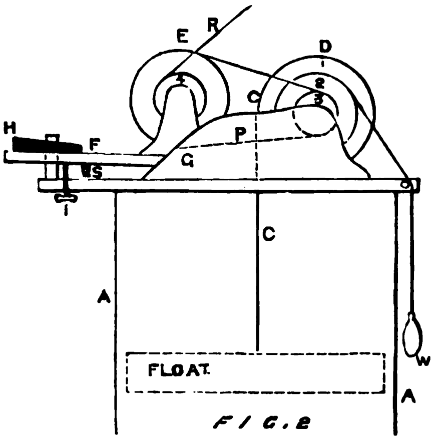


FIG. 2

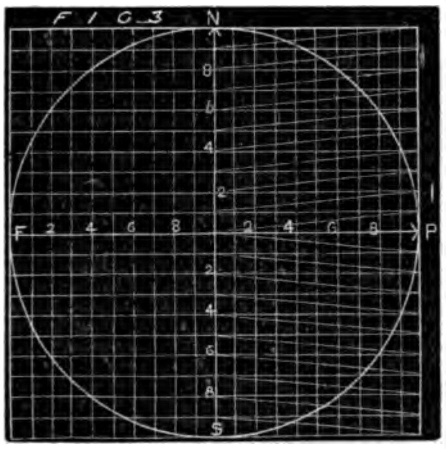
I have now to describe the provision for re-filling the cistern. The wedge, H, being removed, a spiral spring, S, raises the lever arm and throws forward the pulley, E, against a pin at *p*. This slackens the band, so that D is free to revolve, whilst E is held by the pin. W is a weight hanging outside the cistern, the cord from which passes round the rim, 2. On pouring water into the cistern the float rises and the weight, W, descends, winding up the slack of the cord, C, on the pulley, D. The cistern being filled up, and the wedge, H, inserted in its place, the clock is ready to start.

I should have said that the nozzle at the end of the siphon passes through, and is supported by a small block, *m*, that slides upon the wire of the arch. The flow being regulated as nearly as may be by the aperture of the nozzle is finely adjusted by sliding the block up or down, than by shortening or lengthening the leg of the siphon.

My clock discharges 1,004 grains of water per minute, and runs about 3½ hours.

A tap at *n* is useful in setting the clock to the telescope. The telescope being set a little behind the object, the tap is turned on, which brings the telescope up to position, and the float to its proper bearing in the water. The tap is then stopped. I had intended the float to act directly upon the telescope with only a guide pulley; but I found that, owing to the friction of the polar axis, the telescope would hang back until the water had somewhat subsided, when it would jump forward some 2min. in R.A.

Time Measurer.—To serve the purpose of a chronograph, I have adopted the following expedient. Under the stream from the siphon are placed two small square funnels, *x y*, attached side by side to a short board that is pivoted at *z*, just below the funnels. Two cords are attached to the board, one above and one below the pivot. The eye being at the telescope, either one of these funnels may be brought to receive the stream by pulling one or other of the cords. Small indiarubber tubing is slipped on to the nozzle of each funnel to lead the stream into vessels placed below.

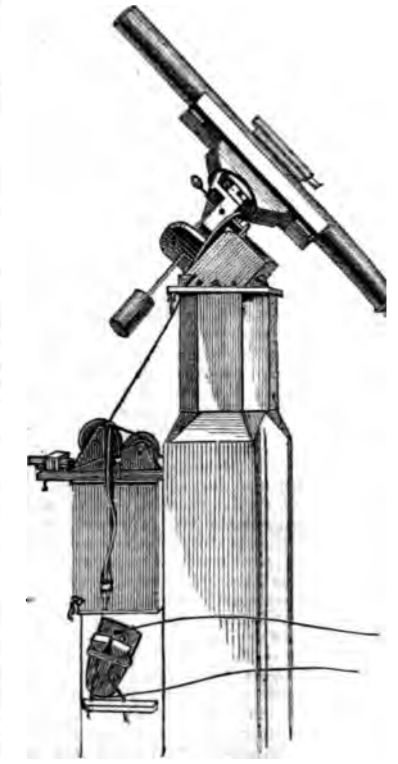


Suppose the stream is passing by the funnel, *x*, into the reservoir, whilst an empty vessel stands under *y*. A pull of the under cord, at the commencement of the interval to be measured, instantly diverts the stream into the empty receiver, whilst, by pulling the other cord at the close of the interval, the stream is as instantly returned to the reservoir by *x*. We have then but to weigh the water received by y to estimate the interval exactly.

Micrometer.—The scale shown in Fig. 3 is s of my *help-myself* contrivances, which I be capable of doing a great deal of useful work, as in my case, the more delicate and expensiv ratus for the same purpose is not obtainable. in fact, the *reticle* micrometer, but with so portant modifications, one of which is the s tion of the principle of the *diagonal scale* renders it possible to estimate measures ir nation with great nicety. It will be observ this scale has *ten divisions*, from the centr border, each way. The scale being set truly telescope, so that a star shall thread one lines from F to P, another star passing t the field will probably pass *between* the ma sions, but must *cut* one of the diagonals. ing the number of spaces from the middle, c line to the point of crossing, will express de the value of the *part* between that point a adjacent line (towards the centre one).

This scale also serves the purpose of a p *micrometer*. For this purpose I have th inscribed in the square. To measure the of position of a double star I turn the scale the components are threaded upon the N.S the comes towards N. Then, bringing the p to the centre, I run it out, noting exactly th of exit from the circle. The number of di from a quadrant point to the point of exit wi the sine of the angle in that quadrant. The angle is estimated from the P point, round to S., so that if any whole quadrants interven must be added to the part. (The tangents r read outside the circle if preferred.)

FIG 4.



The scale is constructed as follows :—A sl glass, about 8in. square, is first painted in three coats of a dark colour. When dry it is upon a board having a straight edge. By m a carpenter's square, and a sharp cutting po lines in one direction are cut through the pai a divided scale placed at the edge of the glas glass is then turned the other way, and th lines similarly ruled. The diagonals ar wards drawn with a straight edge, and th struck with a pair of compasses. This glass placed against a window (darkening all ro and photographed with a sharp short fo upon a thin glass micro-cover, cemented wi wax to the centre of an ordinary phot glass-plate. Of course, the scale may be graphed to any size, to suit the different ey (I have one 1-12th inch in diameter for my eye-piece.) The scale may be protected by ing another thin cover upon it with Canada

To measure the equivalent focus of a sm eyepiece, or combination.—I place the combination, to be measured upon the sub- a microscope by means of a convenient carri may be of thin wood). Place the microsc zontally, with a stage micrometer of 1-100 inch upon the stage. A bold scale of inc ferably white lines on black) is to be steed the instrument. Focus the microscope u stage micrometer, and move the sub-stage f the inch scale, formed by the lens, is seen nicroscope along with the lines of the stage eter. Move the inch scale to or fro until s coincide with those on the stage. Then e the distance between the lens and the inch This distance, divided by 100, will give its conjugate focus, which, in this case, will be ally the same as its principal focus. To find vers of the telescope, we have only to divide ns of its object-glass or speculum by that of ferent eyepieces obtained as above.

ntauri.—We, in this hemisphere, have the age of northern observers with respect to ır nearest neighbour among the stars. The n and distance of its components have changed since I first saw it as a double star some 10 go, by means of a little pocket glass of 1in., hen plainly and easily divided it. It requires 300 in my 3in. to do it now. So far as I can e it, its distance is scarcely (if any) more than s position, as read by me, is—Sine S 69 F = + 90° = 113° 40′. It stands, in "Webb's l Objects," at distance 16·52, position 219°. lose a photograph of my telescope and clock, as it stands. **A. B. Biggs.**

pbell Town, Tasmania, June 7.

MANUFACTURE OF STEEL BY SIEMENS' PROCESS.

1.]—It is almost impossible nowadays to give urate and comprehensive definition of what , but to distinguish the material made by the ier and Siemens' processes from iron, be sufficient to describe steel as a compound with carbon and manganese in appreciable ies, traces only of these elements being pre- "iron" properly so called.

Bessemer process has now been in practical on for nearly a quarter of a century, and its ical principle is understood by almost every of ordinary information. Siemens' process, on er hand, is comparatively new, and is scarcely at all, except by those engaged in metallur- ursuits. By way of comparison, it will be to state that good mild steel, admirably d for constructional and other purposes, is y both processes, the Siemens having the ad- e as to uniformity of results, and that the production in both cases is at the present time equal.

object of these papers is to give a practical tion of the plant, and method of working this ting process as clearly and briefly as possible, ncing with the gas producers.

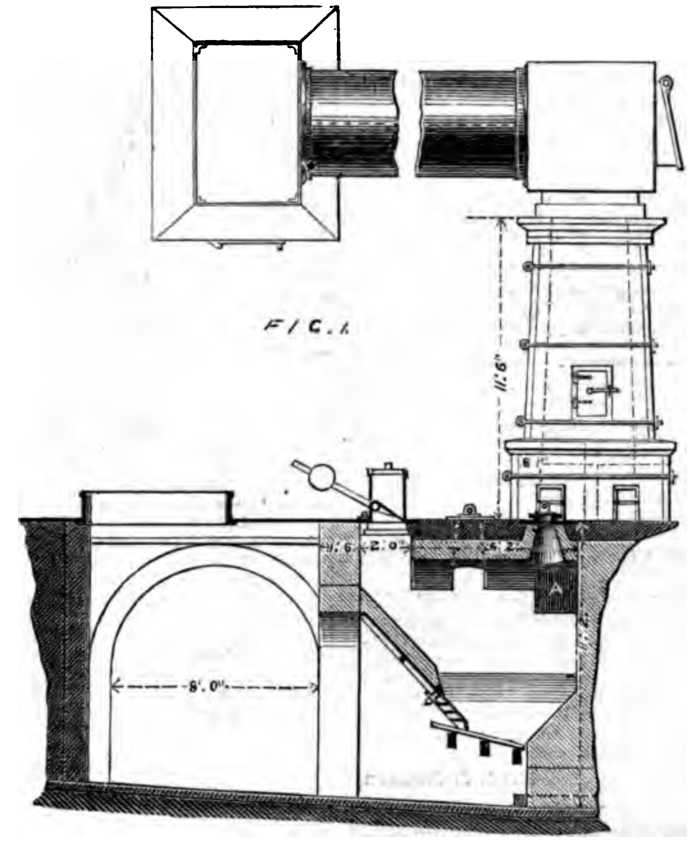


FIG. 1.

Siemens Gas Producers.

1 shows a section through a gas producer of m which experience has shown to be the most e, and also an elevation of the stack and tubes which surmount it. The roof is arched, the sides and back are almost perpendicular, except near the fire-bars, where they slope inwards at an angle of about 45°. The front, which is formed of cast-iron plates lined with 3in. of fire-brick, is also inclined at an angle of about 45°. The fire-bars, of 1¼in. square bar iron, are not fixed in any way, but merely rest on three cast-iron bearers fixed into the brickwork, so as to be easily removable for cleaning and repairs. Two hoppers or chargers, provided with hinged tongues, are placed above the inclined plane for the introduction of the fuel; and the gaseous products of combustion are carried into the stack by the flue, A. The charging floor, which is covered with cast-iron plates, is pierced with several sight holes for the purpose of inspecting and stirring the fire. These orifices are about 3in. in diameter, and when not in use are closed with tight fitting plugs. The internal capacity of the producer is about 230 cubic feet, and the area for the admission of the atmosphere at the fire-bars about 12 square feet. Four such producers are built under one stack, and are collectively called—a stack of four producers.

When there are several stacks of producers they re built in a row with a covered passage or tunnel on each side for giving access to the firebars, and removing the cinders. A water pipe with a short hose opposite each fire is carried along the roof of the tunnel for quenching the ashes which fall from the firebars during cleaning. A small quantity of water is always allowed to lie under the grate, the superfluity being carried off by a drain at the back of the ash-pit provided for that purpose.

The interior of the producer is built of firebrick cemented with fireclay, common brick being used for the external walls and tunnel.

The stack, which is about 11ft. high, is entirely built of firebrick, and is placed over its four fires so as to cover an equal part of each, the four flues from them being carried up within it separately for a distance of 4ft. above the charging floor. By means of dampers inserted through narrow horizontal openings, built in two sides of the stack for that purpose, any of the fires may be shut off without interfering with the working of the others. Two doors opposite one another are provided for sanding down the dampers to prevent leakage. Small doors are also placed on a level with the charging floor for removing the accumulations of soot, &c., which gather in the flues leading from the different fires.

The stack is surmounted by a square wrought-iron chamber 5ft. × 5ft., which rests in a square cast-iron trough about 3in. wide, fixed into the top of the brickwork. From this chamber a circular tube, 4ft. in diameter, and generally about 15ft. long, extends to the main collecting tube, 6ft. high by 4ft. wide, the rectangular section being chosen for convenience in cleaning. To prevent injury from the varying temperatures to which the tube is exposed, expansion boxes, which are simply enlarged portions 9ft. high × 7ft. wide × 1½ft. long, are provided at regular distances of about 40ft. Numerous man-holes and cleaning-doors must be placed in all the tubes, and to prevent damage from possible explosions the man hole covers on the tops of the tubes are not fixed down, further than by their own weight. The main collecting tubes are supported either on columns or on brick piers provided with expansion rollers.

The length of the collecting tubes varies according to circumstances, but the longer they are the better will be the quality of the gas they supply. Connection is made with the underground flues, which conduct the gases to the furnaces, by means of a circular wrought-iron downtake, the size of which depends on the number of furnaces to be supplied. A diameter of 3ft. will be sufficient for two 5-ton steel-melting furnaces. The lower end of the downtake rests in a circular cast-iron trough, about 3in. wide, and is supported on a number of small cast-iron balls, which allow a small movement in any direction. This trough, as also the one on the top of the stack, are always sealed by the tar which collects in them, any leakage of gas being thus effectually prevented. The plates used for all the tubes may be ¼in. thick, angle-iron, 2½in. by 2½in. by ¼in., being used for the corners, with rivets ¾in. dia. and 2in. pitch. **P. F. McC.**

(*To be continued.*)

THE REFLECTED RAINBOW.

[14722.]—There has been recently some correspondence in these pages on the supject of the reflected rainbow, and I trust you will allow me a little space for the following extract from Tyndall's "Light," 2nd Edition, p. 26. If I am not mistaken, some of your readers will be much pleased to meet with this lucid statement:—

"From what has been said it is clear that two observers standing beside each other, or one above the other, nay, that even the two eyes of the same observer do not see exactly the same bow. The position of the base of the cone changes with that of its apex. And here we have no difficulty in answering a question often asked—namely, whether a rainbow is ever seen reflected in water. Seeing two bows, the one in the heavens, the other in the water, you might be disposed to infer that the one bears the same relation to the other that a tree upon the the water's edge bears to its reflected image. The rays, however, which reach an observer's eye after reflection, and which form a bow, would, were their course uninterrupted, converge to a point vertically under the observer, and as far below the level of the water as his eye is above it. But under no circumstances could an eye above the water level, and one below it, see the same bow—in other words, the self-same drops of rain cannot form the reflected bow and the bow seen directly in the heavens. The reflected bow, therefore, is not, in the usual optical sense of the term, the *image* of the bow seen in the sky." So also De Morgan excellently remarks, "Budget of Paradoxes," p. 471, "what are called the reflected rainbows are *other* rainbows, caused by those *other* drops which are placed so as to give the colours to the eye after reflection, at the water or the looking glass." **George Hunt.**

Hopefield, West Dulwich, August 7th.

THE RAINBOW.

[14723.]—I am not at all surprised to find this question of a reflected rainbow cropping up now and again. From the very nature of the phenomenon it is certain to be puzzling to many when they first begin to think about it. From our every day experience we are apt, and naturally so, to think of the rainbow as something having an actual material existence, and a fixed position in space, and though most of us nowadays are acquainted with the usual explanation of the phenomenon, it requires an effort to reason ourselves out of the belief in its materiality.

It occurs to very few to question whether a rainbow can or cannot be reflected, and I believe that at least 99 per cent. of the few must first have their attention directed to the subject. To those, however, with a fair knowledge of optics, it ought not to be difficult to settle how far there is any truth in the oft-repeated assertion that "a rainbow cannot be reflected." My own attention was first given to this subject some years ago, when reading Tyndall on "Light," 1873 Edition. At pp. 25 and 26 he devotes a paragraph to prove that there can be no reflection of a rainbow. The subject is thus introduced—"And here we may devote a moment to a question which has often been the subject of public discussion—whether, namely, a rainbow which spans the tranquil sheet of water is ever seen reflected in the water." And then he explains that "the rays effective in the rainbow are emitted only in the direction fixed by the angle of 41°. Those rays, therefore, which are scattered from the drops upon the water, do not carry along with them the necessary condition of parallelism, and hence, though the cloud on which the bow is painted may be reflected from the water, we can have no reflection of the bow itself." I was greatly puzzled with this. I read the passage many times, in all sorts of ways, but failed to get satisfaction. It never occurred to me at first that Tyndall might be wrong. What annoyed me was my inability to lay hold of the question and look at it in the way he evidently wanted me to do. I grew quite desponding over it, then doubtful, and ultimately resolved to put the whole question to test at the first opportunity. For some weeks, like one demented, I haunted the neighbourhood of pools of water looking for a rainbow, giving occasion for much concern to my friends. I was successful at last. One afternoon, while the sun was still high, I noticed a rainbow, small, low down, of course, but very brilliant. I ran to the nearest pool, and, though I could only get into a proper position to observe the reflection, if any, by going well-nigh knee deep in mud, I did so without hesitation, and was amply rewarded. The whole question was set at rest, for I saw a most beautiful rainbow reflected from the water. Now, this rainbow, which I saw reflected from the water, could not be a reflection of the same bow which I saw directly, because the rainbow has no existence, as a bow, outsidethe eye. The "bow" is a purely subjective phenomenon. As quoted above, "the rays effective in the rainbow are emitted only in the direction fixed by the angle of 41 degrees;" therefore any rays from the same drops reaching the water had not the necessary fixed direction, and though they might be reflected, could not produce the image of a bow. But changing my position as much as I liked I could always see a rainbow; of course, at each change an entirely different set of rays produced the effect, and also, of course, these rays must have proceeded from a different set of raindrops. This proves that whenever the generating raindrops are sufficiently numerous, they send backwards quite a flood of dispersed light, making, with the original direction of the sun's rays, the necessary angle of 41°. If, then, rays endowed with the necessary properties to produce the impression of a rainbow fall all round and about a pool of water, there is nothing to hinder others to fall on the water, and having struck the water it would be very curious if they did not suffer reflection. After reflection they still preserve among themselves their relative directions; the angle of reflection being equal in magnitude to the angle of incidence, they are in no whit altered, except that all are now proceeding in an upward direction instead of downward, and an eye placed in the path of the reflected rays would build up with them an inverted rainbow. I know that a number of people, with a professed knowledge of scientific matters, doubt the possibility of a reflected rainbow; in fact, it is not so long since there was a discussion in "ours" on this very point. I hope that what I have said above may help a little in clearing away their doubts. As to the more recent part of the question, started again by Mr. Webb the other week—whether, namely, the end of a rainbow seen directly over the water ought to coincide with the end of another seen by reflection in the water—Mr. J. W. Durrad, in letter 14657, has given, in a pretty satisfactory way, the explanation why they should not coincide; but there are two or three points in his letter to which I should like to refer. Of course it was necessary in his diagram to assign a position to his bow, although in nature we cannot do so; but why should he place his second bow, C, so much further away than B? It would have been simpler, and have made his explanation easier of comprehension by the general reader, if he had placed C in the same vertical plane with B, and would, at all events, have avoided the use of the word perspective—not a very good word in this connection. He also says: "A boatman at F would see the bow, C, while A only sees its inverted image." Now, I do not suppose that Mr. Durrad thinks that those rays which sufficed to form a bow, as seen directly at F, are all reflected thence to A; but, because a friend of mine understood this to be what was meant on reading the letter, I thought a word on this point might not be amiss. At F the effective rays meet in a point, and after reflection they are no longer convergent, but diverge from each other; so that an eye at A can by no possibility take them all in. Only a very few of the rays effective at F—those which formed the very summit of C—can enter A's eye. A, nevertheless, sees a bow reflected in the water; but the rays effective in its formation proceed from no single point on the water surface, but from a great many. This will be easiest seen if we follow all the rays backwards from the eye till they meet the water, when we find that they do so in innumerable points, ranged continuously in the form of a large hyperbolic curve.

Dundee. **John Thomson.**

PROPERTIES OF NUMBERS.

[14724.]—As my unknown friend and namesake, Mr. S. Jewsbury, and "Amara" have so fully gone into this subject, I almost feel afraid to trespass further on your valuable space. However, as I shall *have less to say, and having* received a few letters from your readers (two of which were from schoolmasters) requesting information as to the construction of these remarkable squares, I crave your indulgence. In a square of 16 cells the number of terms contained in the diagonal rows, and also their sum, respectively equal half the number of terms contained in the square, and half the total sum of all the terms. Now by writing the diagonals the contrary way from the natural, the square will be magic, as shown by the two small squares. All larger squares whose root is divisible by 4 can easily be constructed in the same manner, as follows:—Line out a square containing 16 cells, each cell to be large enough to contain 1-16th of the whole number of terms—that is, the root divided by 4 and the quotient squared—gives the number of terms for each cell—thus $\left(\frac{\text{root}}{4}\right)^2$ = 1-16th of the whole number of terms. In the larger square it will be seen that all the terms that are contained in the diagonal cells are written the contrary way, which makes it magic, because we reverse half the number of terms and half the total sum diagonally. This holds good, however large the square may be. I have written the terms of the smaller square in the centre of the cells of the larger, merely to show that the one is virtually the same as the other—the latter only expanded. It is not absolutely necessary that the terms in each cell should be consecutive, as shown; but as this method is the simplest to write, and showing such curious properties of figures, I have adopted it. For description of these curious properties of figures, see ENGLISH MECHANIC, June 21st, page 373.

10	26	42	58
74	90	106	122
138	154	170	186
202	218	234	250

250	26	42	202
74	170	154	122
138	106	90	186
58	218	234	10

64 63 250 62 61	5 6 26 7 8	9 10 42 11 12	52 51 202 50 49
17 18 74 19 20	44 43 170 42 41	40 39 154 38 37	29 30 122 31 32
33 34 138 35 36	28 27 106 26 25	24 23 90 22 21	45 46 186 47 48
16 15 58 14 13	53 54 218 55 56	57 58 234 59 60	4 3 10 2 1

Joseph Jewsbury.

Brookfields, Birmingham.

THE HYPHARMONIC SERIES OF THE DIATONIC SCALE.

[14725.]—IN reply to Mr. Ballard's letter (14072), I have no doubt he sufficiently understands the proposition to deal with it. I note that he detects a similarity between it and a geometrical proposition—Euclid 1, 4. He will, however, find that, though the harmonic and hypharmonic series are perfectly equal, they are not identical, and that they contribute equally to complete the structure of the diatonic scale.

Aug. 9. **Fred. J. Jackson.**

HIGH-PRESSURE BOILERS.

[14726.]—A RECENT number of your periodical contains an abstract of a paper on this subject lately read before the Institution of Civil Engineers. What the author says on the value of high steam is undoubtedly true, but it is doubtful whether, as he seems to think, the best mode of obtaining it is by the use of the sectional or water-tube boiler.

Sectional boilers have been before the public for many years—the idea, in fact, of obtaining greater strength and safety by using a number of small boilers instead of one larger one, is so obvious that it is no wonder it suggested itself to the early engineers. Woolf employed boilers of this class for his compound engines; then they were taken up by some of the first makers of road locomotives, and in various forms they are now to be seen advertised in the engineering papers. But water-tube boilers have not as yet come into general use, and the experience of those who have tried them does not seem encouraging. I have had a little to do with boilers of this kind myself, and found them very troublesome customers, and the other day I noticed that the chief engineer of one of the large insurance companies spoke strongly against their so-called safety. Boilers of the Galloway class, in which a large flue is crossed by water-tubes, come of course under a different heading; but the purely water-tube boiler, whatever its future may be, cannot as yet be regarded as a practical success. It se
fore, worth while considering whether by
mode of construction boilers of approved
Cornish, for example—cannot be built so
stand a higher pressure of steam; and m
writing to you is to suggest ways in whic
to me this might be done, with the object
the opinions of those of your correspo
may be practically engaged in boiler build

Large boilers for stationary engines are
usually built of ⅜in. or 7-16in. plates, joi
rivets. Thicker plates or larger rivet
well be managed with the hand-ham
plates overlap each other, so that the bo
be truly cylindrical, nor the strain a
through the middle of the plate. The
marked off by a template, and often do
exactly; but if the point of the drift can
the energetic application of a small s
makes a passage for the rivet. When t
finished everything looks well, but it is e
the plate must have been unduly strai
rivets also, though they draw the plat
together, cannot fill the holes properly
Plates, again, are often injured by careles
and not long since I noticed the case of a
boiler giving way, with fearful results,
shell had been deeply cut by the caul
Excellent boilers can no doubt be made b
sent system, but still it seems possible
stronger ones.

If the riveting were done by powerful m
larger rivets and plates of, say, double t
thickness could be used. These plates,
overlapping each other, should be butted,
being planed or faced, and the joints
covering strips inside and out. For the
Cornish boiler the longitudinal seams
welded, the welding being preferably done
plates, or rather rings, were rolled ou
required thickness. Special machinery
course, be necessary for this; but if the
demand for such plates there would soon be
The flange for the end plates could be rol
same time, thus dispensing with angle
rivet holes to be drilled through both
joint strips while in position—the ends of
being first drawn tightly together by dri
holes separately with a little draw on the
driving in drifters; then the strips to be
and the burr removed with the file. (
might be looked upon as a rather startli
tion, but if they were made of the softes
curable, and turned to fit the holes, t
reason why they should not answer ad
they could never get loose in the holes, an
being held firmly together by the machin
rivet was being compressed and the cap
end shrinkage of the rivet, now found n
draw the plates tightly together, wou
required. The principal strain on the riv
a transverse or shearing one, so that a
only would be sufficient; but if hot rivets
the holes should be coned from each side t
middle of the plate, so that the contrac
rivet in length would compensate for th
ness, and the rivets would keep tight in t
they cooled.

For the internal or fire-tube, plates of
thickness than ½in. would perhaps be uns
by the use of T-iron rings, tubes of even
ness could be strengthened to almost a
extent; or, perhaps, the best way would
the plates, the transverse joints of the
made by riveting the flanges together, wit
strengthening ring between them. The l
seams should be formed, like those of t
butting the plates—perfect circularity
necessary for the tube than for the shell.
need not be carried back for its full
whole length of the boiler—room for the
the perfect mixing and combustion of
all that is necessary, and beyond this the
might be carried to the back of the boi
smaller tubes.

Boilers thus constructed would of cou
expensive than those built by the prese
but, taking into account the greater thic
plates, perhaps the cost per ton would
If high steam is wanted some additional
be incurred in order to obtain it, and the
be solved in each particular instance is,
cheaper to save fuel by paying for a stro
to save cost in the boiler at the expen
creased consumption of fuel?

Cornish boilers are often strained, w
steam from cold water, by unequal ex
back of the tube getting hot before the
the tube and shell, the heat being cond
wards very slowly. I have known the
boiling above the tube, while that under
cold; the effect of this being seen in le
end seams of the tube, which stopped as
boiler got thoroughly hot. This would
of still more consequence with heavie
boilers, and I would propose to obviate
a temporary grate in the bottom flue, to
raising steam after cleansing, &c. Th

beneath the outer shell, the boiler would
'ormly heated throughout, and unequal
roided.

ars ago the idea occurred to me of
ıg—or rather relieving—an internally-
by placing it within an outer case or
space between the boiler and the case
with steam of half the pressure of that in
Supposing, for example, the safety valve
', blowing off into the space between the
he case, to be loaded to 50lb. per square
he safety valve of the case, blowing off
ıosphere, to be also loaded to 50lb. per
, steam might be raised in the boiler to
e neither the boiler nor the case would
: more than 50lb. There are, of course,
:tical objections to this plan, and there
'eason why boilers should not be con-
rong enough for all general purposes
orting to it, but still there might be cases
e application of this principle would be
ıl. There are one or two other points
'ith the construction and management of
I should like to touch upon, but for the
hink I have encroached too much upon
ıle space. **W. M.**

SURVEYING.

·The following method of ascertaining
from a plan is, I suspect, far too simple
al, yet I am at a loss to know what is
ıl objection to it, as it is more expedi-
I believe, more correct than the usual
ay down the plan of any irregular piece
› the scale of, say, 2 chains to an inch.
'regular the boundaries the more advan-
s the method appear to be. Cut out the
pair of scissors, and weigh it in a sensi-
l balance, with a series of weights cut
me or a similar sheet of paper. These
ıuld be cut into squares by dividing a
ı into fourths, sixteenths, and sixty-
hus an inch might well represent 16 poles,
: acreage is found at once. The paper
ıe purpose should be fairly stout and
ving paper. **Guilden Morden.**

E AND COUPLED EXPRESS ENGINES.

·The subject of single and coupled
ines has now been under discussion in
of the English Mechanic for several

ɔns in favour of coupled engines for
ıss trains, and my reasons for those
: so well known, and have several times
in the back numbers of the Mechanic,
not take up valuable space by reiterating
in this letter.

: 369, your New Zealand correspondent,
" says, "that it has not been shewn
ıpled engines could run the G.W. and
ses, or that the G.W. and G N. single
d *not* run the L. and N.W. or Midland
he also states "this is the real point at
until this is proved the advocates of
ıes have not made out their case."

ıy intention to quietly ignore the point,
M." says, "has been done by all
' coupled engines;" on the contrary, I
ing forward facts and calculations which
'e the allegation that coupled engines
keep time with the G.W. or G.N.

ngine with 7ft. driving wheels can keep
ıe Great Northern 10 a.m. down Scotch
ıis is a well-known proved fact.

, as the resistance to be overcome does
the power that can be exerted by an
ıg cylinders 17in. × 24in., and driving
diameter, giving a tractive force of only
at reason can be given why a coupled
wheels of the same diameter, and
in. × 26in., giving a tractive force of as
'285lb. cannot do the same work?

the arguments always used by the
f single engines is, "that their engines
the fastest trains in England." This is
but it will always be found that they
ingle engine running upon a compara-
ailway, with a coupled engine running
gradients.

ɔ proof; it simply shows that gradients
t increase in the resistance, but does not
prove that the coupled engine upon the
r could not work the trains as well, or
than the single one.

ion of single and coupled engines resolves
ıe of *tractive force versus resistance*,
al speed of trains on different lines has
do with the *locomotive performance*,
ı data is given from which to calculate
e upon each line.

iew to make my comparison as fair as
ave taken three trains from London:—
Western 11.45 a.m. as far as Swindon,
the Great Northern 10 a.m. to Grantham, and the Midland 10.30 a.m. to Leicester.

I have obtained every information as to the gradients, loads, speed, both average and actual, and I find that the average speed is as follows:—

Great Western 1st.
Great Northern 2nd.
Midland 3rd.

I then worked out the resistance to be overcome by each engine upon each line, and I find, as I expected, that the order is reversed, considered from the locomotive point of view.

The Midland engine stands 1st.
Great Northern 2nd.
And Great Western 3rd.

And it will be seen from the following table that the tractive force of the engines used to work the trains runs in the same order.

—	Diam. of driving wheels.	Diam. of cylinder	Stroke.	Tractive force.
	ft. in.	in.	in.	lb.
Midland (rebuilt 800)...	6 8	18	26	105·3
Great Northern	8 0	18	28	94·5
	7 0	17	24	82·57
Great Western	8 0	18	24	81·

I cannot agree with the statement of "C. R. M." as I am of opinion that any of the Midland 7ft. coupled engines designed by Mr. Johnson, or the rebuilt engines of the 800 class could run any train in England with the greatest ease.

In answer to the question upon page 270, the reason that the Midland coupled engines do not run between London and Leicester at the same average speed as the Great Northern trains from London to Peterborough, is that unfortunately the Midland was obliged to have heavier gradients.

If any one will compare the sections of the Great Northern line with the long Kibworth, Desborough, Irchester, and Sharnbrook banks (the last of which is 1 in 120 for 3¾ miles), they will see at once why such powerful engines are necessary, and also why a single engine could not keep time with the heavy loads and high speeds which are required when ascending the inclines.

In my letters upon the resistance of engines and trains in last volume pages 121, 171, and 237, the formula is given which will enable your engineering correspondents to obtain all the information they may require upon the subject of the resistance upon inclines.

There is one other point which I observe the advocates of single engines always avoid.

When the resistance is great, a large tractive force is necessary, and, therefore, great weight is required upon the driving wheels. In single engines this weight, as much as 16 tons, is concentrated on one pair of wheels, and it is this great concentration of weight upon any one part of the line which does so much damage to the permanent way. It is not the total weight of the locomotive which causes it to be called the *destroyer of the permanent way*, but it is the great weight on any one point or on any one pair of wheels. Every one will, I think, agree with me that in a coupled engine the weight is far better distributed, and also more of it is available for adhesion. **C. E. S.**

August 8.

L. AND N.W. ENGINES.

[14729.]—In accordance with my letter (page 499) herewith I hand names of class called "Little Bloomers" built about 1854 to 1860, and are 29 in number:—

602	Caliban
603	Langdale
607	Inglewood
614	Wyre
615	Lune
617	Partridge
621	Bela
623	Medea
625	Mastodon
626	Earl
627	Bull Dog
629	Swan
630	Ribble
666	Pheasant
703	Osprey
717	Swift
740	St. David
765	Herald
768	Glyn
780	Bucephalus
789	Cadmus
838	Petrel
840	Lonsdale
917	Napier
977	Sultan
978	Mammoth
979	Wasp
980	Vandal
981	Councillor

These have cylinders 16 × 22, driving-wheels 6ft. 6in., and are running principally between London, Rugby, Birmingham, Wolverhampton, and Stafford—mostly slow trains, with one or two exceptions, between Rugby and Stafford, viâ Birmingham. In my letter (page 499) for "the following have not cabs—887 has not (nor 898)," read nor 848. I will send large bloomers next week, and will also give "W. E. H." some of their present working. **Egeria.**

BRAKES ON PILOT ENGINES.

[14730.]—On p. 526 I notice a correspondent asks is it necessary for a pilot engine to be fitted with the same brake if the continuous brake is fitted through the train? Certainly not, as the connection pipes are only at the tender end. When a train is so running care should be taken that the brake is put on the pilot engine first; otherwise, by suddenly applying the brake on train engine, the driver would most likely break the coupling between the two engines. **Joseph Green.**

USEFUL AND SCIENTIFIC NOTES.

An Electric Manometer.—*La Chronique Industrielle* describes a new manometer of a sensitiveness which is said to be almost absolute. This instrument is the result of a combination of two apparatus already known—Bell's telephone and the batoreometer of Professor Giordano, of Naples. The latter instrument is designed for measuring thicknesses, or the minutest variations of thickness. Thus, after having measured the thickness of a pane of glass at an ordinary temperature, the batoreometer will show the increase of thickness which results from expansion due to the warmth of the hand which holds the pane. A vertical tripod is traversed by a very fine micrometer screw, and surmounted by a dial, the border of which is marked off into divisions according to a certain scale. The object is laid upon the table, and the micrometer screw caused to approach it. As soon as contact takes place an electric current, shown by a galvanometer, passes between the point of the screw and the table. If the object to be measured is a poor conductor it is coated with gold-leaf. Let us now suppose that a current of air, whose intensity we wish to measure, is exercising a pressure on the flexible membrane of a Bell's telephone; the membrane will bend under the influence of an extremely small quantity, but this quantity can never be so minute as to be inappreciable by the electric current of a batoreometer. The new instrument is extremely sensitive to movements of the air, and detects and records even the waves produced by ordinary noises. It is both a manometer and anemometer of great accuracy.

Reeky Linn.—Mr. J. Valentine, photographer to the Queen, of Dundee, has sent us a photograph of Reeky Linn, the well-known waterfall, in the Den of Airlie, 20 miles from Dundee, which, as we stated in our "Scientific News" on page 497, it is proposed to utilise as a motive power for dynamo-electric machines, as suggested by Dr. Siemens to the Dundee Gas Commissioners.

Thymol.—The employment of thymol as a substitute for carbolic acid in surgical dressings is, says the *Lancet*, a natural consequence of the discovery of its greater antiseptic and less septic power. A lecture on the subject has been published in Volkmann's series by H. Ranke, of Halle. The solution used instead of the 3 per cent. solution of carbolic acid consists of one part thymol, ten parts of alcohol, twenty of glycerine, and a thousand of water, and can be employed as either a spray or a solution. An impregnated gauze is also used. Since thymol does not irritate the wound, the gauze may be laid directly upon it—otherwise the same method is employed as in Lister's plan. If the gauze becomes hard and dry it may be moistened once or twice a day with thymol water. In order to prevent the evaporation of the thymol from the dressing the gauze is covered with oiled paper. From an experience of forty-one wounds dressed with thymol the lecturer concluded that the method leaves nothing to be desired as to its antiseptic effect, and that it answers better than the carbolic acid dressing, since the secretion from the wound is less, the period of healing shorter, and the cost of the dressings is smaller. Further, it has no poisonous properties, and eczema was never observed in its use.

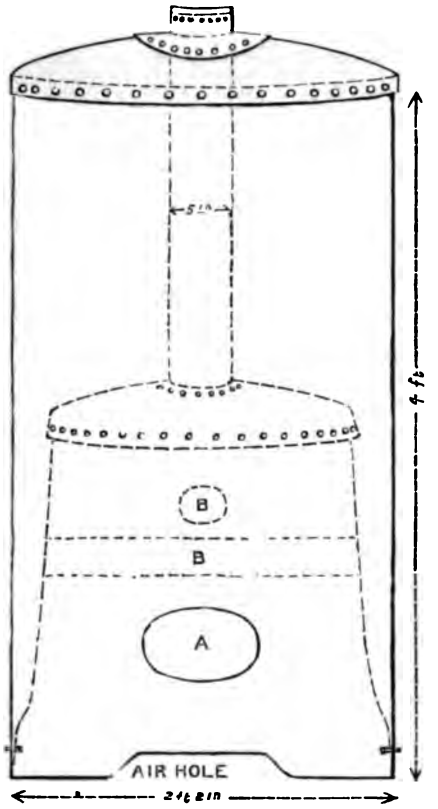
Precipitating Gold Contained in Old Toning Baths.—The baths when no longer fit for use are filtered into a white glass flask, rendered alkaline with a little bicarbonate of soda, and a concentrated alcoholic solution of magenta is added drop by by drop until the liquid has taken the deep red hue of syrup of raspberries. The flask is then exposed for six to eight hours to the light of a bright window. At the end of this time the gold is found to be deposited as a violet powder, whilst the supernatant liquid has become colourless. It is carefully decanted, so as to preserve merely the deposit. When a sufficient quantity of protoxide of gold has thus been collected, it is carefully washed upon a filter, dried, and the filter are burnt. The dry residue and the ash of the filter is then dissolved at a gentle heat in an excess of *aqua regia*, and the solution—diluted with distilled water—is separated from the insoluble substances by filtration.—*Chem. Centralblatt.*

Paper Exhibition at Berlin.—An interesting, and in many respects unique, exhibition has just been inaugurated at Berlin. It is devoted solely to the paper-making industry, and the exhibits comprehend everything that can be made of paper, from collars and cuffs to furniture and houses.

REPLIES TO QUERIES.

⁂ *In their answers, Correspondents are respectfully requested to mention, in each instance, the title and number of the query asked.*

[32409.]—**Yacht Boiler.**—I regret that distance has prevented my answering the above sooner. Explanation :—A, furnace door ; B B, two Galloway tubes, each 3½in. ; firebox, 2ft. high, made of 12lb. copper—outside shell, 6lb. copper, each one sheet of copper, vertical seams of both brazed, crowns riveted ; weight of boiler, about 4cwt. ; no iron used except a thin sheet to line uptake, to keep flame off the copper above the water line. Contract price for boiler, without gauges and safety valve, £47 ; drives a screw engine, 4in. bore and 5in. stroke ; 240 revolutions with 60lb. steam. The boiler makes much more steam than the engine can use even with the worst coal that it is possible to obtain. Who can say the same of an iron boiler of the same size? "Practical Boiler-Maker" has omitted to say whether a brazed seam is equal to a riveted one, &c. ; and, with great deference to his opinion, I cannot see that the outside shell should be ¼in. thick, and the firebox 3-16in., as copper will stand far more internal than external pressure (proved).—Firefly, Melbourne.



[33029.]—**Electrotyping in 15 and 18 Carat Gold.**—Thanks to "Os," and R. H. Thomas, Fermoy, for their replies to this query. I have seen a great variety of electrotyped articles in 15 and 18 carat gold which could not be struck in a die on account of their form. As to the alloy, it is the same as the ordinary alloys in gold that we use, containing copper as well as silver. These articles are coloured in the ordinary way, with the same result obtained with our regular gold. I believe it is done with as great a certainty as electro gilding or plating. But I think they must have some process by which they can use any kind of moulds. I should like to know if, in dissolving gold (which contains copper and silver) whether the copper and silver is acted upon by the acid and cyanide in the same way as the gold is. If it is, dissolving the gold in nitro-muriatic acid would be easier and quicker. If there is any more information you can furnish me with I should be glad. I have a good practical knowledge of gilding and plating, but have experienced some little difficulty in obtaining a thick and regular deposit, on account of solution varying in temperature, evaporating, &c. Perhaps a little light upon these points will help me.—R. N. C.

[33288.]—**Grammar.**—By absence of inflection, "Read and Mark" means, I suppose, the omission of the s in the 3rd pers. sing. pres. indic. ; but, then, "dare" is as often written "dares." Perhaps, as in the verb "to dare," there were once used two forms—with and without the final s. The forms, "wotteth, wotting," are quite correct, only obsolete. The form "wots" I have never seen before.—Ram Chand Biswas.

[33352.]—**Gas Meter.**—The index must be run forward to 0—not backward. Is it a dry or wet *meter?—Ruby.*

[33354.]—**Salt Pan.**—"Urra" should visit some salt-works where they evaporate sea water. St. Malo, for instance. and different parts of the Mediterranean coast.—Rebor.

[33355.] — **Injector.** — What size injector is wanted? If so small that it can't be bought, better apply to the model makers, unless smaller than they make.—Essar.

[33365.]—**Transparent Polish for Walnut.**—Does "Beaumont" want a polish or a varnish? If a polish, proceed in just the same way as French polishing, using best pale polish.—T. J. L.

[33375.]—**Wild Flowers.**—Try drying them in warm sand. The process was described in a back volume. I will find the reference if querist has not the numbers.—S. M.

[33390.] — **Decolouring Shellac.** — I doubt whether you can remove the colour from an alkaline solution ; however, you can but try. Add some fine bone dust, and stand in the sun for a day or two. Sugar is decoloured by passing it through animal charcoal while hot and liquid. but I suspect it would not answer for shellac.—S. M.

[33408.] — **Albumen.** — Fresh liquid blood is whipped with twigs to separate the serum. At many of the public slaughtering places, instead of sending the blood to the albumen-makers, the serum is separated, from the clot, and sent in casks. Blood, however, is generally sent in shallow iron vessels, and immediately it is received at the factory is carefully sliced, and the slices arranged upon iron strainers, with a pan beneath to receive the serum, which flows out as the clot dries and contracts. According to the weather this operation lasts from 12 to 24 hours, but coolness is essential, as is also freedom from vibration. The serum is transferred to settling tanks, and when clear is put into shallow iron trays in a chamber steam-heated to 120° F. When quite dry and brittle it is packed. For details you must go to the works.—Essar.

[33462.]—**Harmony.**—My best thanks to the correspondents who have answered the above. Does C. J. Leaper mean Stainer's "Harmony," founded on the tempered scale? If so I think it too difficult. —Poor Musician.

[33491.]—**Spirit used by Glove Cleaners.**—"Dandie Dinmont" informs "Delta" that it is common petroleum spirit, which is right. He also says benzine collas and such-like preparations are the same thing. This is not the case. Benzol or benzine, when first prepared, was obtained from a mixture of benzoic acid and lime, but is now chiefly obtained from coal tar. Wholly different from benzol is benzoline—the first or most volatile product of the distillation of petroleum. It is a mixture of various hydrocarbons of different boiling points and specific gravities, containing, among others, the hydrides of butyl, amyl, and capryl. It has a petroleum-like odour, quite different from that of benzole, and when shaken with an equal volume of alcohol of 90 per cent. it separates, whereas benzol treated in the same manner yields a perfectly clear and uniform mixture. Owing to its considerably smaller percentage of carbon, it burns with a much less smoky flame than benzol. 1lb. of good benzol costs about as much as 1 gallon of benzoline. I have shown there is a difference ; but for cleaning gloves it matters not which is used. In some operations, however, the substitution of one for the other would mean failure ; hence my remarks.—Roy.

[33494.]—**Cliffs.**—Having been away in N. Wales has prevented my corresponding to our pages for some weeks, and consequently I am now behindhand. This query, I find, has been answered so satisfactorily as to leave no room for any addition, with the exception that perhaps I may add there are occasions when, from such an elevation, you would see more than 34 miles, and that is on a hot summer's day, when the air is saturated with moisture ; then the distance to horizon would be increased owing to greater refraction.—W. J. Lancaster.

[33504.]—**Honey Dew.**—Can it be that honey dew is caused only by insects? I saw it come against the window when there was no appearance of an insect. The white specks on larch are very sticky, and, when crushed, yield a dirty brown colour—not pink.—Chas. Robinson.

[33506.]—**Mineralogy—Wanellite.** — Wanellite is, I believe, rather rare. It is usually either of a greenish or yellowish grey colour. I have several specimens out of clay slate, mostly small crystals, and I find it to be essentially a phosphate of alumina. I cannot, however, give you any particulars as to the colour it would give as to clays. I should, however, from the specimens I possess, say, that it would be useless as a colouring agent. It is sometimes found in granite, but all I have came out of clay slate.—W. J. Lancaster.

[33509.]—**Photographic.**—The method I gave you is all you require. The impression of the fronds will be white on a black ground. Of course, the colour of the background will depend upon the length of exposure and the amount of toning. If you do not succeed let me know, and I will help you.—W. J. Lancaster.

[33512.]—**Magnetic Engine.**—Just the information I would like to receive. Really, this is too bad. You cannot obtain the power you wish unless at the expenditure of a greater power, and you could turn the handle of the magneto-electric machine for ever without making the engine move an inch. No, you are on the wrong track this time. Write another query, giving full particulars of what you wish to accomplish, and I will endeavour to help you.—W. J. Lancaster.

[33518.]—**Pancratic Eyepiece.**—There is not any easy method of calculating the power of a pancratic eyepiece on a given lens, but you can obtain the relative diameters of the object lens, and small disc of light seen on front lens of eyepiece, then divide diameter of o.-g. by diameter of spot of light. This will give you the power of the eyepiece. You can measure the diameter of spot of light either with a dynamometer, or, with care, you may use a pair of compasses. Take care to focus an image first, then point the telescope upwards and measure. These remarks apply to the astronomical eyepieces as well as pancratic eyepiece.—W. J. Lancaster.

[33528.]—**Telescope.**—A non-achromatic telescope will show you Jupiter's moons, and Saturn's ring ; but I would advise you to make up an achromatic telescope. The time and trouble of making the two would be about the same, and the result would be so much better with the achromatic-glass. You need not spend more than 10s. for an achromatic lens, say 1½in. diameter, and sufficient lens to make an astro-eyepiece giving a power of 60. This would enable you to do good work. Such a lens would require a tube 1½in. diameter and 20in. long. Having been trued at both ends in the lathe, then have a cell at one end to take the lens, and at the other end a casting, to be turned down to take a tube containing astro-eyepiece. The eyepiece would consist of two best plano-convex lenses, ¼in. and ⅜in. focus, mounted ⅜in. apart, with a diaphragm same diameter as eye lens. Midway between the two lenses a small hole, ¼ diameter of the eye lens, should be placed just in front of eye lens, and as nearly central as you can get it.—W. J. Lancaster.

[33530.]—**Telephone and Æolian Harp.**—Have two telephones coupled, one near harp, the other as receiver in some distant room. Fasten the transmitter to base of harp, and you will hear every sound easily—in fact, I know no experiment so beautiful with the telephone as such a one as this. Last year I repeatedly attached one telephone to the harp in a distant room, and could hear distinctly the tones of every string, and such would be the case with the Æolian harp.—W. J. Lancaster.

[33533.]—**London University Examination.**—You will find all the information you require in the *Calendar* of the University. Write to the Registrar of the University for a copy, and he will send you one. Be careful to ask for "Regulations for Matriculation." You can have at the same time "Key for Degrees in Science and in Arts" if you require them.—W. J. Lancaster.

[33541.]—**Worm-Eaten Harmonium Case.**—I strongly recommend a saturated solution of the common commercial carbolic acid. Turn the worm-eaten part upwards, and, by means of a pipette, or a photographer's dropping bottle, put a single drop into each worm hole, and let the wood remain in the same position for 24 hours, when any worm-hole that may have been missed will become apparent, then drop again.—East Anglian.

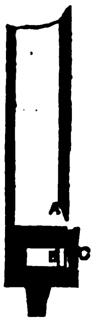
[33553.]—**Astronomical Books.**—Herschel "On the Telescope" is or was published by Black ; if he has not a copy, probably Spon, Sotheran, or Batsford may have a second-hand one. Coddington's "Optics" is an old work ; I should think a modern treatise would be far preferable.—Orderic Vital.

[33554.]—**Battery Power.**—To Mr. W. J. Lancaster.—You cannot send a current through one wire in a lot without sensibly affecting all the other wires ; hence I am afraid you are going wrong. Can you explain more fully what you want to obtain? Then, I think, we may go to work at once to remove doubts, &c. At present I must tell you that no current would be so selective as you wish it to be, and, if you require a limited attraction, you must limit the number of wires on both sides. Some of the batteries you mention as being lately advertised are good, and a lot of them bad. Let me know the work you want the battery to do, and I will tell you the best battery for you to have.—W. J. Lancaster.

[33556.]—**Chemistry.**—A very good book to commence with is "Elementary Inorganic Chemistry," by R. Meldola, published by Murby, London. This will give you a good start. and when you have gone well through it you could read Roscoe's, following with Galloway's "Second Step," and then Miller's "Elements." A course of practical chemistry would then be useful to you, and would make your knowledge more practical.—W. J. Lancaster.

[33557.]—**Geological.**—Collect any fossils that you may come across, and label them with the locality where found, and, as far as your abilities will allow, name the rock in which found. Then get Page's "Elementary Textbook of Geology," read it through, and make as many notes as you can. See if you can obtain names of the fossils you possess. Name those you find illustrated, and arrange them in order of succession. Then get Lyell's small work on "Geology" (about 9s.). Afterwards obtain Lyell's "Elements," and any other good geological work ; but, mark, you will not be a geologist in a day or a year—scarcely in a lifetime. —W. J. Lancaster.

[33560.]—**Lieblich Gedact Pedal Pipe.**—The scale will do perfectly well for a manual, always being reduced to half size on the eleventh ; or, what me thing, each C is ¾ the C below it. Cut e boards the internal depth of the pipe, and to the sides of the block; now cut the back nt boards the external width, and glue on Prepare front by cutting the lip, bevelling it



nside (A); glue on, keeping the lower side outh exactly level with the top of the block. out the part that covers the throat of the aking it even with the throat all round (B). means the block is virtually made level with nt of the pipe. Finally make cap (C) as nd fix it on a trifle below the block, as is most wooden pipes. As you will doubtless the front board is cut the whole length of .—DIAPASON.

]—**Rash.**—From your query I should ima- ur friend suffers from "chronic eczema." ave had occasionally for some years, and d the best of advice, but apparently of no s the rash seems, under medical treatment, in just as it was. I have, however, obtained able relief from taking "Clarke's blood ," and, although I never care to recommend medicines, yet this one appears to merit a endation. Try it.—W. J. LANCASTER.

]—**Microphone.**—It would, and to this t is due. Any simple couple will behave moistened.—W. J. LANCASTER.

]—**Ancient Literature.**—I thank those en who have so kindly replied to my query, being able to procure any of the papers men- nay I ask them if they know of a work ontains the required inscriptions, and, if one which would give information as to the of decipherment.—ERNST SPRAGUE, Lynn.

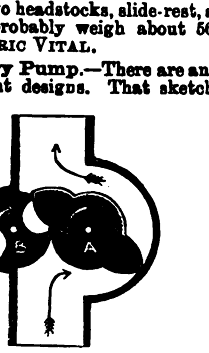
1.] — **Communication between Two** —Carry a speaking tube through the cellars, nto each shop. By all means use a tube. hone will be troublesome, and much less , in your case.—W. J. LANCASTER.

]—**The Comet.**—The stranger has not yet ed it wise to show itself here. Still, as the are first in so much, I guess we may see et by-and-by. I am, however, surprised one seems yet to have noticed it here, more ly as the American papers have an account W. J. LANCASTER.

]—**North Pole of a Magnet.**—According om, we must call the real south pole of a its north, for, as it points to the north, it e absurd to dub it south. The point has no on the telephone, for it does not matter ay the current goes—in fact, sometimes the is travelling both ways at the same instant. LANCASTER.

]—**Lathe Castings.**—If H. Allingham can s own patterns, any of the firms advertising s" will make his castings at about 1½d. per rsued this plan, and have every reason to ied with my lathe. By making your own , you can adapt them to suit your require- It is not always convenient for an amateur p the forms used in machine shops. The for the two headstocks, slide-rest, and hand- cet will probably weigh about 56lb. for a e.—ORDERIC VITAL.

]—**Rotary Pump.**—There are an immense of different designs. That sketched here-



ne of the simplest, and perhaps most effec- is known as Eurard's or Greindl's.—JAN.

]—**Lathe Crank.**—Coupling two cranks same treadle cannot give any increase of is asserted by "Jack of all Trades." (Can he original "Jack" revived?) The only e gained by using two cranks in this manner ere is less strain upon the treadle (if the bed is a long one) when the operator is standing er end of it.—A., Liverpool.

[33594.]—**Lathe Crank.**—If the cranks were placed opposite each other the advantage would be that one would be in a position for work, while the other is not.—J. E. FLOYD.

[33594.]—**Lathe Crank.**—At present the two of you are only able to use your feet during half of each revolution, the momentum stored in the fly-wheel during such half carrying it through the remaining half; but if you use a double-throw crank, with the cranks opposite each other, one or the other of you will be exerting a positive action during almost the whole of each revolution, whereby the treading will be somewhat easier and more even, and you will be able to drive the lathe at a much slower speed without its stopping.—JAN.

[33595.]—**Leyden Jars.**—It is most likely the glass is not suitable, or the foil could not but be good for the purpose, if it is tin at all. I think the best form of jar is one without a cover. The ball is supported on a central wire, bent into a ring at the bottom so as to stand inside the jar. Do not carry the tinfoil too high, and cover the exposed glass, and about ¼in. of the foil, with shellac or sealing-wax varnish. See that the jar is well dried and dusted before used.—J. E. FLOYD.

[33595.] — **Leyden Jars.** — "John-o'-Groat's" jars are covered too high up the neck with tinfoil, or the glass is bad. At least 2½in. should be left uncovered below the neck, and this part should be well wiped clean and dry before using. The glass should not be too thin, and must be without a crack; green or coloured glass will not do. I believe flint is the best.—HESPER.

[33596.]—**Powdered Wood Charcoal.** — You had better throw the entire mass into water at or about the boiling point; then stir freely, and allow the heavier particles to subside. By weighing the residue the amount of admixture, possessed of a density greater than water, will at once be apparent. There may still exist other matters, however, ranging in specific gravity between that of charcoal and water; and these must be searched for independently at a subsequent stage, if necessary. The primary estimate of the specific gravity of the suspected material would suffice to detect adulteration; but I understand W. Foster's real object to be that of removing the questionable products. In a critical case I should examine chemically for mineral matters.—DOUGLAS SCOFFERN.

[33600.]—**Expansion.**—Provided "Steam's" engine is worked by an ordinary slide valve, he can make it work expansively by giving some lap to the slide valve, and (probably) angular advance to the eccentric. It will be necessary to have a new slide valve, and perhaps it will be impossible to expand for so much as ¾ of the stroke; but if "Steam" will send size of steam and exhaust ports, and spaces between them, amount of travel of slide valve, and stroke and diameter of piston, I will let him know proportions of a valve to comply as nearly as possible with his wishes.—JAN.

[33603.]—**Straight Toes.**—Were I so affected I should, each night and morning, gently rub in a liniment, made up of equal parts of tincture of iodine and olive oil, with a piece of flannel or sponge, taking at the same time internally about 4grs. of iodide of potassium, dissolved in water. You might in a fortnight's time rest for a week, and then renew the attack upon the unruly members, continuing such a course for several months. The question that occurs to me is, have you ever had acute rheumatism?—DOUGLAS SCOFFERN.

[33604.]—**Theta Delphini.**—In No. 649 of the ENGLISH MECHANIC (query 30481) I drew attention to the magnitude of this star, and in No. 651 Mr. W. S. Franks confirms my observations of it, but does not attempt to "account for its invisibility;" indeed, we both seem to have seen it, and estimated it about 6th magnitude. The "B. A. C." gives it, I believe, of 4½ magnitude. Although that catalogue is by no means a good authority on star magnitudes, such a large discrepancy is curious.—MAC.

[33609.]—**Perspiration.**—Bathe the surface of the body frequently with tepid water containing about a quarter of a pint of vinegar to the gallon, and wear flannel (frequently changed) next the skin. Do not smoke immoderately, and by no means seek to *check* the effect; such a course might involve serious bodily disturbance. Also take, now and again, a large tablespoonful of castor oil poured into a cup holding a little strong black coffee, and then carefully augmented with a further addition of coffee. In this way you will find the drug go down almost like a greased oyster—and with scarcely more taste.—DOUGLAS SCOFFERN, St. John's Wood.

[33611.]—**Chemical Food.**—I think you could obtain the formula from the latest edition of the "British Pharmacopœia." The preparation is that of the "Syr. Ferri Phos. Co." (in "*dog Latin*" terminology)—that is, the "compound syrup of iron." It is very easily decomposed, and should be given either alone or merely with the addition of distilled water. The dose for an adult is about a large teaspoonful thrice daily, *after meals*, as with every preparation of iron. I shall be pleased to obtain the formula for you if you would like me to ascertain, and will advertise your address.—DOUGLAS SCOFFERN, St. John's Wood.

[33613.]—**Tea.**—Do you possess steam at a temperature not lower than 212 Fahr. *ad lib.?* If so, the problem is simple, for, if you pass a current of it into any vessel containing water and the undigested tea, the liquid will quickly be raised to the boiling point, and in this way fully exhaust the leaves.—DOUGLAS SCOFFERN.

[33615.]—**Disease in Fowls.**—The effects are probably due to an overloaded "crop," as with rugged bits of stone or nails. I shall be pleased shortly to contribute a short paper relative to this subject, and one dealing, moreover, with a novel system of wholesale poisoning of fowls which I undoubtedly detected last year while acting as chemical assistant to the public analyst for Paddington.—DOUGLAS SCOFFERN, St. John's Wood.

[33621.]—**Wheel Gearing.**—Any of the following books would suit "Country Subscriber":—"Elements of Mechanism" (Goodeve), "Machine Design" (Unwin), 3s. 6d. each; or "Machine Construction" (Tomkins), 2 vols. (one of text, one plates), 2s. 6d. each. Also "Principles of Mechanism," by Willis—the first scientific treatise on gearing.—JAN.

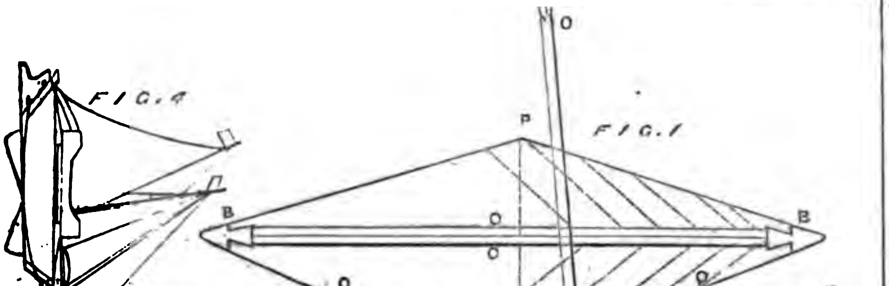
[33625.]—**Boat Building.**—"W. A. R." proposes to begin his work at the wrong end. Make the bottom first, fix the stem and stern post, then work the sides round, nailing them to the edge of the bottom. The bottom should be of inch fir, with ledges 3in. by 1in. nailed across inside. The joints of the bottom may be either tongued and grooved, rebated, or put together square with a batten over the seam inside. The latter is easiest for one not experienced in carpentry, and is more likely to prove watertight if both batten and joint are painted with thick white paint, and a strip of brown paper placed under the batten. When the bottom is made and cut to shape, work a strip of 3in. by 1in. fir all round the edge between the ledges; this will thicken the bottom up and give better fastening for the sides: these should be of half-inch stuff, and if divided into 3 or 4 strakes will require timbers to stiffen them; these can be of ash or oak. Work a grown knee 8 or 9 inches up the stem and stern post and 15 inches along the bottom, and smaller knees along the sides. The centre-board case should be fixed at the centre of the length, and the best form of centre-board is one hung at the lower fore corner on a bolt which passes through the case, the after end being raised and lowered by a line, chain, or rod. This form, it will be readily seen, will jump up into the case if it strikes the ground when sailing. A punt of this description will go very well to windward with the centre-board down. The beam should be quite 4ft. for sailing—6in. more would be better. Fasten top of centre-board case to one of the thwarts to stay it and prevent working and consequent leakage. If you cannot be sure of watertight joints, serve all like the joints of the bottom with paint and brown paper: it will save considerable annoyance afterwards.—A. B. H.

[33625.]—**Boat Building.**—The following sketch perhaps may suit "W. A. R."—it answered all I wanted. I have made two of them, and built them without mould or templates. Draught, with 11 or 12 stone on board, about 6 or 7 inches, carrying between 60 and 70 square feet of sail, 14ft. long, 3ft. 6in. wide, 18in. deep, 22in. deep from top of combing of hatch, stem and stern, both alike. A A consist of two pieces of 3in. elm plank, 2ft. 3in. × 9in. section, shown at B B, strokes, L L, two boards good tough spruce, 16ft. × 9in. × ½in. M A strake to cover joint, 16ft. × 3 × ½in. the two large boards being put together, but with tie pieces inside, 1, 2, 3, 4, 5. The keel consists of a piece of spruce 13ft. 4in. × 1½, carried right through and spiked upon A A at D D. The deck and bottom are supported and fixed to fillets 1½in. × ¾in., that run all around R R R R, and along the sides of keel and gunwale, S S. These are chamfered on their inside edge, those in the bottom to form a level with bottom keel inside for the gratings to rest upon, and the three centre tie pieces and rail are screwed on to carry the thwarts or seats. E E is the combing of hatch; centre from deck 2½in. high, cut away from back as shown, the back being 6 or 7in. high. I I is a rail 2in. × 1in., and 3ft. long, of oak or rock elm, live ash well supported upon blocks of deal, elm, or oak, 1½in. clear off deck and free of gunwale combing. About 1in. through the centre of this is a hole for the brass rowlocks, K K, the ends about ¾in. diam. My idea for this rail was this: I had an idea that my punt would float when filled with water, and being particularly fond of water, but no swimmer, that if I should meet with a spill—for I am very venturesome—I should have something to hold on by or make myself fast to. Twice this stood me in good stead in deep water, for once out with a friend it was blowing very hard. I was sitting in the steerage; all sails set. The motion of the craft did not suit my friend, and he insisted upon the sails being taken in and pulling in. I objected. My friend made no more to do but jumped up, taking the sheets out of my hands, although I begged of him to sit still, he not knowing one sheet from the other or how to work them. He got confused, turned round, and preceeded to claw the sails down with his hands, as if he had so much paper to deal with. In doing this, he lost his equilibrium; standing upright he made a clutch for and caught the mast—the consequence was over we went, about a mile or more from shore. He was a good swimmer, and struck out for shore. I went down a little way, but could not go far, for I had always a painter fast to my waist, and to this rail, with some three or four yards of slack, I came up, turned over on my back as if for floating, unshipped the mast and allowed it to drift; took a hitch or two with the line from my waist and kicked out manfully on my back under the boat. My friend, after getting some distance off, shouted out, "Strike out, man; let the boat go, or you will get drowned." I replied, "I cannot swim a stroke, and I and the punt go together for good or bad—good bye." He begged of me to leave it, but with kicking and keeping a good look out I managed to land as soon as and within 20 yards of him. I put to sea again, as I and my friend had to find our home 2 miles distant. My friend preferred walking, I riding. These rails I have found useful when out "trotting," or dab fishing, shooting, &c. When out dab fishing I was capsized by the thoughtlessness of a friend in jumping up all of a sudden and losing his balance in taking in the trout and dab nets. He swam, and I went through the above performance, only we had no sails. When out shooting I have found it useful for shifting my position without moving from the bottom of punt or showing my head by making fast by a long line from land, where you could not anchor well, the rise and fall of tide and currents being awkward. The rig was spritsail, as shown in Fig. 4, with jib and foresail, but I think a stunsail more easily managed. Do not build it sharp as at P P, but over a piece of board put in across the centre and a good sweep, as at Q Q. Instead of putting solid keel put two boards as shown at C C, and block off for space for your bottom boards, and allow them to come through as at Fig. 4. My boat had neither bottom boards nor lee boards, but from the rail at sides I have hung out ballast in the shape of a bag of sand when sailing. The step for the mast was through the front of forward thwart and down to keel, H H. The bottom was boarded diagonally, as shown at dotted line, from keel to stricks or bilge pieces, the rudder shipped in pintle and brace with yoke. The sculls were made of pine 7ft. 4½in. × 3in., making two cuts down from ⅛ one side to ⅛ on the opposite side. On the 3in. there is a shoe consisting of a piece of wood 1¼in. thick, screwed upon front for forward combing for shoe for sprite, N, and pillar rod with strip forward. I used the punt some years for collecting starfish and seaweed for manure for my garden, and lent it out for shooting and eeling, and it has been out for a pleasure trip with four on board. It was put together principally with screws; holes bored and some paraffin oil and Stockholm tar dropped into the holes. All joints payed with the same, and old shirting saturated with the same put into the joints. After it was finished I gave it a good dressing outside and in, except the seats, combing, mast, and sculls, with 1 gallon gas tar, 1 pint boiled oil, 1 pint paraffin, and 1 quart of turps. Build where it will be thoroughly dry, and go over it with the above as evenly and as finely as you can, allowing it te dry every time for a day or two—give five or six coats. Paint the other part to suit yourself. In one side at the bow I bored a hole and put a cork in it. This was for emptying out the water which leaked in or was shipped. Mine never leaked, and after having it some years I parted with it for more than the stuff cost me. I made inquiries into the cost of such a thing, wanting one, and was asked about £12 or £14. The material altogether stood me in about £1; it was built in my bedroom, and my neighbours knew nothing about it until I took out the window and launched it out over the roof of the washhouse and into my yard one night between 9 and 10 o'clock, pitch dark, not a light to be seen, until the neighbours were frightened to death very nearly, and came out to see what was the matter. I was very much amused to hear their various conjectures as to what it was that made such a noise. In the morning, to their astonishment, there was a good-sized punt in my yard ready for sea, and they *christened it "Jack's Coffin."*—JACK OF ALL TRADES.

[33628.]—**Diving.**—I suppose the diving in this case means taking headers. Diving, in the strict sense of the word, means bringing up substances from the bottom, the eyes being open. The hands should be just behind the ears, the chin touching the chest, and the fingers touching above the head, the legs straight out, the knees and ankles touching. There are not two people out of thirty that take headers that fulfil all these. Most keep the head high, and the arms low; many bend the legs at the hip joint, and more at the knee. When a person keeps his hands low the head receives, as it enters the water, a bang, because the arms are not there to break the surface. The hands are not there to get the required position, but to save the head. "Law Student" would find few if any persons who would take a header from a greater height than 100ft.; and none without their hands above their head. "Amphibian" is quite right when he says that the turning of the hands brings the head up.—B. SNOOKS.

[33628.]—**Diving.**—If "Law Student" is able to swim let him try diving from a height of, say, only 6ft., and allow his head to strike the water first, when, I think, he will be convinced that the protection of the head by the hands is a consideration. In diving the palms of the hands are used to steer with, so that a man may dive from a height of 30ft. without going more than 5ft. under water. There is, besides, the advantage offered by the hands reaching the bottom, or any object in the water, first, and thus also protecting the head.—NOVUS HOMO.

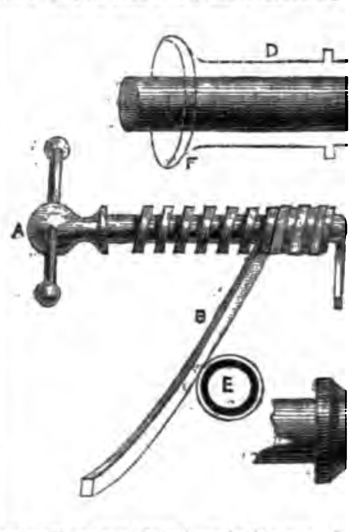
[33628.]—**Diving.**—I am obliged to "Amphibian" and "Gimcrack" for their replies to my query. "Gimcrack," however, hints darkly that irretrievable damage would ensue from not placing the hands before the head in taking a header, and proceeds to give an instance where a dive (not a header) was taken from a height of 100ft. without injury, and the hands did not enter the water first. I do not see how these two things are reconcilable. What I want to know is this—would the impact of the water damage the skull if a header of any height were taken without the hands being placed in front of the head—*i.e.*, do the hands make a hole for the head to enter? As I said in my original query, I incline to the opinion that the other reasons are those which cause the position in question to be almost invariably assumed; and I may add one more—viz., the hands are thereby ready to strike out the moment the diver is in the water.—LAW STUDENT.



[33639.]—**Spectacles.**—If "Optic" desires to retain the use of his eyes he must give them absolute rest until they have recovered their normal strength. The best and simplest cure would be to sit in a darkened room for several weeks, and wash the eyes frequently with cold clean water. All ought to do this every morning, whether the eyes are weak or not. To do it properly dip the face into the wash-hand basin, with the eyes closed, and open them under water—of course, close them before lifting the face out of the basin. The eyes soon grow accustomed. There must be no soap in the water. If "Optic" cannot leave his work he must spare his eyes all possible avoidable labour, and should try to obtain some temporary employment that does not require constant use of the eyes. After business hours give the eyes an absolute rest; neither read nor write, and on no account wear spectacles, except, if necessary, tinted glasses, made of ordinary glass tinted neutral tint, blue or green. The most advantageous manner of spending the evenings is to go into the country where there is plenty of green—a colour pleasant to the eyes—and to keep the eyes steadily fixed on the grass and shrubs. On returning home avoid gas. Either go straight to bed or remain in a dark room. Should the eyes be very weak then go into a dark room imme
finishing business, and remain there til
T. S.

[33640.]—**Cabbages.**—Since rea
Rymes's" communication on "Club
Brassicæ" I have examined a number o
find that those which do not form head
of all shapes and sizes at the roots (wh
be said "clubbing" alluded to by hi
these lumps cut up firm, somewhat li
whilst other are in a rotten state, but I
any grubs, as mentioned by "G. J.
mention that a gardener tells me that t
dig in plenty of fresh lime and salt at
of season.—A., Liverpool.

[33653.]—**Repairing a Vice.**—To
quirer" over the difficulty of obtaining
vice without the lathe, let him look at
sketch, in which A represents the screw
which a strip of iron, B (cross section,
wound. This strip constitutes the fut
the nut. File way the superfluous iro
about 1-16in. projecting all round. N
previously prepared tube over the scr
represents a cross section of the same i
Drive on the cap, F. All parts of cont
be clean, and no grease must be suffered
Screw out the screw, and the nut is ready
To braze the same you must have a pret
Get some clean brass filings and some po
wet the inside of the nut with water, a
filings and flux inside. Don't be spari
moisture looks rather more than it actua
fused. Do the same outside, where the
driven on; then inclose the whole in pipe
round with iron wire to keep it together,
the fire. When the pipeclay begins to g
turn the whole round in all directions for
10min.; keep on turning until quite co
rest. If you break now the surrounding



nut will appear almost ready for use. A
ness inside the threads can easily be rem
serting a steel cutter in a hole drilled on
the screw, and protecting the end of the
you screw on it will bite its own way.—P.

[33653.]—**Repairing a Vice.**—I don't s
can use your slide-rest to cut a screw, u
be connected to the mandrel of the lathe.
for vice screw is not chased up in a lathe,
the square-threaded screw is finished
sized piece of wrought-iron gas-pipe is use
is added the collar and end piece. This
loose fit on the screw. Next a piece of iro
so as to fit into the thread of the scr
slightly project above its surface, so as wh
that it will fit into the aforesaid piece of t
or three turns of thread being sufficient).
being filed upright inside previously, some
spelter is dropped in, and it is brazed o
charcoal fire.—A., Liverpool.

[33654.]—**Pressure.**—The difference i
at the dome and at the bottom of the fire
due to the weight of water, and is but tr
gauge were attached 6ft. below the sur
water it would indicate about 2·5lb. per
more than one attached at the surfa
HOMO.

[33654.]—**Pressure.**—The pressure is,
greatest at the bottom, on account of th
the water upon it, while the dome o
the pressure of the steam. The differenc
at the points named depends upon the d
water.—J. E. FLOYD.

[33656.]—**Rowing.**—In the first place
should be careful not to drink more th
lutely requires. His food should cons
slightly underdone, with plenty of reg
dry bread. It is also necessary that he
his meals, and his exercise, and his sleep
possible at regular hours. Secondly, as
he should not allow himself more than
should rise at the same time every m
should take a brisk walk or run before

l not expose himself to the sun more than ry ; and I myself, when in training for a lly use my legs at all except in the neces- cise for the race.—Hawks.

—**Size and Weight of Anchor.**—The would be the proper measurements and or an anchor and chain suitable to Z.'s" boat :—Anchor : Shank, 2ft. long ; reen flukes, 18in. Weight, 14lb., and a ¼in. le of good length, say, 15 or 20 fathoms.— glian.

—**Potted Meats.**—These tins are placed l) in a shallow bath of water, and this heated. The air in the contents of the great part of it, is thereby expelled (by its , and rising to the surface). This pre- ie contents from decomposition. Besides air in the empty (so called) part of the tin l. Whilst the tins are in the bath a drop is put on a small hole in the top of the tin s been left for the purpose, the top having ered on before the tin is put into the bath. e tin is removed from the bath, and gets air inside contracts, and when the tin is ir rushes in to supply the lack inside, until iside is of the same pressure as the outside w Student.

] — **Cheshire Lines Railway.** — The lines comprise the lines from Liverpool to ter and Glazebrook to Stockport, which are the three companys—viz., G. N., M. S. L., land. The Cheshire lines are not completed e being in course of construction the Wigan Glazebrook, the Widnes extension, and a ie north end of Liverpool. A line to Bolton, to be made from Manchester, was nipped in by a committee of the House of Commons. have been obtained for a line from Knutsford lesfield, but I do not know what progress is ade with it. "Passenger" will see that plenty of unproductive capital which is a able burden on the Cheshire lines. The I. and S. C., at Marple, mean Midland and Committee, whose dominions comprise the m Manchester to New Mills (both old and ites) and Marple to Stockport. I am not any new north route for Midland expresses. do not now call at Trent, as separate trains Nottingham to Derby, reaching in advance north expresses. The following trains ex lo not stop at Trent :—8 10 a.m., 2.49 p.m., The following ex Leicester do not stop : ., 5.56 p.m., 11.22 p.m. All ordinary Midland op at Derby. What does "Passenger" mean ig that "also some run direct through ' They never ran any other way. The g is the booked running of the 8 p.m. St. to Edinburgh :—

	Arr. p.m.	Dep. p.m.	Dis.	Speed.
rras...		8.0		
.	9.5	9.8	47½	43·84
r	10.13	10.18	99¾	48
	10.46	10.49	120	43·21
l	11.40	11.46	157½	43·82
	a.m.	a.m.		
iton	12.23	12.33	187¾	40·05
	1.28	1.35	223¾	38·5
	3.30	3.37	310½	45·52
gh	5.57		406	40·82

speed, London to Edinburgh, 40·08 miles r ; average speed, deducting 43m. for stop- ncluding Shipley, 43·98 miles per hour. I understand why this train should stop so stations, and then run at high speeds to ie time up, as between Skipton and Carlisle, l and Normanton, &c. Perhaps "C. E. S." xplain it, and also say what is the average The letters M., B., and M. referred to by nger" means Macclesfield, Bollington, and —L. L.

6.]—**Mining.**—The 25ft. from bottom of e the seam will form the sine of a right- triangle, and the distance to be driven will be ne. Now, if the sine of an angle of 30° be ed as unity, the cos. will = 1·732 ; ∴ 25 × 43·3 the distance to be driven. Another he hypothenuse of an angle of 30° = 2 sin. ; case the sin. = 25 ; ∴ hypot. = 50 ; then by , 47, $\sqrt{50^2 - 25^2} = 43{\cdot}3$.—J. Roscoe, Golden

3.]—**S. E. R. Locomotives.**—The engines n the mails on the S. E. R. are 7ft. single ; cylinders, 16 × 22 ; diameter of leading 4ft. 6in. ; diameter of trailing wheels, 3ft. 9in. -box has a heating surface of 132·31 sq. ft., arranged for burning coal. Heating surface s, 973·01 sq. ft. ; total heating surface, sq. ft. An experiment made with one of these , over 4,931 miles of running, gave a consump- Welsh coal of 21·34lb. a mile, with an average 13·06 carriages, weighing 142·3 tons, at an speed of 44·15 miles per hour. The tender 500 gallons of water, and is sufficient for from London to Dover. Other engines of ss are numbered—No. 2, built at Ashford 1865, and Nos. 43, 72, 81, 83, 85, 198, 199, l 204. No. 43 has run from London to ome in 85 minutes, including time taken in , stopping, and for signals, with 10 coaches. The mail trains seldom exceed the rate of 55 miles per hour on a level part of the line, with a load of 13 coaches.—G. L. P.

[33716.]—**Etching on Glass.**—The most simple way of etching on glass bottles is as follows :—Warm the bottle to be etched, and coat the part where the etching is to be done—with paraffin or wax—by rubbing it over the warm glass, which must be sufficiently hot to melt it, and get as even a coat as possible. Then let it get cold and quite set. The coating should extend well beyond the part to be etched. Next with a pointed knitting-needle write what is required, taking care to cut right through the coat of wax. Then procure a common leaden ink-pot, or, if not large enough, a piece of lead pipe, with a piece of lead hammered water-tight into one end so as to form a flat bottom, will do. Then cut the top such a shape that the bottle will lie upon it with the writing on the inside, and fit closely. The etching may be done in two ways. Either put a little fluor spar (powdered) into the pot, and pour on it some common oil of vitriol, or simply pour in a small quantity of common hydrofluoric acid. In either case now put the bottle on the top, and gently warm the contents of the pot, but take care not to melt the wax on the bottle. Fumes will arise, which will in some five or ten minutes etch the glass wherever it is unprotected by the wax. The bottle may then be removed, washed, and the wax melted and rubbed off. Fluor spar and vitriol are cheap enough, and perhaps best, as hydrofluoric acid is very dangerous stuff to get on the hands or nails, and requires to be kept in gutta-percha bottles which are expensive. The fumes which come off when the etching is going on must not be allowed to get about much, as they are very irritating. If care is taken, and with a little practice, very neat etching may be done in this way, though it is rather slow.—Lasye.

[33724.]—**Hens and Eggs.**—I cannot say how many eggs it is possible for one hen to lay, but I know they can lay every day without a grass run, as I have two that were hatched early in June of last year in the run they now occupy, which commenced to lay a day or two before Christmas, and have continued to do so up to the present time, missing only a day now and then ; sometimes, indeed, especially in the early part of the year, laying every day for weeks together, though they are beginning to slacken now, missing about twice a week. They are common fowls, having very much the appearance of Hamburgs. The run is at the bottom of a garden, in the north-east of London, is about 12ft. long, covered, with open wire front. I am inclined to regard this as somewhat of an exception, as, though nothing unusual for them to commence laying thus early, I had quite expected they would have stopped for a week or two, and then gone on again. They have soft food in the morning and mixed corn in the evening, with what greenmeat comes to hand. I have had other fowls lay every day, but not for so long a time.—C. Lark.

[33728.] — **Thunder and Lightning.**—For the purpose of calculating approximately the distance in a direct line from the observer, of a flash of lightning, the time that light takes to traverse a given space may be disregarded. Sound travels at about the rate of 1,142ft. in a second, and the number of seconds elapsing between the flash being seen and the thunder being heard, multiplied by 1,142 will, therefore, give in feet the distance of the flash from the observer. Another method is to count the pulsations of the wrist pulse between the flash and the thunder, and as in the interval between two pulsations sound travels about one-sixth of a mile, it follows that the number of pulsations divided by six will give the distance in miles of the flash from the observer.—Law Student.

[33729.] — **Naviget Anticyram.** — Anticyra, a town of ancient Thessaly, was said to produce the genuine hellebore, so much recommended by ancient physicians for the cure of insanity. Hence, the saying of the ancients, "Naviget Anticyram" (perhaps "Let him go to Anticyra"), alluding to this hellebore. The saying was applied to a person regarded as insane. I have got the above information—except the attempted translation between parentheses, for which I take all the blame—from Lemprière's "Classical Dictionary."—Law Student.

[33729.] — **Naviget Anticyram.** — There were three towns of this name—one in Phocis, on the Corinthian Gulf, now Aspra Spitia ; one a town of Locris ; the third a town of Thessaly. All these were famous for the hellebore, which was produced and prepared in them, which plant was reputed to cure diseases, and insanity in particular ; hence the proverb quoted.—Ernest Sprague, Lynn.

[33731.]—**Barometer as a Weather Guide.**—Read the chapter on this subject in "Scientific Dialogues," a book than which, though it is rather old-fashioned, I know no better for teaching the elements of natural philosophy. The words "fair," "change," &c., at the side of a barometer are merely to show what weather has by experience been proved to most usually accompany a particular weight of the atmosphere. The barometer is but a weight measurer, as its name indicates.—Law Student.

[33731.] — **The Barometer as a Weather Guide.**—A satisfactory reply to this query would occupy a great deal of space. May I recommend your correspondent to get "The Coast or Fishery Barometer Manual," compiled under the direction of the meteorological committee of the Royal Society. It only costs 6d., and is a most complete little work. To be had from Mr. Stanford, 55, Charing-cross, or Mr. Potter, 31, Poultry.—X.

[33732.]—**A or An.**—The question raised by "Etymologos" is one which can only be decided by an appeal to the ear. Euphony demands the employment of a instead of an before the long u and before all combinations of letters having that sound—thus, we say a unit, a university, a ewer, a yew-tree. In the case of the last-mentioned word the use of an might lead to an equivoque, as we might understand a new tree instead of a yew tree. On the other hand, before the short u an is used, as an uncle, an undertaking. One, being pronounced as if written won, is an exceptional word, and we ought undoubtedly to say a one. Before words commencing with a silent h an is, of course, always used, as an hour, an honour, but I should like to ask "Etymologos" whether he would say a hotel or an hotel, a hospital or an hospital.—A. E. S.

[33732.]—**A or An.**—A is correct in all the cases mentioned, for the sake of euphony. An, originally meaning one, was formerly used, being derived from the Latin *unus*, one, through the French *un*. Some writers and speakers continue to use the old form, an, in such cases ; but it cannot be considered correct at the present time. Who ever heard of "an one-pound note ?" It should be, "a one-pound note," the reason being that the o is pronounced as if preceded by the consonant w. A university is correct, because u long is pronounced as if it followed the consonant y in you.—N. J.

[33732.]—**A or An.**—"In older English, an is used before h aspirated, as, an host (Ps. xxvii., 3), and before u (yu), as, an unicorn (Ps. xcii , 10). An becomes a before consonants, including w and y ; also before h aspirated, and (usually) before u (eu) when sounded yu. Thus : An eagle, an hour, an umpire ; but, a man, a woman, a yew tree, a history, a unicorn, a European." These are extracts from Dr. Wm. Smith's "English Grammar." A university, a one, a ewe, are therefore correct.—Ram Chand Biswas.

[33732.]—**A or An.**—I am glad "Etymologos" has called attention to this subject, for I often get my auricular nerves dreadfully thrilled by the cacophony of speakers and writers who use such horrid combinations as, an union, an one, &c. An should, of course, be used before vowels, for the sake of euphony ; but u in union, o in one, are not vowels—they are semi-vowels. Spell them as they are sounded, and see. Union is pronounced yewnyun, one is wun. Therefore it would be just as correct to write or say, an yew tree, an youth, an wonderful feat, as to write or say, an university, an ewe, or such an one. It is strange that teachers do not take the trouble to learn this simple lesson for themselves, and impart it to their pupils. The fact is, they judge of sounds by the eye, which is no less absurd than to test colours by the ear.—J. Symes.

[33732.] — **A or An.** — Strictly speaking, the original form of the article was an, from *unus*, through the French *un ;* but most grammarians have given the article as a, which becomes an before a vowel, to avoid the hiatus or disagreeable effort which would be made in sounding separately the two vowels in succession. It is, therefore, for the sake of euphony that a is used. 1. Before the words beginning with the aspirated vowels, y, u, eu, ew, pronounced as if y was before it, as, a youth, such a one, a university, a eulogy, a ewe. 2. Before words beginning with silent h—viz., heir, herb, honest, honour, hospital, hostler, hair, and their derivatives. The word humble used to be h mute, but our best writers now aspirate that letter. If a word beginning with h aspirate has the accent on the second syllable, the article an is used instead of a, as, an heroic deed an historical book.—Kenny's Grammar.

[33732.]—**A or An.**—A university, a one, a ewe, is correct, because, according to the rule, the n is dropped before words beginning with a vowel sounded as though it were preceded by a consonant, which is the case in each of the words cited. I am aware that many authors write an before words of this class, but cannot conceive why, as it is certainly, to my mind, more euphonic to say a European, than an European. The reverse of this rule is seen where the n is retained before words beginning with h mute, as an hour.—C. Lark.

[33736.]—**Maple Sugar.**—The following description of the method of making maple sugar I found in a recent number of the *Gardeners' Chronicle*, and I send it, as a good reply to the query of "Sabbas :" it formed a portion of American notes by Mr. G. Maw :—Acer saccharinum is a much larger tree, and is at once distinguishable from the red maple by the roundness of the notch between the lobes of the leaves. The rising of the sweet sap commences immediately after the first break-up of the long frost from the middle to the end of February, continuing through March and into the early days of April, but varying in different localities and at different seasons. A cold north-west wind, with frosty nights and sunny days in alternation, tends to incite the flow, which is more abundant during the day than the night. It is, however, most sensitive to unfavourable changes, and from a flow of 3 gallons a day from one tree may almost cease in a few hours, and then gradually recover itself. From this it will be seen that the flow given from day to day is uncertain, and that reliable statistics of produce are difficult to record. A continuous course of favourable weather tends to the largest production, a rising and falling supply reducing the total produce of the season. The time at which the flow commences varies, not only with the season, but with the exposure and elevation of the ground, being earliest in warm and low situations. A thawing night is said to promote its flow, and it ceases during a south wind and at the approach of a storm, and so sensitive are the trees to aspect and climatal variations that the flow of sap on the south and east side has been noticed to be earlier than on the north and west side of the same tree. There are generally from ten to fifteen good "sap days" in the sap season, which continues on and off for about six weeks, after which, as the foliage develops, the saccharine matter is reduced, and the sap is said to be "sour" though a restricted flow still continues. Emerson, in his work on the "Trees of Massachusetts," referring to Michaux's observations, considers that the product of sugar depends also on the character of the previous summer, and that a season of plentiful rain and sunshine prepares the tree for an abundant harvest of sugar in the succeeding spring. Open winters are thought to cause the sap to be sweetest, and much freezing and thawing to make it most abundant and of the best quality. The sap of isolated trees is richer in sugar than that of those which are massed together in the forest. In the maple bush at Haysville the produce of sugar was at the rate of 1lb. to each 6 gallons of sap, and the average may be 1lb. to 4½ or 5 gallons, but Emerson records instances in which 1lb. of sugar has been produced from 3 gallons of sap. With reference to the produce of individual trees, in a good sap season an average tree will run as much as 3 gallons of sap in a day, occasionally more, and produce about 4lb. of sugar in the season, but Emerson records instances of the production of 10, 20, 33, and 43lb. of sugar from single trees. Such weights are, however, altogether exceptional. The highest weight was produced from a draught of 175 gallons of sap from a single tree. The average quantity per tree would be from 12 to 24 gallons in a season. Young trees under twenty-five years old are seldom tapped, the smaller trees scarcely paying for the trouble, apart from the debility it produces in the young growing tree. Repeated tapping of the matured trees produces no apparent injury or effect on their vigour. Emerson records instances of trees that have been tapped for forty consecutive years without injury, and it is said that both the quality and quantity of the sap are visibly improved after the first tapping. The trees are usually tapped at a height of 3 or 4ft. from the ground, with a ¾in. auger, to a depth of from 2 to 6in., into which a perforated plug is driven to lead the sap into the collecting vessels, or a simple notch 1½in. deep is cut with the axe. From one to three taps are inserted in each tree, and these have to be renewed in succeeding years in fresh places, generally alternated on opposite sides of the tree. The sap is evaporated either in iron chaldrons or shallow boilers, 6ft. long, 2½ft. wide, and about 8in. deep. Those of copper are preferred to iron, as they are said to yield a whiter sugar. Care is taken to keep the boilers filled up with fresh additions of sap during evaporation till the syrup attains a sufficient consistency, which is ascertained by its "breaking" or crystallising when dropped into cold water. The syrup is strained during evaporation, a small quantity of lime or soda added to neutralise any free acids that may be present, and a little white of egg or milk to clear it. After straining and skimming the syrup is poured into pans or moulds to crystallise, and it may be further clarified by gently boiling in tapering cans with a tap at the bottom, towards which the molasses gravitates, and is drawn off as the crystallised sugar sets. Maple sugar is made not so much as an article of commerce as for the home use of the producers, and the great bulk being consumed where it is made, it is difficult to arrive at anything like an accurate estimate of the total production. Emerson states that in Massachusetts alone between 500,000 and 600,000lb. weight of sugar are annually produced from the maple, and he values it at 8 cents per lb. In 1874 the price rose to from 10 to 22 cents a lb. In Canada, at the beginning of April last, new maple sugar was selling at from 10 to 11 cents a lb., about the price of the best cane sugar. A considerable proportion of the maple sap product is also preserved as syrup without crystallisation, and in this state it is used as sweet sauce and for various culinary purposes. The maple sugar production is said to be a growing industry, and if the preparation could be centred in well-ordered factories, on the plan of the cheese and butter factories, there is little doubt that carefully prepared maple sugar would closely compete in price with cane sugar. As it is, with the simple and almost rude appliance for preparation, there is little to choose between the purchase of cane sugar and the cost of producing the local home-made sugar from the sap of the maple.—Hereward.

[33737.]—**Lobelia Cardinalis.**—The following is condensed from a work on flower gardening:—"Can be raised from seed or cuttings. The seed should be sown, as soon as possible after ripening, in pans or boxes in rich moist soil, and either not covered at *all, or very slightly* with a sprinkling of dry peat. *Protect from frost or heavy rain.* Keep young plants moist. Best in open air with morning sun upon them. Pot when large enough; re-pot when necessary. Shelter during winter, re-pot in spring; will probably flower in August, though some may not do so until third year. Cuttings from stem in usual manner, also by suckers thrown up from the roots of old plants, potted singly, heat applied in frame or otherwise, sheltered, re-potted from time to time. Keep in greenhouse till hardy enough for open air. Keep moist during growth of flowering stem."—C. Lark.

[33738.]—**Black Diamond.**—This can be obtained from Professor Tennant, in the Strand, near Somerset House. A piece suitable for grindstone turning would cost about 5s., and, mounted as described by me a week or two back, would last for years, and pay its cost over and over again. I should not think it would be very suitable for cutting plate glass, or a piece with the special angle requisite for this purpose would be too good to use for turning up grindstones, and would be used for glass-cutting, and command glass-cutting price.—Law Student.

[33743.]—**Phlegm in Throat.**—I have suffered from this for years, and have never found any relief in medicine. The only method I have found of service has been to gargle the throat every night and morning with cold water. This loosens the tough tenacious phlegm, and enables one to spit it up. The practice has now become a habit with me, and I could not go to bed comfortably without doing it. Sometimes it is necessary to get up in the night to gargle, sometimes, also, in the course of the day—in fact, whenever the accumulation becomes troublesome. The plan has never failed to give me ease, and I recommend it with confidence. Perseverance and regular living, of course, are necessary.—R. C. D

[33744.]—**Swimming below Water.**—I have never found any difficulty in opening the eyes under water, and have never seen anybody who found that he could not open them. "Amphibian" says that he always takes a header with his eyes shut, but I have never hurt my eyes, although, of course, I might; in fact, I generally keep them open, in order to see my reflection in the water, as that is the only way I can find out if I take a good header or no. I find that after some time my eyes get sore, and that is why I seldom swim under water.—B. Snooks.

[33744.]—**Swimming below Water.**—Like "Amphibian," have never been able to understand the statement that the eyes cannot be opened under water, and I have never found the slightest difficulty in opening or shutting them as often as required under water.—Law Student.

[33745.]—**Coin Cabinet.**—Suppose your trays to be 1ft. 6in. × 10in. Take a clean, sound, and well-seasoned piece of pine, 1ft. 7in. × 11in. × 3in.; plane up truly to 2¼in. thick, and best edge square; draw a line down centre of best edge (by edge is meant by workmen a narrow side: what geometricians call an edge—*i.e.*, the line where two planes meet—the workmen call an arris). Now mark off the length, and divide the sinkings equally; bore to any convenient depth—say, 1¼in. Plane the edge again perfectly square, set fence of circular saw to take off a slice thickness of coin, shoot the edge again, and take off another, and so on. Four of these will fill the bottom of tray, and if well cut, will only require a slight touch of glue to make a clean job. Make your ⅛ holes in two rows, zigzag. Have a truly-planed block fitting loosely into tray; put this on top of slices when glued in, and a weight. This will prevent warping.—Old Ploughman.

[33749.]—**Plants.**—I can recommend Beeton's "Shilling Gardening Book" as a useful little book to "Hilda T., Cornwall."—A., Liverpool.

[33751.]—**Sale of Stock (Consols).**—"Scrivener" can easily make calculations relating to Stocks by simple proportion. I will take his own example: If £100 stock costs £95⅜, what will £25 10s. cost?

```
As £100 : £25 10s. :: £95 7s. 6d.
                            20
                          ------
                          1,907
                             12
                          ------
                         22,890
                            25½
                          ------
                        114,450
                        45,780
                         11,445
                          ------
                    12) 583,69*0*
                          ------
                      20) 486 4
                          ------
                       £24 6s. 4d.
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* Erased figures.

—Fred. J. Bolt.

UNANSWERED QUERI

The numbers and titles of queries which rema
nswered for five weeks are inserted in this list, an
unanswered are repeated four weeks afterwards.
our readers will look over the list, and send what in
they can for the benefit of their fellow-contributors.

33101.	Injector Condenser, p. 325.
33103.	Wheelmaking, 325.
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33125.	Painting on Silk, 326.
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33148.	S.E. and G.W.R. Train Service, 326.
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33350.	Copper Smelting, p. 430.
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33377.	Cloth Analysis, 430.
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33382.	Making Bicycle Wheel Rigid, 430.
33383.	Roller Bearings, 430.
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33405.	Chinese, 431.
33406.	Belemnites, 431.
33407.	L. and N. W. Engines, 431.

QUERIES.

[33756.]—**Land Surveyors in the Colo**
Would some reader inform me to which of the co
would be best for a land surveyor to emigrate,
United States offer any employment to surveyors
possible, state rate of wages usually received?
Surveyor.

[33757.]—**Driving Lathe by Wind.**—
some one kindly inform me the best way of dri
lathe by wind so as to have regular speed in
rough weather? The roof is high, and the roo
to the roof.—J. Roberts.

[33758.]—**Engineer's Examination.**—Co
reader inform me the subjects I require to pass i
obtaining a certificate for engineer on board a ve
also the names of textbooks?—Anxious.

[33759.]—**Leclanche Cells.**—I have a lot o
cells belonging to Léclanché battery; having bee
some time, I presume they must be worn out.
one tell me how I can test them to see if they a
further use, and, if they are not, can they be repl
or can any use be made of them?—Wanderer.

[33760.]—**Dull Black Bronze on**
Glasses.—I greatly desired to obtain the d
black to be found on French-made opera glasses.
the method stated in your paper, No. 695, July 1
475, under title, "Black Finish for Brass." I di
as there noted. The effect was to produce on t
in the mixture, a brown-black thick coating in
vescent state, which, when dried by heating
brownish powder on the metal, which could eas
moved by a rub of the finger. I have tried seve
with the mixture of nitrate of silver and nitrate o
without result of a favourable character. Can
your many readers further help me to obtain a d
black for metal, which, will stand every atm
change without the need of lacquering the me
bronzing?—J. Balsam.

[33761.]—**Time at the Antipodes.**—I ha
puzzling for some time at the following:—Sup
to be 8 p.m., August 1st, at a certain place, say
what would be the time at the Antipodes—wo
8 a.m., August 1st, or 8 a.m., August 2nd? I
that there would be just 12 hours difference in th
W. W. H.

[33762.]—**College of Surgeons.**—What
are necessary for entering the College of Su
When and where is the next examination held?
Hunton.

[33763.]—**Tinting Mechanical Drawing**
somebody kindly give me any information on
mechanical and geometrical drawings? Is th
cheap book on tinting? If so, who is the aut
lisher, and what is the price?—A. S. B.

[33764.]—**Rescuing Drowning Person**
considered an average good swimmer, but should
to know, as I am at the sea-side, the best wa
supposing I had to rescue a person from drowni
without clothes; 2nd, with clothes.—T. Evans.

[33765.]—**Photographing Instrument**
Mr. Lancaster.—I should feel deeply obliged
reliable information in my difficulty. I wish
accurate photographs of a variety of instrument
cal and optical—I possess. I find the ordinary
plate portrait lens quite useless, as it does not
sharp lines, or enable me to get the camera nea
to the object. What had I better do, or is it a
ticable attempting the work? Could accurate
be made from prints taken from negatives of
work? I fear that photography may be usele
purpose.—A.

[33766.]—**Spectacles.**—A patent for spect
taken out some years ago by Mr. A. A. de la
Great Winchester-street, London. The inventio
in fixing to the joints or bows of common spe
pair of mirrors or reflectors, so jointed and pl
enable the wearer to see sideways in any dir
even behind him, without turning his head. In
these spectacles the ordinary glass lenses are ou
the mirrors only used. The wearer thus obtai
boasted powers of the fabled Argus. There is a
the invention in Hebert's "Encyclopædia Mech
E. B.

ore Skin from Shaving.—Can any of e a remedy for the above inconvenience? I low-ground razors, also the usual kind, but ke the skin of my throat tender and irri- ints for the cure of the above will be thank- by—Hosnikos.

hemistry—Specific Gravity.—Would dent kindly tell me whether the following nethod for finding the specific gravity of any compound? One litre of air = 14·4 criths; it of any gas in criths $\frac{1}{14·4}$ = s. g. I have eral works on chemistry, but cannot find or finding the s. g.—J. H. Rowney.

lechanics—H.-P. of Engines.—What act rule for finding the h.-p. of high-pressure g engines? I have several formulæ which I customed to work by, but the results are some of them very serious. Any informa- ankfully received by—J. H. Rowney.

latling Gun.—Will some one of our describe, briefly, the principle of the Gat- ther it is the same as a revolver, on a large ?—A Subscriber.

lack Dye for Leather.—Can any me in making a black dye for harness and amfordian.

etters on Tombstone.—What is the ion of black paint used for painting the let- a marble tombstone? And how can the ied appearance be restored to the marble ecome rough-looking through exposure?—

ravatt's Level.—I have accidentally de- pider lines of my level. How can I secure tersection of the new ones, being in the line ?—Daleth.

epositing Copper on Iron.—Can any inform me how to deposit a coating of ron? I have tried immersion in a solution copper, but cannot get the copper to adhere nly to the surface of the iron. I think the be simple, as iron-wire and common iron ow coated with copper.—Acidum Aceticum.

ledical.—How will the new Medical Bill that is now before the House affect— —the students of that profession? Will it efit or not? Will some one please answer oblige—Dosrhe?

yprus.—Will one of "ours" inform a nic as to the condition of the above named t prospect would there be for a young enty of work in him desireus to emigrate? H.

all Taps.—Will one of "ours" please in- is contained in the floating ball of a ball- soldering there is a continual spluttering of the solder until the air seems to be ex- ase explain.—Ignoramus.

hotographic.—To "Finem Respice."— our reply. I have made a small quantity of our formula, and have tried a few of the I may say, moderately fair success, but I better acquaintance with the process, that better results. My former experience with led me to expect a dark olive green tint, was not produced—is this due to my mis- What effect would adding a little benzoate the emulsion have?—Gelatine.

iniature Coil.—I have made a small in. long, for secondary; 2oz., 41 wire, imary, two layers of No. 22. I want a small le for it, to carry in the pocket, and so tle room. It works well with a small bichro- . Also would a condenser be any improve- If any, please say what. I want it for Egr.

eaching Singing.—Would "Ne Sutor" the following questions? I am 25 years of always had a very great inclination to study I have a very fair tenor voice. Could he proper system of training and cultivating ice? Is it probable that at my age I could hing like proficiency? I have good range, iation, and very fond of music, and able to ttle. Have had a few lessons in singing, but t on a proper or systematic scale. For e not had a word about formation of mouth, onouncing certain words, nor any difference n between chest and head notes, which, I a most important part in teaching. I have talian system of teaching, but don't under- is. Could anything be got from books? If e best?—Vocalist.

emi-Liquid.—I want to procure, and to r use, a semi-liquid about the consistency of , when put upon cloth and pressure applied, ickly, adhere to the cloth, and show an im- ithdrawing the pressure. If any reader can ances I might mix and experiment with, or liquid possessing the properties required, I ceedingly grateful.—I. P.

estoring Morocco Leather Chairs. r kindly inform me what will restore the f morocco leather chairs that have gone front and corners? Other part in good con- nham.

Midland Railway.—Travelling from uxton I observed a very long span of tele- he poles being placed on top of the hills on alley. Will some one kindly inform me the , number of wires, &c.?—P. O. Tele.

razing Small Articles.—Could any the best method for brazing iron together, and other things too light to be welded?—

rucibles.—Will some reader give me some this subject—how to make them, and the or melting brass?—J. S.

usical.—Would any reader inform me the the tenor slide trombone, also for the ventil ort of mouthpieces have to be used? Both e B flat.—Wear Engineer.

[33787.]—**Lamp.**—I wish to procure a lamp in which refuse oil can be burned with a clear flame, but without a globe, also without smoke or smell. Any information to assist me in procuring such will greatly oblige—Darkness.

[33788.]—**Level Tubes.**—Can any of your correspondents tell me how to hermetically seal the end of a spirit level which I have broken? A blowpipe will not do it, as the spirit catches fire. The hole is no larger than a pin's head.—Benjamin Bolt.

[33789.]—**S. S. Arabia.**—Will any of the readers of your valuable publication give the number of boilers and fireboxes in the steamship Arabia, of the Cunard line?—Steamship.

[33790.]—**Wooden v. Iron Teeth in Cog Wheels.**—Will any of "ours" explain the advantages of wooden teeth over iron ones in cog-wheels?—Boxwood.

[33791.] — **Height of Tank Wanted.** — Will "M. O. W.," or some other correspondent, inform me how high a tank ought to be off the ground in order that I may work my hydraulic engine at 50lb.? It is 4in. bore, 10in. stroke, and single action.—Hydraulic.

[33792.]—**The Cornish Coast.**—I propose walking down the north Cornish coast, round past the Land's End and back, as far as time will permit, to Plymouth, during a short holiday a week or two hence, starting from Bude. Can any correspondent give me information as to the best route, keeping to the coast as much as possible, the cleanest and cheapest inns, principal places of interest, &c.?—Kappa.

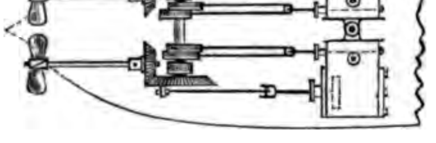
[33793.]—**Explanation Wanted.**—When a bit of Arkansas oilstone is ground on an ordinary grindstone with water a peculiar light is seen at the point of contact. This cannot be an electrical effect, as the stone is wet. What is it?—J. E. F.

[33794.]—**Stone Floor.**—Will some reader kindly state what will eradicate stains and grease from a stone floor and improve its colour?—Housekeeper.

[33795.]—**Work on Clock Making.**—I should be obliged if any of the readers of the Mechanic would inform me of a good work on the above, containing diagrams of the laying out of the various parts.—Ratchet Wheel.

[33796.]—**The Common House Fly.**—Will some reader well up in entomology kindly give me the title, publisher, &c., of a book that gives an exhaustive history of the common house fly? I wish to know how he is propagated, and from whence he comes in such numbers at such short notice.—Musca Domestica.

[33797.]—**Model Steam Launch.**—I am about to make a model of a twin screw launch about 3ft. long and 8in. broad, and should be much obliged if some one would give the size of cylinders and diameter and pitch of screws.



I propose having two cylinders, and placing them in the same way as in a locomotive, with outside cylinders, and connecting the screw-spindle with engine by cog-wheels, as sketch.—E. L. P.

[33798.]—**Rheumatism.**—Can "Sigma," or any of "ours," give an afflicted one any directions as to diet? Believing that prevention is easier than curing, I wish to avoid articles of diet that tend to irritating this complaint. I would more particularly ask about bitter beer, vinegar, apples, or anything acid or sour, such as lemon, &c.—Borrowdale.

[33799.]—**Deformed Leg.**—Will one of your kind correspondents help me? I have suffered for some time from what is commonly called knock-knee, my left leg being very bad, while the right is, when dressed, barely noticeable. The bone (of the left) has several times slipped from under the knee-cap (returning, of course, instantly), causing great pain, and a stiffness and swelling, which has kept me to my room three or four days. I have used elastic knee-caps, which have kept the bone to its place, but the leg gets no straighter. What can I do?—Knee-cap.

[33800.]—**Pure White Flexible Hard Enamel.**—To "Dandie Dinmont."—Will the above contributor inform me how I can make a very pure white enamel that shall be flexible and hard when dry? I have tried many of the oil varnishes mixed with flake white ground in oil, but although they answer most all other requirements, the colour is not pure enough. The ordinary pale spirit varnish used for light wall papers is very well for colour and flexibility, but it does not dry hard enough. I have thought of experimenting with poppy oil and cold drawn linseed oil, mixed with something to make them dry, but should be pleased to get a little advice from some experienced person, who, perhaps, might know just what would suit me. Is there anything I could mix with such an enamel that would disguise its disagreeable odour?—W. Bourne.

[33801.]—**Electrical.**—If two copper wires, connected with a delicate reflecting galvanometer, are inserted into a dilute solution of caustic soda, the one slightly before the other, the spot of light will be deflected, say, to the right; withdraw the wires and again insert them, but reverse the order of immersion. The spot of light will now be deflected to the left-hand side of the scale. What is the explanation of these experiments?—Carbon.

[33802.]—**Watchmakers' Societies.**—To "Seconds' Practical Watchmaker."—What societies are there that grant certificates of competency to watchmakers? Where would be best to apply for men who are really competent, and what certificates should they have guaranteeing them proficient? What society would you recommend a watchmaker to pass to qualify himself for a diploma of proficiency, either in this country or elsewhere?—Watchmaker.

[33803.]—**Slide-Rest Boring or Inside Turning Tools.**—Will "J. K. P.," or any other correspondent kindly inform me—if possible, with a few diagrams—what is the correct form of the cutting edges of these tools for light work in brass and iron?—Ordbric Vital.

[33804.]—**Society's Thread.**—May I ask "F.R.A.S." or Mr. Lancaster what is the diameter and number of threads per inch of the universal screw for telescopic eyepieces, known as the society's thread?—Ordbric Vital.

[33805.]—**Nicol Prism in Field-Glass.**—Under the heading "Tourmaline," 32192, p. 30, Mr. Lancaster suggested the use of Nicol's prisms in a field-glass in order to quench the reflection from water. I have tried this, using a prism belonging to a microscope in a single-barrelled opera-glass, but with small success. The reflection from water in a basin is slightly subdued, and the shape of an object beneath the surface is dimly seen; but when tried on the Thames no apparent effect was produced. I could only place the prism between the diaphragm and the O. G, on account of the smallness of the tube, but I imagine that would but lessen the field of view. I shall be glad to hear if Mr. Lancaster has tried this idea, and with what success.—Faber.

[33806.]—**Flying Scotchman.**—Will some reader kindly inform me of the number of the Flying Scotchman; also a few of the principal dimensions, and the highest speed it has attained?—Signal Box.

[33807.]—**Boiler Questions.**—1. Assuming a winding engine to be supplied with steam from two boilers, and the indicator to show a pressure of 30lb., would the said indicator show the same pressure if in connection with only one of these boilers, and why? 2. What proportion of fuel would be consumed, with only one boiler, to give the engine the same power as with two boilers? Any other hints as to the communication of steam from the boiler to the engine will be thankfully received by—A Controverting Company.

[33808.]—**The Phonograph.**—To Mr. Shelford Bidwell.—Having constructed a phonograph according to your description, and not being satisfied that its performance is as good as it should be, I shall be extremely obliged if you will answer me the following questions:—1. With your instrument, as described on page 157 of last volume, could you hear what it said provided you had not heard what was spoken to it? 2. Does the paper cone make a great difference? 3. Have you tried a tin cone? 4. Is the record on the foil as distinct as that made by the instruments exhibited by the makers? 5. Can you give me an idea how sharp the style should be, and how deep a scratch it should make on the foil when in position? My reason for troubling you is this: A friend of mine when out the other evening at a private house saw an instrument which was hired for the evening from the makers, and he brought away one of the foils to show me. He was rather amused at the performance of my instrument, though even in its present state it has considerably astonished many who have not seen any other. On examining the foils I noticed that the grooves were much broader than I expected, and the indentations quite plain and readily visible. Now my foils require very close scrutiny to see the indentations at all, and the scratch produced by the point is quite narrow. I also noticed that the foil used is much stiffer than what I use, though about the same thickness apparently. However, having gone so far, I am very anxious to make my instrument as good as possible, and think that if you will give me some idea of the performance of your own, and a few hints as to where I may best work to improve mine, I shall succeed better. I am altering my diaphragm to your present form as described in last Friday's issue, and am having a tin cone made of very thin sheet. Of course the cone must always be on with this arrangement, both in speaking and reproducing, I suppose. It has occurred to me that possibly the woodwork carrying the diaphragm, being merely held back by the springs, may take up some of the vibrations and spoil the effect. Do you think this likely? Can you reproduce singing?—Lasye.

[33809.]—**Curing Indiaubber.**—Can any reader inform me how to cure or vulcanise small articles of pure indiarubber? Also the proper method of joining edges of same?—E. E. L.

[33810.]—**Electric Pen.**—Will any of the correspondents of "ours" who have either seen or used Edison's electric pen, answer the following questions:—1. Does Mr. Edison use any special paper for writing on, and does he wet it? 2. What does the ink consist of? Is it the common printing ink? 3. Is the inking roller made of glue and treacle, like those used for printing?—Pluma.

[33811.]—**Charging and Drawing Gas Retorts.**—Would any reader inform me of a good method of charging and drawing gas retorts by machinery? A drawing or sketch would greatly assist. Also what method or substance could I use for destroying carbon in the retorts?—J. H. B.

[33812.]—**Manufacture of Sulphuric Acid.**—Would W. J. Lancaster, or any other contributor, kindly answer the following?—I burn 16 tons per week of copper pyrites in the manufacture of sulphuric acid, and wish to erect a Glover tower. I have been advised to make it 16ft. high, and 6ft. square—are these dimensions correct? Also a few hints on the packing of it—whether all brick, or part brick and part flints, and how far the bricks are kept apart?—Vitriol Maker.

[33813.]—**Impregnation for Woodwork.**—Will any one tell me the best preparation I can apply as an impregnation for woodwork under water? I am building some new sluices, and am afraid to tar the timbers, as they are not sufficiently seasoned, having been cut last fall. Do not refer me to back numbers please, as I have none here.—A. F. Parish.

[33814.]—**Steel Stoves.**—Can any reader tell me how to preserve my steel stove and fender from corrosion? I am going to leave home for some months, and should like to find something to keep them bright.—Housewife.

[33815.]—**Chinese Screw.**—Can any of my fellow-readers explain the principle of the Chinese screw, and how it is that great power is combined with a small thread?—Hawks.

[33816.]—**Civil Service Appointments.**—Can any one inform me in what offices or departments appointments are open to all by open competition, without a nomination? I know all other particulars, as to age, qualifications, salary, &c.—Rufesvadum.

[33817.]—**Moist Water Colours.**—I should be glad if some fellow-reader would give me particulars of the medium used in preparing or grinding the moist water colours sold in tubes.—H. J. Burton.

[33818.]—**Legal.**—Will "Sperans," or any of our legal friends, kindly answer the following? A has for many years been living with his brother B, A paying to B £30 a year for board and attendance. A few weeks ago A died, leaving about £140 in money, which he wills as follows:—He directs that £20 be paid to another brother, C, the rest to be equally divided between two illegitimate children, a son and daughter. For a period of 9 months previous to A's death, A paid nothing to B for board, &c., A being badly about a fortnight before his death. After A's death, B puts in a claim for £95 for board and attendance, &c. Can B legally claim £95, or only for the 9 months in the same proportion as A paid B yearly, or can B claim anything? A appointed a nephew of his along with his illegitimate son joint executors. A's son having possession of A's bank book, withdraws some of A's money without the knowledge of the other executor, A's nephew. A's son also employs a solicitor, in connection with A's affairs, and pays money to the said solicitor without the other executor being cognizant of it. Are the managers of the bank wherein A's money is invested, justified in handing over any of A's money without the consent of both executors? And has A's son, as one of the executors, any right to pay money or employ a solicitor or take any steps whatever without the knowledge of the other executor? Should A's funeral expenses come out of the money which he left, or who is liable? No money whatever has passed through the nephew's hands. He received a note from the undertaker which he at once handed over to the other executor, A's son, which note still remains to be paid. Can the nephew now refuse to act, or what steps must he take?—Anxious.

[33819.]—**Photograhpic.**—Many thanks personally to "Finem Respice" for his valuable article on the gelatine process. I should feel much obliged if he would kindly say what proportions of methylated spirit, chrysoidine, and shellac he used, as I have some difficulty in that matter. Also can he say what is the common name for the dye mentioned? Is it in Judson's list of cheap dyes?—Medical Practitioner.

[33820.]—**Damp Walls.**—Can any one inform me if there is any method by which the drying of damp walls in a new house may be facilitated? I have tried with fires and without for three months, but they continue to be damp. Only the party-walls in the two parlours the fireplace side are damp, and the front wall a trifle. There are no folding-doors. The walls appear to be dry at night, but in the morning are wet again. The two upper floors are perfectly dry. There is no basement. The windows are usually open all day. Could perforated bricks be inserted anywhere to create a good draught?—E. A.

[33821.]—**Pressure of Air.**—What is the pressure per square inch in pounds at the sea-side at a temperature of 62° F.? If 25,500 cubic feet of air per minute, when circulating through a mine, give ·71 inch of water-gauge, to raise the quantity to 75,000 how much would the water-gauge be increased?—Overman.

[33822.]—**Black Dyeing.**—Can any reader kindly teach me how to black linen or cotton nets with a deep and durable dye, so that their tissue may not be injured as it is the case with the ordinary gallate of iron?—Cinocephalus.

[33823.]—**Bird Catching.**—Is it possible to catch birds by means of electricity? I would set up an artificial tree with metallic branches, and by a discharge of the pile I think it possible to kill birds resting on, or at least to cause them to fall down, but I want instruction.—Cinocephalus.

[33824.]—**Preserving Fruits.**—What is the best method to preserve fruits, such as peaches, grapes, &c., so that they might be found fresh and good in winter?—Cinocephalus.

[33825.]—**Minotti's and Daniell's Battery.**—The directions given by Wiesendanger for making Daniell's battery, are so incorrect—he says, "put the copper in the centre and the zinc outside!"—that I want to know if his account of Minotti's battery is right—viz., copper disc at bottom, then layer of sulphate copper, next layers of blotting paper, then sand, on which lay your zinc, and finally cover with water, &c., and is this correct? Do not some people use clay without any blotting paper? Will Minotti's battery do for electrotyping?—Dr. Syntax.

[33826.]—**Submarine Torpedo Boat.**—I notice in the newspapers that the Rev. G. W. Garrett, who exhibited his submarine torpedo boat in the Mersey, has patented an arrangement of chemicals for purifying the air in the said boat, which remains down for one or two hours at a time, and is made to travel at a speed of 4 or 5 knots an hour. Can any correspondent kindly inform me what the arrangement of chemicals is?—Ram Chand Biswas.

[33827.]—**Weaving.**—1. Is it the practice to weave twill, either coloured warps or plain warps, with rods in the same as plain calico? 2. What reason is there for six healds instead of three for weaving drills?—Tombo.

[33828.]—**New Forest.**—Can any of our readers give me any information about the state of the roads in the New Forest, Hants, during the month of September? Are they in a fit state for bicycling; and are they sandy or stony?—G. R. A.

[33829.]—**May Examination.**—Will any student who has passed first class honours in inorganic chemistry in 1878 state minutely what salts he found in the practical examination, and whether any one else who passed first class obtained the same result? Information from other competent sources would oblige—J. Bath.

[33830.]—**Black Stains on Silver Articles.**—I have some silver salt-holders which have been turned quite black round the rim, no doubt through the chemical action of the salt. What is the certain cause of these stains, and how can I remove them without injuring the silver?—Collier Leigh.

Those who have purchased Pumphrey's PATENT WRITER, previous to July of this year, are invited to *apply to J. PUMPHREY*. Broad-street, Birmingham, and they *will receive gratis some additional materials and directions for use, slightly altered, that make the process perfect.*

ANSWERS TO CORRESPONDENTS.

*** *All communications should be addressed to the* Editor *of the* English Mechanic, 31, *Tavistock-street, Covent Garden, W.C.*

HINTS TO CORRESPONDENTS.

1. Write on one side of the paper only, and put drawings for illustrations on separate pieces of paper. 2. Put titles to queries, and when answering queries put the numbers as well as the titles of the queries to which the replies refer. 3. No charge is made for inserting letters, queries, or replies. 4. Commercial letters, or queries, or replies are not inserted. 5. No question asking for education or scientific information is answered through the post. 6. Letters sent to correspondents, under cover to the Editor, are not forwarded; and the names of correspondents are not given to inquirers.

The following are the initials, &c., of letters to hand up to Tuesday evening, August 13, and unacknowledged elsewhere:—

D. Siemens.—J. Burn Murdoch.—G. G. Warren.—Lambert Bros.—T. C. Burton.—W. H. Burke.—R. E. Sprott.—J. Forbes Mitchell.—J. G. F.—C. O. Hawk.—Os.—John Earl Clare.—R. S. T., India.—Tamerlane.—Ernest A. Nuth.—Joseph Green.—Aliquando.—J. T. W.—Hastrew.—M. M. R.—Deputy.—A. E. S.—L.—J. L. B.—Reader.—Young Plumber.—F. W. Smith.—I. F. Ballard.—Engineer.—Derby.—J. W. W. E. N.—Perse. Incog.—Lancashire Fitter.—Vercingetorix.—T. C. B.—W. G. H. A.—Serendib.—Decorator.—X.—Concise.—G. H. H.—H. G. Moberley.—R. Scott.—Straight Link.—Rev. T. Calliphronas.—Wilson Batty.—W. R.—B. F.—Pioneer.—J. O.—y.—A Stead.—Wear Engineer.—J. C.—Perdu.—Light.—W. P.—Philoctetes.—G. S. T.—Hercules.—W. H. B.—Creditor.—H. O. R.—J. D.—L. J. Joyner.—B. R. S. Frost.—Sussex Farmer.—Alexander Campbell.—Solomon Birkett.—Vega.—D.—Henry Palmer.—Egeria.—Idem.—South Saxon.—J. A. M.—Dundee.—Anxious.—Betelgeux.—Fix.—56in. Superb.—G. J. H.—Wine Merchant.—B. Riley.—Pitman.—E. B. Fenessy.—Furnace.—Ne Sutor.—Dandie Dinmont.—J. N. D. Tuxford.—Wiesendanger.—J. Alexander Smith.—Cupola.—Norfolk.—Seconds Practical Watchmaker.—Menelaus. — Gimcrack. — S. Bottone. — Douglas Scoffern.—Bosh Faker.

Short of Steam. (Try the "Field" boiler tubes. You will find them advertised in these pages.)—Pater. (We cannot tell you nor can any one else—we wish they could. Whoever discovers why some people are exempt from measles and other zymotic diseases, as they certainly appear to be though frequently exposed to the influence of the contagion, will, as Dr. Alfred Carpenter has observed, "confer a boon upon humanity, as in that discovery will follow the establishment of a means for preventing altogether those forms of disease.")—Balsall Heath. (1. Get Mr. Sprague's book. 2. Beyond the power of any correspondent unless he saw the specimens. Get some elementary manual of geology.)—W. C. (We have no space to spare for the discussion of such ridiculous superstitions.)—J. L., Glasgow. (See "Useful Notes" on p. 252.)—Law Student. (They have already replied, and we shall be surprised if they do not treat all further rejoinders with contemptuous silence.)—H. Clements. (Your long communication commencing with "Alcohol" and ending with "Hippuric Acid" lacks a title. Is it complete or to be continued?) Oilman. (See reply 33593.)—Alexander. (Fill the tubes with melted lead, bend when cold, and then run the lead out again.)—Artist. (Copal varnish will do very well.)—Photo. (Get Stanley's "Photography Made Easy." See advt. on front page.)—L. L. H. (A very good system of builders' book-keeping is advertised by a Mr. H. C. Bevis in the *Building News*.)—W. H. R. (The *Manx Sun*, the *Mona Daily News*, *Mona's Herald*, the *Isle of Man Times*, and the *Weekly Advertising Circular*, all published at Douglas. Probably *Mona's Herald* would best suit your purpose. For the rest of the information you require you must consult the journals themselves or a guide-book.)—P. D. (The farmer was right. A *horse dealer* cannot maintain an action upon a contract made by him upon a Sunday for the sale and warranty of a horse, but where neither parties are horse dealers a contract between them for the sale of a horse is good although made on a Sunday.)—H. (It is reckoned that 1 cubic yard of chalk lime, 2 yards of sand, and 3 bushels of hair, will cover 75 yards of *render and set* on brick, and 70 yards on lath.) John. (It is an American invention and we do not know the patentee's address.)—W. E. Barker. ("Plumbing," by W. P. Buchan, published by Lockwood and Co., London.)—Perdu. (Much information on the cure and prevention of constipation is to be found in back vols., more especially on pp. 365, 390, 441, 467, 491, 517, and 544, Vol. XV.; and pp. 19, 73, and 119 of Vol. XVI. Here is one simple remedy which was given at the time on medical authority:—Put in a wide-mouthed bottle a pint of the best salad oil. Place next therein a dozen figs and let them steep in the oil for 24 hours. Take one immediately before breakfast and after dinner.) A Learner. (Apply to the Secretary of the Society of Arts, John-street, Adelphi, London.)—L. Jumper. (Your own circumstances regulate the time. Information as to means will be found on reference to indices of back vols.)—B. R. S. Frost. (We do not remember your previous communication, and think it cannot have been received. The expression referred to is merely one of good fellowship on the part of those who use it with the rest of their fellow-readers and contributors, and we need scarcely say we are always glad to welcome additions to the circle. Reply sent will appear next week.)—A Club Man. (There is no "principle" involved; the matter is simply one of calculation, and you had better put the matter into the hands of an actuary if you want a reliable estimate.)—Tyro. (Write E. and F. N. Spon, 48, Charing-cross; or Lockwood and Co., 7, Stationers' Hall Court.)—Lator. (You have acted quite correctly, and it was in the interests of correspondents who kindly offer to do what you have offered that the correspondent you refer to wrote. You would hardly like to be troubled by perhaps twenty correspondents who had written to the querist you were corresponding with, and obtained your address from him in an underhand way.)—G. S. T. (Mr. Muybridge, photographer, San Francisco, U.S.A., is sufficient address.)—Photo. (1. You had better write to the secretary. 2. There is no such book; you had better subscribe to the *Photographic News* and the *British Journal of Photography*, and get the excellent handbooks they issue.)—J. C. (Hints as to learning Italian were given on pp. 98 and 123 of last vol.)—Decorator. (There is nothing of the kind published as a periodical worth buying. Some valuable articles appeared in the *Building News*, under the head of "Furnitute and Decoration," during 1869 and the three following years.)—J. W. E. N. (We know of nothing, but you can ask for any information you want through our own columns.)

"Don't Refer me to Back Numbers."—"J. L. E." writes:—"How often do we see the above at the foot of a query? To me it appears a selfish request. 1. It shows that the querist requires the information solely for his own benefit. 2. That, if an old subscriber, he is too idle to search back numbers; or, if a new one, too unwilling to purchase that in which the desired information may be contained. 3. That he wishes your valuable space to be occupied by answers to queries which, probably, have been given often before. What is worth having is worth searching for, and, as Captain Cuttle says, 'When found make a note of.' I would rather look through back volumes every night for a week than give a fellow-subscriber the trouble of replying to a query until I was satisfied that an answer to a similar one had not been given. Considering the immense amount of information contained in the pages of the English Mechanic, a man ought not to begrudge either his time or the money necessary to purchase a back number in order to obtain what he requires."—"J. L. E.'s" remarks are very sensible ones. Many readers forget that most of the indices to our back vols. can be purchased, and the desired numbers selected without purchasing the complete volumes.

Verax, Thorn, Spero Meliora, A Poor Cripple, Boneshaker.—Your queries are advts.

W. H. W., O. E. W., and others have replied to queries already similarly answered.

CHESS.

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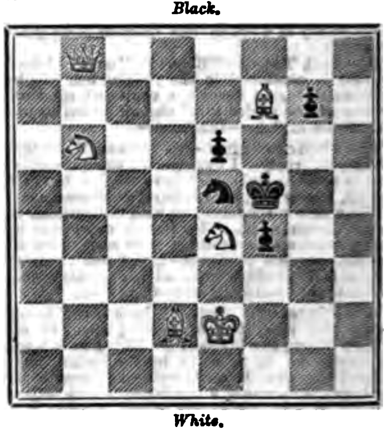
All Communications intended for this department must be addressed to J. Pierce, Copthill House, Bedford.

PROBLEM CCCCXXXVIII.—By H. M. Prideaux.

Black.



White.

White to play and mate in four moves.

Solution to 436.

White.	*Black.*
1. Kt to Q 2.	1. R takes Kt (best).
2. Kt to K B 3 (ch).	2. K takes B.
3. R to K 5 (ch).	3. K takes Kt or moves.
4. R takes P mates.	

Notices to Correspondents.

H. F. L. M.—Many thanks for the problems, which are very acceptable.

E. B. H.—You fail to see in your solution of 435 that when 1. Q takes Q the White King is in check. We do not know of any such club, but any chess editor would insert a notice on your requesting him to do so, and you would soon find your hands full.

R. H. M.—We are glad that you discovered the error yourself. We think with you that 431 is an excellent problem and worthy of the fame of its author.

Correct Solution to 435 by Arcanum; that by J. Ro is incorrect, as there is no mate if 1. Kt moves, or 1. P takes P.

Elastic Stamp.—A new form of elastic marking stamp has lately been patented by Pieper, of Dresden. This is based upon the elastic properties possessed by a mixture of gelatine and glycerine, which resists perfectly the action of oils and petroleum, but is not sufficiently permanent to answer a very good purpose. To give it the desired durability, the stamp, as made, is immersed for about 3min. in a mixture in the proportion of 1 part of tannin to 15 parts of alcohol, and then allowed to dry with the stamp side underneath. This is to be repeated hourly for three or four hours, and after the last drying the tanned surface is to be washed with a sponge with lukewarm spirits, in order to remove the superfluous tannin, and prevent its action on the colouring surface. A leather-like surface, with an elastic body, is thus produced, which answers all the purposes of the ordinary rubber stamps at present in use, besides being very much more easily prepared.

English Mechanic
AND
D OF SCIENCE AND ART.

'RIDAY, AUGUST 23, 1878.

ARTICLES.

v. THE ELECTRIC LIGHT.

ɔattle between coal-gas and the
tric light has, at last, fairly com-
n this country; and although the
the surveyor to the Chelsea Vestry
main, unfavourable to electricity
stitute for street lamps, there is
son to believe that that gentleman
mistaken in the conclusions at
has arrived. It may be true that
ɔre economical than the electric
ɔrdinary street lamps—though we
o doubt even that; but it is cer-
the new system is immeasurably
where large areas have to be illu-
We reserve a discussion of the
ised, however, in order to notice a
.d at the first sitting of Section A
itish Association. It is acknow-
hat the electric arc is the most
illuminating agent known, and its
y for lighthouse purposes has been
:d in a practical form by our
rs. We have been slow to take
;e of it, although we are the first
nation, and have a very long
coast to guard. Mr. J. R. Wig-
taken advantage of the meeting of
ish Association in Dublin to call
ı to the lighthouse arrangements
ɔmmissioners of Irish Lights, and
's were amongst the most interest-
valuable of those read on the first
ıe session. Galley Head is a pro-
on the coast of Cork, in the
ırhood of which many shipwrecks
ırred. It is an important point,
[rish Commissioners at once saw
ssity of displaying the best light at
nmand. Prof. Tyndall was con-
ıd asked to give his opinion as to
t powerful and distinctive light
.d be obtained; the distinctiveness
ght, as can be readily understood,
most important consideration.
ıpon the advice of Prof. Tyndall
ımissioners determined to adopt
lriform Group Flashing Gas Light,
y were, accordingly, the first to
s as the illuminating agent for an
ıt lighthouse. It will be under-
ıt the question was put some years
ɔre the capabilities of the electric
re well understood. Mr. Wigham
ed upon to devise the necessary
ıs, and he therefore sought to
ıe greatest possible intensity with
test volume of flame; and he suc-
by the means we are about to
. He employed a number of fish-
ıers arranged in a peculiar manner,
ısing talc, or some other suitable
ɔe, he succeeded in rendering the
ɔ smoky part of the flame a mass
ng light. The oxygen of the air
l at two places; first at the bottom
flame, and, secondly, at the top,
s action raised to a white heat the
antity of solid carbon which would
ıe have escaped unconsumed. The
f the lamp was illustrated during
ing of the paper—first by showing
ut the talc oxidiser, and afterwards
A complete burner was exhibited,
by what means chimneys had been
:d with, and the manner in which
t could be increased to adapt it to
e of the weather. On clear nights 28 jets are used; but if the weather is thick that number can be instantly increased by degrees to a maximum of 108 jets. The gas supplied is of 32 candle-power; but Mr. Wigham relies mainly upon a suitable arrangement of lenses for concentrating the maximum power of the gas in his lamps. There are at present some restrictions as to the use of lenses, the ordinary pattern being suitable for use with an oil-lamp, giving a flame 4in. in diameter and 3½in. high. But Mr. Wigham's largest gas-flame is 12in. in diameter and 8½in. high, and a lens suited to that, would, of course, largely increase the illuminating power. For illuminating during fogs he uses the largest lenses permitted, and he has devised a means of quadrupling the power of his largest gas-light. This plan consists in placing two, three, or four burners vertically, and in making arrangements by which the products of combustion of the lower burners are carried away so as not to interfere with the upper burners. In the Galley Head light there are eight sets of burners and 32 lenses which touch one another, so that the rays of light blend and throw out one brilliant beam—equal, when necessary, to about one million sperm candles. This enormous power is, however, so much under the control of the keeper that only one-fourth or one-half could be used at his discretion, according to the state of the weather. The light is a group-flasher, the extinction and re-ignition of the gas-flames being regulated by the same clockwork as works the lenses. We thus have not only a very powerful light, but one that can be distinguished and identified, and the master mariners, who are the most interested persons, have expressed their satisfaction in very complimentary terms. Mr. Wigham, however, was not satisfied with his arrangements, and in endeavouring to improve them determined to try the electric-light in combination with his gas-flames. While the British Association was sitting, then, the Bailey Lighthouse was accordingly illuminated by the electric arc in combination with gas, and Mr. Wigham stated that the light was so clear and intense that he had been enabled to read the programme of the meeting while at a distance of six and a half miles from the source of the light. The electric light will be used only during fogs, so that no extra expense is incurred during ordinary weather.

A fog-signal has also been devised by Mr. Wigham, the report being produced by the explosion of a mixture of atmospheric air and coal-gas. A gas-gun of his invention was placed in the grounds of Trinity College, and exploded by electrical means, to show the members assembled the possibility of the scheme. A new atmospheric gas machine was also exhibited, which was said to be well adapted for outlying stations where coal-gas could not be obtained. All these experiments served to demonstrate the value of coal-gas, and at the same time helped to show that if the electric arc could be utilised, a superior illuminating agent would be placed at the service of those who have our lighthouses in charge. We confess to some surprise that the report of the surveyor to the Chelsea Vestry should have been of an indefinite character. He acknowledges that the electric light might be used with splendid effect in large areas, such as that of Trafalgar-square, but he practically condemns its use on such places as the Chelsea Embankment. At present that part of London is illuminated by 109 gas lamps, which cost 2s. 1½d. per hour; but, according to the Chelsea surveyor, 48 electric lamps would be required, costing 24s. per hour, to effect the same degree of illumination. We have no hesitation in expressing our belief that he is mistaken, for at this rate one electric lamp is only equal to a little more than two gas-jets. The figures used by the Chelsea surveyor have not been obtained from any practical trials, but only from such experience as he has been able to acquire in a visit to Paris. He informs us that after a careful consideration of the whole question he is of opinion that the electric light is not at present suitable for street-lighting in the metropolis, but that it is suitable for large areas like Trafalgar-square and Parliament-square, although at an increase upon the cost of gas. He speaks of engines of 16 horse-power being necessary at several stations; whereas the fact is that in London itself there would be no occasion to put down engines at all, because arrangements can easily be made with the owners of steam-power for the working of the requisite machines, as is the case with the Gaiety light, which is worked from the *Echo* office. It appears to us that the Chelsea surveyor has made little if any allowance for the superiority of the electric light over gas, and has confined himself too much to the study of the Jablochkoff candle, which is not the best arrangement that has been devised. We must have been grossly deceived if it requires 48 electric lamps to supply the place of 109 gas lamps, which as at present arranged illuminate the sky as much if not more than they do the streets; and we should like further details before we accept the dicta of the Chelsea surveyor. We suspect that that gentleman has not risen to the occasion, but has accepted certain figures supplied to him, and without any practical experience of what has been done, save in Paris, where he has been, and having presumably made himself acquainted with the details of one system, has practically condemned electric lighting. We know, however, that it is in use at Siemens' works, and we believe that it can be adopted in the streets of London with advantage to the community and economy to the ratepayers, and we are convinced that 48 electric lamps must give more light than 109 gas lamps, which, as we have mentioned above, throw the greater portion of their illuminating power where it is not wanted.

HOW TO MAKE A PIANOFORTE.—VI.

THE check action I have selected is that known as the "Molyneux," as it combines simplicity (and is comparatively easy to put together) with thorough efficiency. There are, no doubt, other double actions that equally fulfil these conditions, but I think and (by the time the regulating is satisfactorily accomplished) I am sure the amateur will agree with me that one is quite sufficient. The patent of this action having recently expired, it may now be readily procured and at greatly reduced prices—viz., from 50 shillings upwards, according to the quality of the hammers. It may be obtained from the late patentees, Messrs. H. Brooks and Co., and Messrs. J. Nott and Co., Kirkwood-road, N.W., and probably at most small-work makers. As the keys of this action work in front of and not under the lever rail, as in the hopper action, they must either be 1in. shorter, or the action frame placed that much further back. In diagram Fig. 2, page 515, it will be seen I have allowed a greater space between the keybottom and strings than is absolutely necessary, so that the latter method can be adopted. As before, the keys are just taken in hand, the process being exactly similar, omitting the morticing. The action frame is also put together in the same manner, the measurements being slightly different. The top of the lever rail for instance is only three inches above the key-bottom, and is flush with the bottom of the standard, and 17in. from inside the lock-board. The centre wire of the hammer rail is 4½in. below the top bridge pin, and the space between these two rails being greater, advantage may be taken of it to insert another called the "stretcher rail" midway between them, for the purpose of and the nitrogen rising to the upper part is removed by means of a pump. The second portion of the process consists in fixing the nitrogen to a metallic base, the product for instance being cyanide of potassium.

BEE MANAGEMENT.

(*Continued from p.* 411).

The Divisional Hive.

THE peculiarity of this hive is, that the front and back of the hive are formed by the ends of the bars. A single bar is shown at Fig. 1. It is formed by first taking two pieces of wood 9in. long and 1½in. wide—A A. These are connected by the two pieces, B B, which are 15in. long and ⅞in. wide. Neither of the strips is fastened at the ends of A, but one at ¼in. from the bottom and the other at ¼in. from the top. These strips form the top and bottom of the frame. At a distance of ¼in. full from A two strips ⅞in. wide connect the top and bottom of the frame, and form the actual sides of the frame—the parts, A, forming the front and back of hive. The section of bar at Fig. 2 will render all clear. To form a hive a number of bars are arranged side by side, and placed inside a wooden case or body, which is supported on four legs, and surmounted by a roofed super cover (which is hinged to one side of the hive body). Five of the bars are shown in position at Fig. 3. The sections or bars are held together by a couple of springs, and there is a frame with a window in it which takes the place of dummy. The advantages of this hive are that the bars can be inverted if required, and there is no fear of the combs being damaged by the motion of the frames should the hive be sent either by road or rail. The reason for the occasional inversion of the bars will be explained when describing the different plans of "bar-frame" management. The disadvantage is the great danger of crushing to death large numbers of bees between the sections after an examination of the hive, and the risk run of so depriving a stock of its queen at a time when it is impracticable to replace her. In the hive as advertised, 10 frames constitute an entire hive, but like other hives the number of frames in use may be regulated by the insertion of the dummy at any required point.

W. S. Travis.

FIG. 1

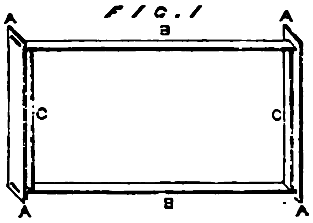


FIG. 2

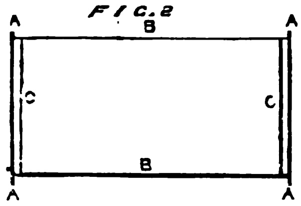
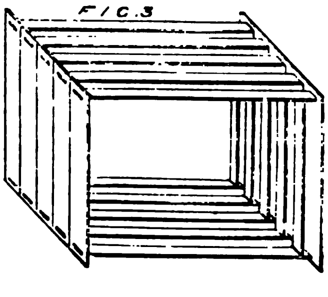


FIG. 3

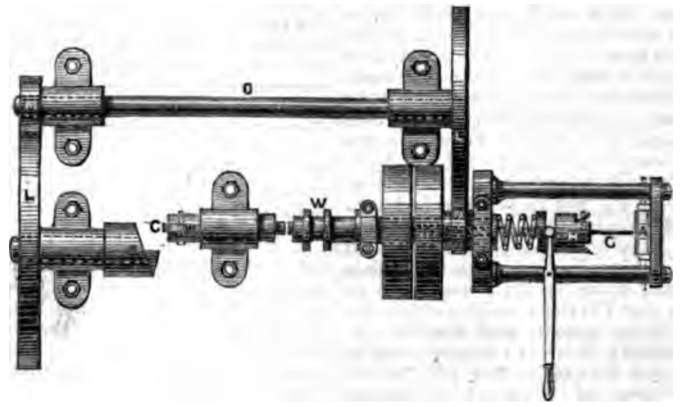


NUT-TAPPING MACHINE.

AN improved nut-tapping machine has been patented by Mr. T. Mason, of Birmingham, which is said to be capable of turning out a *much larger amount of work* with reduced labour, owing to the application of the self-acting principle.

The machine consists of the usual framework, with driving shaft and gear. It is fitted with a long box chuck or hopper, in which the blanks are placed; the tapping tool is fixed at the lower end of this chuck, and is started by means of a cam. As each nut is tapped, the tool is withdrawn by means of a balance weight, freeing the nut from the chuck, when another blank falls into position for tapping, and so on until the chuck or hopper is empty. In front of the chuck there is a slide guide, worked by a lever from the balanced weight, which is to prevent the twisting or dropping of the nut from the chuck until the tapping tool is restarted.

In the engraving, which represents a plan of the machine, seen from above, A is the box chuck into which the blanks are fed, G is the tapping tool held in a spring chuck, H, carried on a shaft driven in the usual manner by a pulley and belt. L and M represent toothed wheels and pinions, by which motion is imparted to a screw cam, B. This cam rubs against a friction roller, C, the impact starting the tapping tool into the blank. When the nut has been tapped, the tool is withdrawn by the action of a balance weight connected by means of a lever to the collar, W; the same lever serves also to work a slide guide placed in front of the chuck to prevent the nut under operation from twisting or dropping until the tap is restarted. The tool, G, is held in the chuck, H, until its shank is covered by the tapped nuts, when by actuating the lever, the tap springs out, and the operations are repeated.



THE LATE TOTAL ECLIPSE OF THE SUN.*

By Richard A. Proctor.

BEFORE many days we may expect to have fuller news than has yet been received respecting the total solar eclipse of July 29th. There are those who infer from the telegrams that little of importance has been discovered on the present occasion. For my own part, I believe we shall find that few eclipses have revealed results of greater interest. When the American photographs have been duly dealt with, and good engravings of them sent over to our scientific societies, we shall probably find the last lingering doubts respecting the solar nature of the corona definitely disposed of. I must confess I was surprised to observe that the correspondent of the *Daily News*, easily to be identified as Mr. Lockyer, still retains rather more than doubt on the subject of the coronal rays. He definitely advances the startling assertion that the observations made during the eclipses of 1870 and 1871 established the fact that the rays seen extending far beyond the coronal glory are either optical, terrestrial, or cis-lunar, as distinguished from solar phenomena. Somewhat as he maintained that the photographs of the corona obtained by Willard at Xeres, and by Brothers at Syracuse, in December, 1871, were entirely discordant, until it was established beyond all possibility of doubt that they were in close agreement; and as, in December, 1872, while the photographs which settled the whole question were being developed, a telegram from him was on its way to Jaffna assuring the observers there (waiting then for totality) that the corona had been *proved* to be almost wholly terrestrial; so, in his letter to the *Daily News*, he stands out for the non-solar nature of the coronal rays within a few days of the eclipse, which has most probably established their solar character in a manner which even he will recognise as demonstrative. Of course I would not deny that an observer may for a moment see beams which have no existence but in his own eye, or that, at the very beginning or at the very end of total eclipse, a long ray of sunlight in our own air may seem to belong to the sun. But the idea that rays which have been seen during the whole continuance of total eclipse can be non-solar phenomena, is one which no one at all acquainted with the facts (with some small inkling of mathematics to aid him in interpreting them) can entertain for a moment. I believe it had its origin in an ingenious experiment devised by the late Father Secchi, and sometimes called the "shutter-and-bung" experiment. If a round hole in a shutter is imperfectly stopped by a somewhat irregular bung, and an observer, in a room which receives no light except through this hole, looks directly at the bung, he will see a number of rays resembling in their general appearance the coronal rays seen during total eclipses. The notion suggested to some by this experiment is, that the moon may perform some such part as the irregular bung. They overlook the fact that the shutter is as necessary as the bung to the shutter-and-bung experiment. In a total eclipse the shutter is omitted; and the omission is rather important. Again, it is not true that photography has failed to show the coronal rays. I have before me, as I write, a magnificent proof of the engraving representing the photographic views of the corona in December, 1871; and many straight rays can be traced to a distance corresponding to more than five hundred thousand miles from the eclipsed sun. These, of course, being photographed at the beginning, middle, and end of totality, and at two stations hundreds of miles apart (one at the sea-level, the other ten thousand miles above it), are necessarily solar. The rays were seen to a much greater distance; but, unless the wild (one might almost say the insane) theory is maintained that the parts photographed were solar, while their fainter prolongations were nearer to us than the moon, the photographs taken in December, 1871, cannot honestly be said to have demonstrated the non-solar character of the coronal radiations. Nay, even on that stupendously absurd assumption, the evidence of the photographs respecting the fainter parts of the rays could only be regarded as negative. But I believe every one whose opinion on such a question could be of the least weight recognises the photographs taken in 1870 and 1871 as demonstrating the solar nature of the whole coronal structure—though, doubtless, some faint luminosity over the coronal region is due to the illumination of our own air by the solar corona. How faint this luminosity must be is shown by the fact that over the dark body of the moon, where this light is of necessity strongest (the part of the air directly between the observer and the moon receiving more light from the corona than any other), the luminosity is so faint that to ordinary vision the moon looks absolutely black during totality.

One reason why I believe that the observations made during the recent eclipse will prove very valuable is this, that the greater number of observers were stationed high above the sea-level. Much less air intervened between them and the corona than under ordinary conditions. It has always been noticed that the coronal rays are better seen the clearer the air is and the higher the observer's station. For instance, whereas the greater number of the observers of the eclipse of 1869 saw no rays, General Myer, stationed 5,530 feet above the sea-level, saw four rays extending to a distance of two or three diameters of the sun—say to between 1,700,000 and 2,600,000 miles. That the conditions were favourable on July 29 last is shown by the circumstance that Professor Newcomb, employing a method of observation which I suggested some five or six years ago, was able to trace the faint light of the zodiacal to a distance of about six degrees from the eclipsed sun. This had never before been plished. Indeed many thought that the al light never could be seen during totality. the *Gentleman's Magazine* for July last I sed the opinion, confirmed by the event, that, reening the brighter part of the corona from the eye might, under favourable atmospheric ions, detect the faint light of the zodiacal. We hat Professor Newcomb erected a screen on a ole, and traced the zodiacal to a distance of grees, or some eight million miles from the

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* [illegible] Echo.

ther important discovery is the recognition of ct that the inner corona last July differed dly from the corona which has been seen in It was much less extensive, but much er. Its light was not that of glowing gas, but wing solid or liquid matter. Its colour was nk, but pearly white. The eclipse of 1871 ed when the sun had many spots, whereas at t there are few spots. Accordingly, Mr. er infers that the corona sympathises with , and is expanded, faint, and partly gaseous, the sun is greatly disturbed, while it is con-, bright, and free from gaseity when the sun no spots. The generalisation is daring, but y trustworthy; *c'est magnifique, mais ce as la science.* It requires only a careful of the evidence afforded by former eclipses to r that in a year when the sun is very little ed, the expanded and faint corona may be while in a year when the sun is greatly ed we may see the contracted and bright . There may be a connection between the and the sunspots. Indeed, before the present occurred, I indicated the probability that, prominences and sierra seem to sympathise he sun, so also may the corona. But the not so simple as has been supposed. Many must be observed before the exact nature of connecting the phenomena of the corona and -spots can be detected. I have examined in le which will appear shortly in the *Contem- Review* the evidence from the eclipse of the present time; but it is not sufficient to us to form a satisfactory theory. Overhasty isation is the bane of true science.

telegrams can be trusted, Prof. Watson, of bor, the discoverer of some score of planets ng between Mars and Jupiter, has discovered t travelling between Mercury and the sun. nnounced in the *Times* telegrams that a " between the fourth and the fifth magni- as seen in such and such right ascension and tion during totality. I pointed out at the ndeed I believe I was the first to point out— star Theta Cancri was very near the spot d by these telegrams. Yet (as I also men- Professor Watson was not likely to mistake Cancri for a planet. I have since received ashingion the chart issued for the guidance e who were to look for an intra-mercurial I find that it includes Theta Cancri, as ave been anticipated. On the whole I think mely unlikely that an astronomer so skilful essor Watson should have mistaken Theta for a planet. I fancy he saw both the star stranger, and that it was by seeing the two thus in juxtaposition that he was able so ly to indicate the brightness of the unknown If so, a new planet—which *may* be Lescar- Vulcan—has been discovered, travelling the sun and Mercury.

W METHOD OF GRINDING GLASS SPECULA.*

By Prof. Elihu Thomson.

use of glass in the construction of specula r telescopes has almost superseded that of The many advantages arising from the nent of silvered glass specula are well known, ne mirrors constructed of this material being ence. The principal expense to amateurs ers desiring to construct for themselves a ble speculum arises from the preparation of rinding tools. These, usually two in number, erally made of brass or cast iron, carefully and scraped to approximate curves, and round together until the desired accuracy of is obtained. This operation of fitting requires of special appliances, and is at once a tedious cult operation to the unpractised. The tools, d as stated, are employed to give form to the which is to constitute the reflector. The difficulties of preparing metal-grinding tools size, the impossibility of avoiding conditions in cast metal, and the greater expansion by the metal tool than of the glass to be make it desirable to avoid the use of metal- where practicable. This is particularly the ere but one or two specula of any given focal re to be prepared.

believed that the method presently to be d provides a means of obtaining a good t the same time that the metal tools are com- dispensed with, and from the simplicity of the process any one who can give the requisite care demanded by all work of the kind, may practise it with success. The principle of the method is the fact that when two equal discs of glass or other material are ground together, one above the other, the under one always becomes convex while the upper one becomes concave, and, by making the strokes of the upper disc wide and sweeping, this change of form may be greatly accelerated.

The reason for this is obvious. When the upper disc, A, Fig. 1, is in the position there shown, the downward pressure is principally upon the edge of the lower disc and upon the centre of the upper one, thereby causing a greater action of the interposed grinding material upon those parts, so that there eventually results a form similar to Fig. 2. The strokes may be so made that the surfaces in contact become spherical, this condition being greatly favoured by the fact of the material of the two discs having the same relative hardness, elasticity, and expansion by accidental changes of temperature during the grinding operation.

By testing, from time to time, the curve acquired by the discs any desired radius may be obtained. Where a spherometer is not at hand, simply using the wet concave in the sun and noticing at what distance from the centre of the disc the reflected rays give the best defined image, we are enabled to obtain the focal length at any stage of the process. Where solar light is not available, the rays of a lamp may obviously be used to obtain the data for calculating the focal length.

The details of the process are as follows:—The grinding material is, of course, emery of various degrees of fineness, the polishing being accomplished with rouge or ferric oxide, prepared either by heating pure ferrous sulphate to decomposition, or by heating precipitated ferric hydrate to a bright red. For details, as to preparation of emeries, precautions to be taken, methods of testing surfaces obtained, &c., we refer to Dr. Draper's very able paper on "Silvered Glass Specula," in the Smithsonian Contributions, Vol. XIV.

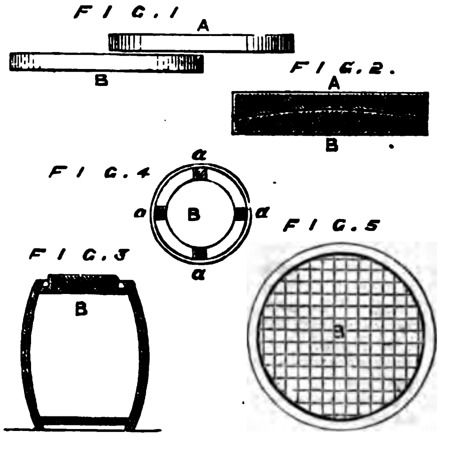
FIG. 1
FIG. 2.
FIG. 4
FIG. 3
FIG. 5

Two discs of heavy skylight glass, nearly free from bubbles and other imperfections, are obtained. They should be of a thickness not less than half an inch, for a diameter of four or five inches, and should increase in thickness with increase of diameter. The edges should be circular, rough or sharp edges being removed by grinding. The surfaces should be flat, and parallel to each other.

The disc which is to be the under one during the grinding process, and which we shall designate B, is placed upon a grinding-post, Fig. 3, the under surface being equally supported at its various points. The disc is kept in position by pieces of wood, *a*, *a*, *a*, *a*, Fig. 4, placed around it at regular intervals, thus permitting easy removal, if desired. The grinding-post, as is usual, may consist of a barrel, weighted or held firmly to the floor.

Having cemented a handle to the back of the disc which is to become the speculum, and which we shall designate A, it is placed upon the disc, B, emery, say, No. 60, and water supplied, and ground over B with wide, swinging strokes, fresh emery being supplied as needed. This process is continued until the tests of curve above mentioned show that the disc, A, has acquired a surface, the focus of which is somewhat longer, say $\frac{1}{8}$, than the desired focus. The discs are now carefully washed, to get rid of all the coarse emery, and a finer grade, say 90, applied for continuing the grinding. The same operation is repeated, using flour emery, and afterwards the washed grades, which may be, successively, $\frac{1}{2}$ min., 5 min. and 10 min. emeries. Between each grade a careful washing of the hands, discs, &c., is necessary, to avoid retention of coarse particles that may fall subsequently upon the glass surfaces, and produce scratches difficult to remove. While using the flour emery, the curve can, with proper care, be made to reach that required to produce the desired focus, on attaining which the swing of stroke is to be lessened, to avoid shortening the focus.

The grinding with the very fine grades of emery, seldom produces any considerable change in the focal length, if the proper stroke be given. If, through any cause, too short a focus has been obtained, it can easily be lengthened by reversing the relative positions of the two glass discs, making A the lower. To obtain a spherical surface, all possible directions of motion are to be given to the upper disc, and the operator should work from various sides of the grinding-post. It may here be said that the writer has not had the opportunity of applying this method to production of specula, otherwise than by hand. There is little doubt, however, of its success with appropriate machinery.

In the last and final grinding with emery, the greatest care must be exercised, as much time may be saved in the polishing by the attainment of a good surface and figure by the grinding.

In the employment of the finest grade of emery, the last charge should be kept on and worked down so smoothy that no grinding noise is made by the two surfaces sliding one over the other. Just sufficient water should be added to keep the surfaces uniformly wet, an excess being apt to wash off the fine cutting powder so essential to success in this part of the operation. The smoothing is continued until the surface of A can reflect the light of a window at incidences of 40° to 50°, and when examined by transmitted light, preferably by using a magnifier, should present a very fine and uniform grain. Before making any change in grade of emery, it is essential that all marks made by previous sizes have been obliterated.

If, in the fine grinding, after sufficient examination, the conditions mentioned appear to have been attained, the speculum is ready for the polishing. This is done in the usual manner. The polisher is prepared by coating the lower or convex disc, B, with a layer of pitch, or other well-known composition, to about $\frac{1}{8}$in. thickness, and after having warmed the coated disc so as to soften the pitch, the concave disc, A, is wetted and pressed upon the pitch surface of B, to insure a fit.

Parallel grooves are then made in the pitch surface in such a way as to divide it into squares of uniform size, Fig. 5—a well-known procedure in polishing specula—after which the surfaces are again carefully fitted as stated above. Preferably, the diameter of the polisher is about one-tenth or one-eighth less than that of the surface to be polished by it, as by this means the desired figure is more readily obtained.

The disc, A, to be polished, is now laid upon the grinding-post, concave side upward, and the polisher, B, charged with finely washed rouge, worked in all directions on it, occasional additions of rouge being made. When the surface of the speculum is sufficiently polished to reflect light, tests of figure are made from time to time, the methods of Draper and Foucault being admirable for the purpose. The attainment of a spherical surface is in this way free from especial difficulties, and it may be converted subsequently into that of a paraboloid of revolution by the method recommended by Mr. Draper, and fully described in his paper previously referred to.

It cannot be too strongly urged upon those attempting the construction of specula that changes of temperature, by handling or otherwise, must, during the polishing, be carefully avoided. The silvering of the finished speculum is readily accomplished by following closely the method given by Dr. Draper.

Tests of this method of grinding specula, made during the last two years, show that its capabilities are at least equal to those of the usual process with grinding tools of metal, and it is possible that with increased experience the latter may be surpassed. The method has, however, undoubtedly the advantage of a saving of time in preparation of the tools, as also of expense for materials used.

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rom the *Journal* of the Franklin Institute.

MR. GLADSTONE ON HANDICRAFT.

THE following sentences spoken by Mr. Gladstone last week at Hawarden, in the course of an address at a local flower show well deserve the consideration of every "English Mechanic." "I would," said Mr. Gladstone, "that the people of this country would give more attention than they do to raising hand labour of all kinds to the excellence of which it is susceptible. They are too fond of getting out of hand labour and getting into what they call head labour—that is to say, getting sufficiently acquainted with reading and writing and casting up accounts, perhaps, to get into the lower class of clerks. I do not believe that there is a more distressed class in the country than that class, and I believe that a great number of the young people would do infinitely better for themselves and for society if they were content to keep much more than they do to the use of their hands, and would try to raise the character of the labour which they perform with their hands, because, pray remember, that a great deal of the very highest labour is labour performed with the hands. Look at the labour of the painter, of the sculptor, and not only so, but look at a great many intermediate kinds of labour—hand labour—which is strictly all dependent on an excellent hand.

And now there is a great deficiency of that kind of labour in this country. Go into the study of a sculptor in London, and you will find the sculptor. probably an Englishman, is obliged to have a great many assistants, because working at the marble requires very much to be done before the stage of finishing comes, and these assistants are well paid; but if you come to talk to them you will find that in the large majority of cases they are not Englishmen at all, but Italians and Frenchmen—very commonly Italians. What I want you to do is this: not to be in such a hurry to get into so low a class of head labour as copying clerks, or something of that kind. People should recollect that handicraft itself is capable of being raised to a very high description of art, and of yielding a very high standard of remuneration. I cannot tell you how anxious I am to impress that upon the minds of young people, and how certain I feel that the lesson is one of great importance to the people of this country. Let them perform their work in the spirit of an artist; let them try to give it excellence, and make a thing that not only will sell, but as good as they can make it, as useful, as well put together, as well proportioned, as pleasing to the eye, as full of beauty as they can make it; and the more they try to do it the better they will be able to do it."

ANIMAL INTELLIGENCE.

THE following is an abstract of the lecture delivered by Mr. Romanes on Friday evening last, at the Exhibition Building, Dublin:—Animal Intelligence is a subject which has always been of considerable interest to philosophical minds, but, as most of you are probably aware, the interest attaching to this subject has of late years been greatly increased by the significance which it has acquired in relation to the theory of descent. As human intelligence is the only order of intelligence with which we are directly acquainted, and as it is moreover the highest order of intelligence known to science, we may most conveniently adopt it as our standard of comparison. When I allow my eyes to travel over this vast assembly, my mind receives, through their instrumentality, a countless number of impressions. So far as these impressions enter into the general stream of my consciousness, they constitute what are called perceptions. Suppose, now, that I were to close my eyes, and to fix my attention on the memory of some particular perception which I had just experienced—say the memory of some particular face. This mental image of a perception would be what is called an idea. Lastly, suppose that I were to analyse a number of the faces which I had perceived, I should find that, although no two of them are exactly alike, they all bear a certain general resemblance to one another. Thus from the multitude of faces which I now perceive it becomes possible for my mind to abstract from them all the essential qualities of a face as a face; and such a mental abstraction of qualities would then constitute what I might call my abstract idea of a face in general, as distinguished from my concrete idea, or memory, of any face in particular. Thus, then, we have three stages:—1st, that of immediate perception; 2nd, that of ideal representation of particular objects; 3rd, that of a generalised conception, or abstract idea, of a number of qualities which a whole class of objects agree in possessing. It will be convenient to split the latter division into two subdivisions—viz., abstract ideas which are sufficiently simple to be developed without the aid of language, and abstract ideas which are so complex as not to admit of development without the aid of language. As an instance of the former class of abstract ideas we may take the idea of food. This is aroused in our minds by the feeling of hunger; and while the idea when thus aroused is clearly quite independent of language, it is no less clearly what is called an abstract idea. For it is by no means necessary that the idea of food which is present to the mind should be the idea of some special kind of food; on the contrary, the idea is usually that of food in general, and this idea it is which usually prompts us to seek for any kind of food in particular. Simple abstract ideas, therefore, may be formed without the assistance of language; and for this reason they are comprised within what Lewes has called the logic of feelings. But abstract ideas of a more elaborate type can only be formed by the help of words, and are therefore comprised within what Lewes has called the logic of signs. Now, with regard to ideas themselves, I need only add that they are the psychological units which compose the whole structure intellectual. They constitute, as it were, the raw material of thought, which may be elaborated by the reflective faculty into various products of thought. Once formed they present an essential property of occurring in concatenated series; so that the occurrence of one idea determines that of another with which it has been previously joined. This principle of the association of ideas, manifested as it is by the ultimate units of intellectual structure, is by far the most important principle in psychology; it is the principle which renders possible all the faculties of mind memory, instinct, judgment, reason, emotion, conscience, and volition. Mr. Romanes then proceeded to give an elaborate analysis of the psychological basis of mind, and in taking leave of that part of his subject he pointed out that in recognising the indisputable fact of mind having such a basis we are not necessarily committing ourselves to the doctrine of materialism. That psychical phenomena are very intimately associated with physical phenomena, is a fact which does not admit of one moment's dispute; but concerning the nature of this association science must declare, not merely that it is at present unknown, but that, so far as she is at present able to discern, it must for ever remain unknowable. Passing on now to our review of comparative psychology, the first animals in which, so far as I can ascertain, we may be quite sure that reflex action is accompanied by ideation, are the insects. For Mr. Darwin has observed that bees remember the position of flowers which they have only several times visited, even though the flowers be concealed by intervening houses, &c. Sir John Lubbock also has shown that, after a very few individual experiences, bees are able to establish a definite association between particular colours on paper and food; and further that, after a very few lessons, a bee may be taught to find its way out of a glass jar. These observations would seem to prove that the grade of intelligence is higher in some articulata than it is among the lower vertebrata. For many of you will probably remember the experiment of Professor Mobius, which proved that a pike requires three months to establish an association of ideas between particular kinds of prey, and the fact of their being protected by an invisible wall. This fact was proved by the pike repeatedly dashing its nose against a glass partition in its tank in fruitless efforts to catch minnows which were confined on the other side of the partition. At the end of three months, however, the requisite association was established, and the pike, having learned that its efforts were of no use, ceased to continue them. The sheet of glass was then removed; but the now firmly established association of ideas never seems to have become disestablished, for the pike never afterwards attacked the minnows, though it fed voraciously on all other kinds of fish. From which we see that a pike is very slow in forming his ideas, and no less slow in again unforming them. As regards the association of ideas by the higher vertebrated animals, it is only necessary to say that in all these animals, as in ourselves, this principle of association is the fundamental principle of their psychology; that in the more intelligent animals associations are quickly formed, and when once formed are very persistent; and, in general, that so far as animal ideation goes, the laws to which it is subject are identical with those under which our own ideation is performed. Let us then ask, how far does animal ideation go? The answer is most simple, although it is usually given in a most erroneous form. It is usually said that animals do not possess the faculty of abstraction, and therefore that the distinction between animal intelligence and human intelligence consists in this—that animals are not able to form abstract ideas. But this statement is most erroneous. You will remember the distinction which I laid down between abstract ideas that may be developed by simple feelings, such as hunger, and abstract ideas that can only be developed by the aid of language. Well remembering this distinction, we shall find that the only difference between animal intelligence and human intelligence consists in this—that animal intelligence is unable to elaborate that class of abstract ideas, the formation of which depends on the faculty of speech. In other words, animals are quite as able to form abstract ideas as we are, if under abstract ideas we include general ideas of qualities which are so far simple as not to require to be fixed in our thoughts by names. For instance, if I see a fox prowling about a farmyard, I cannot doubt that he has been led by hunger to visit a place where he has a general idea that a number of good things are to be fallen in with, just as I myself am led by a similar impulse to visit a restaurant. And, to take only one other instance, there can be no question that animals have a generalised conception of cause and effect. For example, I had a setter dog which was greatly afraid of thunder. One day a number of apples were being shot upon the wooden floor of an apple-room, and as each bag of apples were shot it produced through the rest of the house a noise resembling that of distant thunder. My dog became terror-stricken at the sound; but as soon as I brought him to the apple-room and showed him the true cause of the noise, he became again buoyant and cheerful as usual. Another dog which I had, used to play at tossing dry bones to give them the appearance of life. As an experiment I one day attached a fine thread to a dry bone before giving him the latter to play with; and after he had tossed the bone about for a while as usual, I stood a long way off and slowly began to draw it away from him. So soon as he perceived that the bone was really moving on its own account his whole demeanour changed, and, rushing under the sofa, he waited horror-stricken to watch the uncanny spectacle of a dry bone coming to life. I have also greatly frightened this dog by blowing soap bubbles along the floor; one of these he summoned courage enough to touch with his paw, but as soon as it vanished he ran out of the room terrified at so mysterious a disappearance. Lastly, I have put this dog into a paroxysm of fear by taking him into a room alone and silently making a series of horrible grimaces. Although I had never in my life hurt this dog, he became greatly frightened at my unusual behaviour, which so seriously conflicted with his general idea of uniformity in matters psychological. Of course in thus claiming for animals the power of forming general conceptions, I mean only such general conceptions as can be arrived at by the logic of feelings. So far, then, as the logic of feelings can carry them, I maintain that the intellectual operations of animals are indistinguishable from those of ourselves. My friend Dr. Rae, the well-known traveller and naturalist, knew a dog in Orkney which used to accompany his master to church on alternate Sundays. To do so he had to swim a channel about a mile wide; and before taking to the water he used to run about a mile to the north when the tide was flowing, and a nearly equal distance to the south when the tide was ebbing, "almost invariably calculating his distance so well that he landed at the nearest point to the church." In his letter to me Dr. Rae continues:—"How the dog managed to calculate the strength of the spring and neap tides at their various rates of speed, and always to swim at the proper angle, is most surprising." So much, then, for judgment. For some good instances of reasoning in animals I am also indebted to Dr. Rae. Desiring to obtain some Arctic foxes he set various kinds of traps; but, as the foxes knew these traps from previous experience, he was unsuccessful. Accordingly he set a kind of trap with which the foxes in that part of the country were not acquainted. This consisted of a loaded gun set upon a stand pointing at the bait. A string connected the trigger of the gun with the bait, so that when the fox seized the bait he discharged the gun, and thus committed suicide. In this arrangement the gun was separated from the bait by a distance of about 30 yards, and the string which connected the trigger with the bait was concealed throughout nearly its whole distance in the snow. The gun-trap thus set was successful in killing one fox, but never in killing a second; for the foxes afterwards adopted either of two devices whereby to secure the bait without injuring themselves. One of these devices was to bite through the string at its exposed part near the trigger, and the other device was to burrow up to the bait through the snow at right angles to the line of fire, so that, although in this way they discharged the gun, they escaped with perhaps only a pellet or two in the nose. Now both of these devices exhibited a wonderful degree of what I think must fairly be called power of reasoning. I have carefully interrogated Dr. Rae on all the circumstances of the case, and he tells me that in that part of the world traps are never set with strings; so that there can have been no special association in the foxes' minds between strings and traps. Moreover, after the death of fox number one, the track on the snow showed that fox number two, notwithstanding the temptation offered by the bait, had expended a great deal of scientific observation on the gun before he undertook to sever the cord. Lastly, with regard to burrowing at right angles to the line of fire, Dr. Rae justly deemed this so extraordinary a circumstance, that he repeated the experiment a number of times in order to satisfy himself that the direction of the burrowing was really to be attributed to thought and not to chance. Passing on to the emotional life of animals, we find that this is very slightly, if at all, developed in the lower orders, but remarkably well developed in the higher—that is to say, the emotions are vivid and easily excited, although they are shallow and evanescent. They thus differ from those of most civilised men in being more readily aroused and more impetuous while they last, though leaving behind them but little trace of their occurrence. As regards the particular emotions which occur among the higher animals, I can affirm from my own observations that all the following give unmistakable tokens of their presence:—Fear, affection, passionateness, pugnacity, jealousy, sympathy, pride, reverence, emulation, shame, hate, curiosity, revenge, cruelty, emotion of the ludicrous, and emotion of the beautiful. Now this list includes nearly all the human emotions, except those which refer to religion and to the perception of the sublime. These of course are necessarily absent in animals, because they depend upon ideas of too abstract a nature to be reached by the mind when aided by the logic of signs. Of course the moral sense as it occurs in ourselves involves ideas of high abstraction, so that in animals we can only expect to meet with a moral sense in a very rudimentary form: and, therefore, even if it is true that no indications of such a sense are to be met with in animals, the fact would not establish any difference in kind between animal intelligence and human. But I am inclined to believe that in highly intelligent, highly sympathetic, and tolerably well-treated animals, the germs of a moral sense become apparent. To give an instance, a Skye terrier I had was only once in his life known to steal; and on this occasion, when very hungry, he took a cutlet from a table and carried it under a sofa. I saw him perform this act of larceny, but pretended not to have done so, and for a number of minutes he remained under the sofa with his feelings of hunger struggling against his feelings of duty. At last the latter triumphed, for he brought the stolen cutlet and laid it at my feet. Immediately after doing so, he again ran under the sofa, and from this retreat no coaxing could draw him. When I patted his head he turned away his face in a ludicrously conscience-stricken manner. St. George Mivart has said that an interesting book might be written on the stupidity of animals. I am inclined to think that a still more interesting book might be written on the stupidity of savages. Now there is no doubt that the interval which separates the most degraded savage from the most intelligent animal is, psychologically considered, enormous; but enormous as it is, I cannot see any evidence to show that the gulf may not have been bridged over during the countless ages of the past. Abstract ideas amongst savages are mostly confined to such as may be formed by the logic of the feelings. In comparing the intelligence of a young child with that of an adult animal we are met with this difficulty—that as the bodily powers of children at so immature an age are so insufficiently developed, the mind is not able, as in the case of animals, to accumulate experiences of life. In order, therefore, to obtain a fair parallel, we should require a human being whose mental powers have become arrested in their development at an early age, while the bodily powers have continued to develop to mature age, so serving to supply the aborted human intelligence with full experiences of life. Now, the nearest approach that we have to these conditions is to be found in the case of idiots. As there are all degrees of idiocy, the object of my inquiry was to determine the order in which the various mental faculties become enfeebled and disappear as we descend from the higher to the lower grades of imbecility. Beginning from below, the first dawn of intelligence in the ascending scale of idiots, as in the ascending scale of animals, is invariably to be found in the power of associating simple concrete ideas. Thus there are very few idiots so destitute of intelligence that the appearance of food does not arouse in their minds the idea of eating; and, as we ascend in the scale idiotic, we find the principle of association progressively extending its influence, so that the mind is able, not only to establish a greater and greater number of special associations, but also to retain these associations with an ever-increasing power of memory. Again, the faculty of reason is dwarfed to the utmost —so much so that the investigator is most of all astonished at the poverty of rational power which may be displayed by a human mind that in most other respects seems well developed. A boy, 14 years of age, belonging to the highest class of undoubted idiots, could scarcely be called feeble-minded as regarded many of his faculties. His powers of mental calculation were quite equal to those of any average boy of his age. Yet he was not able to answer any question that involved the simplest act of reason. From the mental condition of uneducated deaf mutes we learn the important lesson that in the absence of language the mind of a man is almost on a level with the mind of a brute in respect of its power of forming abstract ideas. I have, therefore, no hesitation in giving it as my opinion that the faculty of speech is alone the ultimate source of that enormous difference which now obtains between the mind of man and the mind of the lower animals. Is this source of difference adequate to distinguish the mind of man from the mind of the lower animals in kind? I leave you all to answer this question for yourselves. I am satisfied with my work if I have made it clear to you that the question whether human intelligence differs from animal intelligence in kind or in degree hinges entirely on the question whether the faculty of speech has been of an origin natural or supernatural. We are living in a generation which has witnessed a revolution of thought unparalleled in the history of our race. I do not merely allude to the fact that this is a generation in which all the sciences, without exception, have made a leap of progress such as widely to surpass all previous eras of intellectual activity; but I allude to the fact that in the special science of biology it has been reserved for us to see the first rational enunciation, the first practical demonstration, and first universal acceptance of the doctrine of evolution. And I allude to this fact as to a fact of unparalleled importance in the history of thought, not only because I know how completely it has transformed the study of life from a mere grouping of disconnected observations to a rational tracing of fundamental principles, but also because it is now plainly to be foreseen that what the philosophy of evolution has already accomplished is but an earnest of what it is destined to achieve; and, forasmuch as this enormous change in our means of knowledge and our modes of thought has been so largely due to the almost unaided labours of a single man, I do not hesitate to say, even before so critical an audience as this, that in all the history of science there is no single name worthy of a veneration more profound than the now immortal name of *Charles Darwin*.

BRITISH ASSOCIATION.

THE ADDRESS IN MATHEMATICS AND PHYSICS.

THE address in Section A was delivered by the Rev. Prof. Haughton, the president, the Rev Prof. Salmon, being unable to leave his house, through an accident.

After a brief allusion to the views of Plato and his contemporaries as to the importance of mathematics, Prof. Haughton said pure mathematics provided beforehand the weapons and engines which future explorers of nature would make use of. Every one who had studied the applications of mathematics to nature would know that no problem in nature was unsolvable. They could all be brought under the domain of figures, and when the class of problems in which integrations and finite differences could be used were considered, then it would be understood how great a debt was owed to mathematics for inventing the various tables and formulæ which to many persons appeared to interest only a few. All who had studied chemistry knew that that science was obedient to numbers. The doctrine of atomic weights and equivalents showed that chemistry was on the borders of being subject to mathematics. Its combinations in the long run would only be a branch of molecular physics, and the efforts already made were day by day clearing away the darkness that surrounded infinitely small particles of matter. He understood that Professor Sylvester's idea was that there was an inherent identity of form or type between pure chemistry and pure algebra. It was, however, a disagreeable fact that they could not compel other sections to adopt the dogmas which this section laid down, but he ventured to prophesy that ultimately every section of the British Association would sit at the feet of a Gamaliel, and that that Gamaliel would be Section A. Some very remarkable efforts had recently been made by German physiologists to bring not merely anatomical details, but even some physiological questions, under the domain of pure mathematics. In the last century medical men carried this idea too far. They made the whole man a sort of hydrostatic machine. After that a reaction set in, and the school of the Vitalists came into play. But now another reaction had commenced, particularly in Germany, and he believed at a time not far distant a successful attempt would be made to bring portions of physiology and the whole of anatomy under the control of Section A.

THE ADDRESS IN CHEMISTRY.

The address in Section B was delivered by Prof. Maxwell Simpson, M.D., F.R.S., who said it would be difficult to over-estimate the value and extent of the knowledge we derive from chemistry. Without it we can know nothing about the air we breathe, the water we drink, or the food we eat; we cannot understand the processes of combustion, respiration, fermentation, putrefaction, or the endless chemical changes which are continually in operation around us, and which affect our lives for good or for evil. In a word the whole of the phenomena of nature must for ever remain to us, more or less, an inscrutable mystery. Not only is the knowledge we obtain from chemistry very considerable in itself, but it furnishes us with a key which enables us to unlock vast stores of knowledge contained in several other sciences—these are physics, geology, mineralogy, physiology, and, I may now add, astronomy. Physics and chemistry are so intimately connected that it is difficult to say where the one begins and the other ends. The help that chemistry gives to physics is shown by the number of chemists who have distinguished themselves as physicists. I may mention a few belonging to our own time—Andrews, Bunsen, Faraday, Frankland, Graham, Guthrie, and Regnault. With regard to mental discipline, the mind of the student is exercised in both the inductive and deductive methods of reasoning. His original faculties are stimulated by the consciousness that he can in many cases readily test the worth of his ideas by experiment. With inexpensive apparatus and a good balance the intelligent student can make out for himself some of the laws and many of the facts of science, and, it may be, also add to them. He glides insensibly from the known to the unknown. Indeed, his spirit of inquiry demands, in most cases, to be curbed rather than spurred. Some students are constantly finding out new methods of analysis or discovering the precious metals in impossible places. The readiness with which we can cross over into the terra incognita of chemistry, and make little explorations there, constitutes, in my opinion, the great charm of this science, and, to a great extent, its value as an educational agent. What I wish to insist upon is that the student of chemistry can reach the field of original work sooner than the student of most other sciences. Once he commences original research the development of his intellectual faculties rapidly progresses. His imagination is daily exercised in propounding new theories, and devising experiments in order to ascertain their truth or falsehood. And what more valuable intellectual training can there be than the habit of subjecting our ideas to the test of inexorable experiment? In the world outside chemistry we are, alas! too ready to take things for granted. The chemist's motto is "prove all things." The ancients adopted a different method; they assumed certain principles and reasoned from them. They therefore did little in science. Chemistry promotes in a remarkable manner accuracy, thoroughness, and circumspection. An organic analysis requires six weighings; if any one of these is inaccurate, the results are worthless. A qualitative test carelessly applied may cause us, in a research, to waste months in the pursuit of a phantom or will-o'-the-wisp which can have no corporeal existence. If we have to employ absolute alcohol in our experiments, we must not be satisfied with going through the ceremony of making it absolute, but we must assure ourselves that it is absolute. Unless we are sure of every step in our research, our results become doubtful, and therefore of no value. On the circumspection, also, of the original worker large demands are made. The avenues by which error may creep in and vitiate his results are very numerous. These he must foresee and endeavour to close up. Laboratory work teaches us to use our senses aright, sharpens our powers of observation, and prevents us from reasoning rashly from appearances. It also promotes manual dexterity, and trains the hands to work in subordination to the head. Perhaps in no other science is the student so deeply impressed with the order and economy of nature, the immutability of her laws, and the exactness of her operations. These impressions will, no doubt, in after life impart seriousness to his character, and save him from the adoption of many a wild theory. I come now to the effect of original work on the character. Many virtues are necessary to the chemist—courage, resolution, truthfulness, and patience. He is often obliged to perform experiments which are attended with great danger, and no man can hope to fight long with the elements without carrying away many a scar. Sometimes fatal accidents occur. But the chemist must not be discouraged by fear of accident, neither must he be disheartened by the temporary failure of his experiments, nor at the slowness of his processes. Bunsen was obliged to evaporate 44 tons of the waters of the Durcheim springs in order to obtain 200 grains of his new metal, Cæsium. It took Bertholet several months to form, by a series of synthetical operations, an appreciable quantity of alcohol from water and carbon, derived from carbonate of baryta. Many years ago, in the laboratory of Wurtz—my honoured master—a poor student whom I knew, was carrying from one room to another a glass globe, which contained the product of a month's continuous labour, when the bottom of the globe fell out, and the contents were lost. Nothing daunted, he recommenced his month's work, and brought his research to a successful issue. Above all things, the chemist must be true. He must not allow his wishes to bias his judgment or prevent him from seeing his researches in their true light. I am glad to see that the importance of original research as a part of higher education is at last beginning to be recognised in this country. The Royal University Commission at Oxford has recently recommended that candidates for the higher degrees in science shall in that University be required in future to work out an original investigation. In Germany, where education has been so long and so well understood, original work has been, for at least the last half century, a *sine qua non* for a degree. Another admirable rule exists in that country, the adoption of which in Great Britain might go far to wash out the stains from our islands, of not having contributed our fair quota to the advancement of human knowledge. It is this—the Germans make a point of securing invariably that their scientific chairs shall be filled by men who have already distinguished themselves by their discoveries. The professor, on his appointment, naturally desires to continue his investigations, and endeavours to secure, and usually succeeds in securing, the assistance of his pupils. This is a mutual advantage. The professor is able to do more work for science, and the student, on his part, learns to conduct for himself an original investigation. Hence there is always a rising generation of original workers in Germany, who turn out papers more or less meritorious with the rapidity of a Walter's press. They are stimulated by the hope of one day arriving themselves at a professor's chair, the path to which they are well assured is only through the toilsome field of original investigation. But I must not wrong the German student by the implication of a purely selfish motive in his work. His labour is one of love, and his ambition, for the time at least, is bounded by the desire to do something for science. And from a multitude of such enthusiasts the great professors come. Great mountains are only found in mountainous countries. I find myself insensibly led to speak of the encouragement of research in this country; and although it has been very largely discussed in scientific circles I will venture to add a few words. To promote original work here I believe it is indispensable that our professors should be well paid. It would save them from the necessity of supplementing their incomes by commercial analyses, and thus enable them to devote their spare time to original work. And to secure that they shall have spare time, I would like to see in every laboratory a competent assistant, who would be able occasionally to take up the professor's lectures, should he be engaged in important work. There are many around me who know how very exacting original investigation is, and how necessary it is at times to be able to work on without interruption, bits and scraps of time being of no value. I am glad to see that the Oxford Commission also recommends the appointment of well-paid assistan ts. Well-paid professorships and well-paid assistantships would be attractive prizes for our students to work up to; and if it were clearly understood that the only way to these prizes was through original investigation we should very soon have an army of zealous and competent workers. The plan of appointing a staff of original workers unconnected with teaching has been proposed, but I do not approve of it. The original worker is, as a rule, the best teacher, and the rising generation of students should not be deprived of the advantage of this instruction. Moreover, as I said before, the professor may be greatly assisted by his pupils. It is much to be regretted that the Universities of Oxford and Cambridge, with such splendid revenues at their disposal, should contribute so little to the advancement of physical science. I hope the day is not far distant when the fellowships—or at least a a few of them—which now go to reward young men for merely passing a good examination shall be given *without examination* to men who shall have advanced human knowledge in any department. At at present fellowship of £250 or £300 a year, lasting ten or twelve years, and in some cases for life, may be obtained on showing proof of a good memory—or, at most, a capacity for assimilating other men's ideas. To make discoveries—to follow out a new train of thought, and establish it by experiments specially devised to that end, has been left not only without reward, but almost without recognition in our two principal seats of learning. Is it to be so always? The world at large, ignorant as it is, has a sounder instinct on this subject, and the man who makes the humblest addition to the stock of knowledge in the world rarely fails to receive the world's respect and honour. The suggestions I have ventured to make could not, of course, be well carried out, unless the Government take into its own hands the appointment to all scientific chairs. Of this I think I see indications.

THE ADDRESS IN GEOLOGY.

In section C, the address was delivered by Mr. (John Evan)s D.C.L., F.R.S. The president referred to the fact that the veteran geologist, Sir Richard John Griffith, the maker of the first geological map of Ireland, was still living, and after a brief tribute to the memory of Dr. Thomas Oldham, turned his discourse to the consideration of questions which within the last twelve months have occupied the attention of geologists.

As to the geology of this country, I may observe said Mr. Evans, that we are here assembled just on the edge of that great central plain which forms so important a feature in the map of Ireland, and which stretches from Dublin Bay on the east coast, to Galway Bay on the west, with hardly a portion of it attaining to an elevatien of 300ft. above the sea, over a tract of country nearly 150 miles in extent in almost every direction. The boundaries of this great plain and those of the carboniferous limestone almost coincide, so that we have here the somewhat remarkable feature of a formation which in England is of such a character as to have received the name of the mountain limestone, constituting in the neighbouring island nearly the whole of the plain country. In some of the north-western counties, however, as for instance Fermanagh and Sligo, it assumes its more mountainous character. Nearly the whole of this central plain is overlain with boulder clay, limestone gravel, or middle drift, and extensive bogs, so that the subjacent rock is but occasionally seen. In several places detached bosses of old red sandstone rise through the limestone, and there is also good reason for believing, with Prof. Hull, that the whole of the area was at one time covered with the upper members of the carboniferous group, including the true coal measures, of which unfortunately but small patches remain, and those upon the margin of the plain. From the absence of the upper palæozoic, mesozoic, and cainozoic formations over the area, Prof. Hull has arrived at the conclusion that the surface remained in the condition of dry land, while that of England was being submerged beneath the waters of the sea, over the bed of which nearly all these formations were deposited. To a certain extent, however, he leaves it an open question whether some of the mesozoic strata which occur over the north-east of Ireland may not have been deposited over the centre and south. Prof. Judd considers that the amount of denudation in the Scottish islands since the mesozoic, and *even* the miocene period, has been enormous, and *that the great surface features of the Highlands were produced in pliocene times. It seems therefore* possible, if not probable, that so long a period of exposure to sub-aërial influence as that assigned to the central plan of Ireland by Prof. Hull would have resulted in a more uneven land surface than that which we now find. At all events, the history of this remarkable physical feature is one which is of high interest, and can hardly as yet be considered as closed. The north-east of Ireland possesses, however, another geological feature peculiar to itself in that great expanse of volcanic beds which formed the subject of Professor Hull's address to this section at the Belfast meeting. My only object in now mentioning them is again to call attention to their containing the only remains of a miocene flora which are to be found in this island. Analogous beds were detected in the corresponding basalts in the Island of Mull by the Duke of Argyll in 1851. With the exception of the Hempstead beds of the Isle of Wight, which should probably be classed as oligocene, and the Bovey Tracey beds of Devonshire, these are almost the only deposits of the miocene age in the British Isles. The contrast presented by the scarcity of deposits of this period in Britain with their abundance in the north-west, centre, and south of France, Switzerland, and generally in the south of Europe, is striking. Instead of thick deposits covering hundreds of square miles of country, like the miocene beds bordering the Pyrenees or those of the great system of the Auvergne, we have small patches owing their preservation either to volcanic outbursts having covered them up, or to some favourable circumstance having preserved them from total denudation. Whether we are to assume with the late Prof. Edward Forbes that the general dearth of these strata in the British Isles arose from the extent of dry land which prevailed during the long interval between the eocene and pliocene periods, or whether we assume the former existence of widespread marine desposits which have since been entirely removed, the case is not one without difficulty. At all events, the absence of representatives of this period within the British area has a tendency to prevent a due appreciation of the enormous extent of the miocene period being generally felt in this country. Nor, generally speaking, do we, I think, take a fair estimate of the remoteness in time to which we must date back the commencement of that lengthened period. Prof. Haughton, judging from the maximum observed thickness of each successive deposit, has calculated that a greater interval of time now separates us from the miocene period than that which was occupied in producing all the secondary and tertiary strata from the triassic to the miocene epoch, and, without endorsing the whole of my accomplished friend's conclusions, I incline to concur in such an estimate. When it is considered that the Ballypalidy beds of Antrim and the Lough Neagh clays are the sole representatives in Ireland of two periods of such length and importance as the miocene and pliocene, their high interest will be more apparent, and I trust that no opportunity of minutely studying them will be neglected. There is one other point with regard to Irish geology on which it will be well to say a few words, though it is of a negative rather than a positive character. I mean the absence, so far as at present known, of palæolithic implements in this country. It is true that Prof. Hull, in the book to which I am so much indebted, speaks of a raised beach on the Antrim coast as containing worked flints of that rude form and finish known as palæolithic; but this is a slip of the pen, by which the author has fallen into the not uncommon error of applying a term which is merely significant of the age of the implements to their external character. After some further remarks on the geology of Ireland, and the date to be assigned to the implement-bearing beds of palæolithic age in England, the President took up the question which has been restarted by the discovery of a tropical flora in Arctic regions. The general opinion of physicists (said Mr. Evans) as to the possibility of a change in the position of the earth's axis has recently undergone modifications somewhat analogous in character to those which, in the opinion of some geologists, the position of the axis has itself undergone. Instead of a fixed dogma as to the impossibility of change, we find a divergence of mathematical opinion and variations of the pole differing in extent, allowed by different mathematicians who have of late gone into the question, as, for instance, the Rev. J. F. Twisden, Mr. George Darwin, Prof. Haughton, the Rev. E. Hill, and Sir William Thomson. All agree in the theoretical possibility of a change in the geographical position of the earth's axis of rotation being effected by a redistribution of matter on the surface, but they do not appear to be all in accord as to the extent of such changes. Mr. Twisden, for instance, arrives at the conclusion that the elevation of a belt twenty degrees in width, such as that which I suggested in my presidential address to the Geological Society in 1876, would displace the axis by about 10 miles only, while Prof. Haughton maintains that the elevation of two such continents as Europe and Asia would displace it by about 69 miles, and Sir W. Thomson has not only admitted, but asserted as highly probable, that the poles may have been in ancient times "very far from their present geographical position, and may have gradually shifted through 10, 20, 30, 40, or more degrees without at any time any perceptible sudden disturbance of either land or water." I am glad to think that this question, to which I to some extent assisted to direct attention, has been so fully discussed, but I can hardly regard its discussion as being now finally closed. It appears to me doubtful whether eventually it will be found possible to concede to this globe that amount of solidity and rigidity which at present it is held to possess, and which, to my mind at all events, seems to be in entire disaccordance with many geological phenomena. I have mentioned Prof. Haughton among those who, from mathematical considerations, have arrived at the conclusion that a geographical change in the position of the axis of rotation of the earth is not only possible but probable. In a recent paper, however, he has maintained that, notwithstanding this possibility or probability, we can demonstrate that the pole has not sensibly changed its position during geological periods. His objections are at first sight startling, but I think it will be found that if, instead of drawing great circles through certain points, we regard those points as merely isolated localities in a belt of considerable width, there is no need of fixing the pole of either the Jurassic or the miocene period with that amount of nicety with which Prof. Haughton has ascertained its position. The belt may indeed be made to contain the very places on which the objection is founded. Still the method proposed is a good one, and I hope that as our knowledge of foreign geology extends it may be still further pursued. There is, however, one further consideration to be urged, and that is as to the safety of regarding all deposits of one geological period as contemporaneous in time. Although an almost identical flora may be discovered in two widely-separated beds, it appears to me that chronologically they are more probably of different ages than absolutely contemporaneous; and, inasmuch as the duration of the miocene period must have been enormous, there would be time—if once we assume the wandering of the poles—for such wandering to have been considerable between the beginning and end of the period.

Mr. Evans then referred to the discovery of palæozoic rocks under London, to the discoveries of fossil remains in America, and some other points of geological interest.

THE ADDRESSES IN BIOLOGY.

Section D is divided into departments, and Prof. Flower, F.R.S., presided over Zoology and Botany. He took for the subject of his address Linnæus and his Systema Naturæ. We quote his concluding remarks:—The interest of classification, though it has lost much in some senses by the modern advances of scientific biology, has, however, gained vastly in others. The idea that has now, chiefly in consequence of the writings of Darwin, taken such strong hold upon all working naturalists—the idea of a gradual growth and progressive evolution, and therefore genetic connection between all living things—breaks down the artificial barriers which zoologists raise around their groups, and shows that such names as *species*, *genera*, *families*, *orders*, &c., are merely more or less clumsy attempts to express various shades of differences among creatures connected by infinite gradations, and in this sense destroys the importance attached to them by our predecessors. On the other hand, it immensely increases the interest contained in the word relationship, as it implies that the word is used in a real and not, as formerly, in a metaphorical sense. There is a kind of classification, such as we might apply to inanimate substances or manufactured articles. We may say, for instance, that a tumbler, a wine-glass and a teacup are more closely related to each other than either one is to a chair or a table, and that they might be formed into one group, and the last-named objects be placed in a second. This kind of classification is certainly useful in its way for methodical arrangement and descriptive purposes. It is the kind of arrangement which Linnæus and his contemporaries applied to animals. It is, however, a very different classification from that which supposes that the members of a group having common essential characters are descended from a common ancestor, and have gradually, by whatever cause or means, become differentiated from other groups. On this view a true classification, if it could not be obtained, would be a revelation of the whole secret of the evolution of animal life, and it is no wonder that many are willing to devote so large a share of their energies to endeavour to attain it. The right application of the prinicples of nomenclature, first clearly established by Linnæus, to the groups we form is again by no means to be despised, as laxity and carelessness in this respect are becoming more and more the greatest hindrances to the study of zoology. The introduction of any new term, especially a generic name, and indeed the use of an old one by any person whose authority carries weight, has an appreciable effect upon the progress of science, and should never be done without a full sense of the responsibility incurred. All beginners are puzzled and often repelled by the confused state of zoological nomenclature to an extent to which those who have advanced so far as only to care for he things, and to whom the actual names by which hey are called are comparatively indifferent, have ttle idea. Those whose special gift or inclination ads them to the pursuit of other branches of biogy, as morphology, physiology, embyrology, &c., ust have definite names for the objects they obrve, depict, or describe, and are dependent upon e researches of the systematic zoologist for supplyg them, and should not neglect to take his counsel, herwise much of their work will lose its value. veral times has the British Association thought is a worthy subject for the consideration of its embers, and through the instrumentality of a mmittee of working naturalists drew up in 1842 excellent code of regulations and suggestions on e subject of zoological nomenclature. These rules ere revised and reprinted in 1865, and in accordance ith a resolution adopted at the last annual meeting Plymouth they have been again republished at e cost of the association during the present year. he mere issue of such rules must have had a beneial effect, as they have undoubtedly been a guide many careful and conscientious workers. Unrtunately there are no means of enforcing them on those of a different class, and there is still someg wanting short of enforcing them, which possibly ay be within the power of the Association to effect. the administration of the judicial affairs of a tion, besides the makers of the laws, we have an ually essential body to interpret or apply the law particular cases—the judges. However carefully mpiled or excellent a code of regulations may be, ubious and difficult cases will arise, to which the plication of the law is not always clear, and about hich individual opinions will differ. The necessary rmission given in the association rules to change mes which are either "glaringly false," or not clearly defined," opens the door to considerable titude of private interpretation. As what we are ming at is simply convenience and general accord, d not absolute justice or truth, there are also cases which the rigid law of priority, even if it can be certained, requires qualification, and other cases which it may be advisable to put up with a small ror or inconvenience to avoid falling into a larger e.

In the Department of Anatomy and Physiology

rofessor Flower, F.R.S., presided, and Dr. Robert 'Donnell, F.R.S., delivered the address. In bruary last Claude Bernard died in the 65th year his age. He was interred with a degree of pomp ver in this country, and rarely even in France, corded to men of science. Claude Bernard left mark deeply on every aspect of physiology on hich he touched. His discoveries, however, as gards the functions of the pancreas, of the liver, d concerning the vasomotor system of nerves are ose on which his fame will ever chiefly rest. It not too much to say that prior to the communican made by Bernard to the Society de Bologne tle or nothing definite was known of the normal tion of the pancreatic fluid. Even a popular dience can form a judgment as to the practical lue of Bernard's researches in this direction. fore the publication of his memoir the fluid creted by the pancreas was regarded as something stined to dilute the bile and render it less acrid. true action as a liquid taking a special and active rt in the digestion of particular kinds of food was, may say, unknown. Bernard was the first ysiologist who obtained pure and healthy paneatic fluid from a living animal. It was he who owed its reaction, and he demonstrated its extradinary digestive power, not only over fats, but er other alimentary matters. He proved it to be e only one of the digestive liquids which at once rms a complete and permanent emulsion with fats. t there are many excellent physicians who in their ily practice profit by his discoveries who know tle of the steps by which these discoveries were ade. They prescribe pepsine and pancreatine in e form or another, but oftentimes they know as tle of his discoveries of these agents as the cheeseonger does about the secretion or coagulation of e milk from which the cheese is made which he lls over his counter. It is hardly honest in such rsons to form and express a dogmatic opinion upon hat experimental physiology has done for practice ithout conscientiously endeavouring to inform emselves on this subject. As regards the work acmplished by the liver in the animal economy, Berrd did nearly as much as he did for the pancreas. the course of his investigations on this subject rnard showed the influence of diet, of digestion, inanition upon the functions of the liver. He owed the influence of the nerves and nervous ntres in relation to it. He made the important scovery of the production of diabetes artificially. e was led to discover a similar function as regards e formation of amyloid substance in the placenta. e built up an entirely new theory of diabetes—ndamentally changing the views hitherto held on is subject, and, in short, made the whole field his n. It is obvious to every one who allows himself lmly to reflect for a moment that no physician can a good practitioner who does not know *something* of the work done and the duties performed by the heart, or the stomach, or the lungs, &c., in a healthy state. Diseases are deviations from health. To understand the one it is necessary to know something of the other. It must appear quite puerile, therefore, to any thinking person the assertion that the discovery of an important new function in a great organ like the liver did not modify the practice of medicine, and show new light on disease, not of the liver alone, but throughout the whole frame. You will pardon me, therefore, if I express my doubts of the intelligence or the honesty of those practitioners who treat contemptuously experimental physiology, and such work as has been achieved by men like Claude Bernard. It has been the lot, no doubt, of some among those whom I address to have exhibited to some of their friends the circulation of the blood as seen through the microscope in the web of the frog's foot. They will have been struck, as I have been with the effect, which this spectacle when witnessed for the first time has on different observers. Some look upon it much as they would upon a clever conjuring trick. It is to them no more than a transformation scene on the stage is to a child. How fast it goes, they say. They are astonished that anything of the kind should go on in a frog. The cold, unintelligent gaze of open-mouthed wonderment is perhaps even too strong an expression for any emotion which stirs them. Others are struck dumb by the sight before them. One sees at once that they have caught a glimpse of boundless prospect—that they feel that it has been granted to them to see more deeply into the bosom of nature than they have ever done. It illustrates the fashion in which the discovery to which I next allude is viewed by different classes of minds. A small filament of nerve, no thicker than a tiny silken thread, is divided in a rabbit's neck. Immediately a change is observed in the pupil of the eye on the same side; the ear on that side is felt to be obviously hotter than the other; the blood-vessels on that side of the head throb, and contain more blood. This same small filament of nerve is galvanised, and the reversal of the above phenomena is found to take place. To some this observation is not only a mere meaningless juggler's trick, but a cruel one. To others it is a key which opens a chamber full of treasures. It is like a newly discovered isthmus or bridge uniting two vast continents—that of the circulatory system with that of the nervous system. In this controlling power of the nerves over the calibre of the blood lies the explanation of many of the most interesting phenomena which go on within us. The burning blush of shame, the cheek blanched with fear, the sudden activity of glandular secretion, as when an emotion of the mind causes tears to flow, or salt placed on the tongue causes the secretion of saliva, the activity of the brain in our waking moments, its death-like inactivity during sleep, the regulation of our temperature, &c., are, within the limits of health, phenomena connected with this controlling power of sympathetic nervous system. Within the domain of disease, its applications are without end or number. It would be unjust to others to say that Claude Bernard was the sole discoverer of this vasomotor nervous system, as it is called. It would be equally unjust to his memory not to admit that his researches had a large share in this discovery. Assuredly the discovery is one in which experimental physiology has reason to triumph, for it must be regarded as one of the most valuable disclosures of modern science. It cements together the vast number of isolated facts, which, since the days of Prochaska and Robert Whytt, have been accumulating upon the hands of physiologists, but which, in the length and breadth of their importance, even Marshall Hall himself did not appreciate.

In the Department of Anthropology

Prof. Huxley delivered the opening address, of which the following is an abstract:—The points which I think it desirable to put before you in order that I may in a few words express the foundation of my confident conclusions are these. The first is a reason based entirely upon philosophical consideration—namely this, that in the regions of pure physical science, and the regions of what especially constitutes humanity—the conclusions reached by the one can have no direct effect on the other. If you acquaint yourselves in the slightest degree with the history of philosophy, and the variations of human opinion, you will find speculative difficulties have given way. Whoever admits the existence of evil in this world and the law of causation has before him all the difficulties that can be raised by any form of scientific investigation, and these truths have been present to the mind of man since the mind of man began to think. The next consideration I have to put before you is, that whatever be the results of physical research as to the mind of man, they arise out of the necessary progress of scientific thought as applied to man. You all heard in the excellent address of our president the marvellous progress that has been made in our knowledge of animals since the time of Linnæus. The merest tyro in that science now knows a thousand times as much as did Linnæus. If you consider what zoology or the study of animals means—it means the endeavour to ascertain all that can be studied in reference to animals from different points of view. The first embraces the consideration of the structure and the mode of development; in the second place every animal exhibits a great number of active powers, and in this we have to include the enormous light that has been thrown on the subject by Dr. M'Donnell. We have to take in other kinds of activity such as the amount of intelligence possessed by the lower animals. There is a third point of view in which we should regard every animal, and it is this, that it is to be found somewhere that it has a distribution, and that the great majority of animals have a past history. If you ask me what has been done within the past twenty years towards the solution of that problem, and clearing the ground in the direction of obtaining a solution of it, I do not know that I could lay my hand on much remarkable except in regard to one point. I have some reason to know that about the year 1860 there was nothing more volcanic, nothing more shocking, and more subversive of everything right and proper, than the proposition put forward that, so far as the physical organisation is concerned, there is less difference between man and the highest ape than there is between the highest ape and the lowest. That was a very pleasant subject to descant upon. The other day I was reading a very interesting work by an eminent French writer, M. Quatrefages, who has made this question of anthropology a special study, and has written a great deal about it. He has always been a consistent opponent of revolutionary ideas, so that I turned with some interest to his work as giving me a record of the progress of opinion within the past twenty years, and to my satisfaction I found that this gentleman entertained a strong bias in the opposite direction to which my mind would lead me. The substance of his opinion is this, that the truth of the proposition I just put before you is one that no rational man would dispute. That is the difference twenty years has made in that respect, and a great number of anthropologists are prepared to endorse the opinion of M. Quatrefages. It is a comfort to have got that much at all events out of the way. A second direction in which great progress has been made is in the exactness of the modes of obtaining those data which are necessary for anthropologists to reason on. Like all other persons who have to deal with physical science we confine ourselves to matters which can be ascertained, and nothing is more remarkable than the propositions introduced in the mode of ascertaining the physical qualities of man within the last twenty-one years. Anthropology has nothing whatever to do with the truth or falsehood of the different religious systems. It holds itself aloof from these; but the origin and growth of religions, and the different forms of religions—these are its proper and legitimate province. I go a step further, and pass to the distribution of man. This of course, for the anthropologist is in his special region. He endeavours to ascertain what kinds of human race those are. He inquires how far the remains of man may be traced—how far the human race goes back into time—how far the horse can be traced; and the kind of evidence which is good in the one is good in the other. Finally comes the question of the causes of all these phenomena, which, if permissible in the case of animals, is permissible in the case of animal man, and whatever kind of reasoning justifies one in concluding that the horse has come into existence at a certain period, the same evidence and the same logic justify, to some extent, in drawing the same kind of conclusion with regard to man. It is the business of the anthropologist to be severe in his criticism in respect to the origin of man, as it is the business of the pantheologist as regards another form of life. To the scientific mind there is no difficulty in drawing correct conclusions in one case as in the other. And if any one should turn outside the line of scientific evidence, and endeavour to support or oppose the conclusions based on abstract scientific truth by considerations which are not in any way based on scientific knowledge, I, occupying the chair of the section, should feel called on to call him to order and tell him he was dealing with matters with which he had no concern whatever. In this subject, as in many others, a great stimulus to man's reasoning, a complete metamorphosis in the direction of modern investigation has been given by the publication of a single book, the "Origin of Species." It was only subsequent to the publication of the ideas contained in that book that one of the most powerful agencies for the advancement of anthropology was founded in Paris, and also the great Anthropological Society of Berlin; until it may be said there is now no branch of science which is represented by a larger or more advanced body of workers than this science of anthropology; and the whole of these workers are engaged, more or less, in the working out of the ultimate goal, the great problem, whether the ideas which Darwin put forward in regard to the animal world, are capable of being applied in the same sense to man. That question, I need not say, is not answered. It is an enormous question, and one to which a definite answer may be looked for possibly in the next century. But the method of inquiry is understood, and materials are now being accumulated bearing on that inquiry. One of the most singular things is to trace the wonderful consistency of the human mind when it gets into a groove. It stops there. The great object of scientific investigation is to run counter to this tendency. The greatest progress of our knowledge of man is the introduction of man in the fossil state. When any man broached the notion of a fossil man, he would be laughed at. It was contrary to any of the preconceived ideas that man could have existed in a fossil state. That idea fixed itself strongly on men's minds. They thought their eyes the plainest evidence. We have a most astounding accumulation of evidence of the existence of man in ages antecedent to this. What the exact data are I don't think any one can say. It is beyond all question that man existed at a time when the whole physical conformation of the country was different to what it is now. But when it comes to a question of tracing back man further than that, I must confess that the evidence is to my mind of a very dubious character. We have not at present any positive knowledge on the subject. Then comes the very interesting question whether, with such evidence of the existence of man before us, it is possible to trace in the history any evidence of a human type essentially similar to that which exists at the present day. I am free to confess that my opinion on the matter remains exactly what it was some eighteen years ago, when I published a little book to which, to my surprise, I heard Prof. Flower refer, for I had thought that these questions had been forgotten in the greater scandal of later times. I did venture to put forth the opinion that what is common to all such human remains is, that they present a most marked and definite trace of what are called the characteristics of a lower type. I must confess that the arguments brought forward to show that the skull is an abnormal skull have no weight whatever with me. From the remains that accompanied the skull of the human being, I must say that as far as all the fundamental points are concerned they are the same as those of man of the present day, and that that being could wear boots just as well as we. I do not know that there is any more reason for believing that the man who existed in that day could not have been in all respects similar to the man of the present day, than to object to the evidence that the horse which existed in that day was in all respects identical with the horse of the present day. We know the horse presents a series of modifications and evolutions by which he could be traced back, and it would be just possible to trace back man in the same way.

ABSTRACTS OF PAPERS, &c.

Report of the "Close Time" Committee.

The Rev. Canon Tristram read the report of the committee "appointed for the purpose of inquiring into the possibility of establishing a close time for indigenous animals." The report stated that for the first time since its original appointment in August, 1868, the work it had not unsuccessfully had in hand had been brought in question, and this in a way which required serious attention on the part of all who wished to preserve our indigenous animals from the extermination that, until the last few years, was threatening so many of them. The committee referred to the report of "The Herring Fishery on the Coast of Scotland," and proceeded to show that the conclusions at which the commissioners had arrived were erroneous. The committee urged the utility of sea-birds in pointing out the situation of shoals of herrings and other fish, and this, they said, was admitted in the report of the commissioners, and the committee contended that if the Sea-birds Act were repealed on the grounds alleged for Scotland, its repeal for England and Ireland must logically follow. The committee trusted that no steps would be taken to repeal the Act for Scotland. The committee pointed out that, though the Sea-birds' Preservation Act contains a provision for varying the close time therein enacted on due application, no such application appears ever to have been made on the ground of detriment to the herring fisheries caused by sea-birds. On the other hand, your committee may refer to the fact, already mentioned in former reports, that several applications have been made for prolonging the existence of the close time. Dr. Rae said that the Preservation Act was no benefit, and that the gannets were multiplying so much that the rocks which they inhabited were now becoming limited in space for them. There was no doubt, he said, that the gannets killed young grouse. Dr. Gwyn Jeffreys said he knew that the young coal fish constituted, to a great extent, the food of gannets and other sea-birds. Herrings were not alone the food of gannets. Mr. Howard Saunders said he dissected several gannets, and found that they principally fed on coal fish. The Rev. Canon Tristram, in closing the discussion, spoke of the report of the commissioners as mischievous, and said it was impossible for any one to read the evidence on which the commissioners based their report, without coming to conclusions totally *different from those at which* the commissioners *arrived. He trusted that* naturalists would see that, *for the sake of human food,* and on the ground of science and of political economy, they should support the work which they had carried out in the Acts for the preservation of wild fowl.

The Distribution of Animals.

Dr. J. Rae, LL.D., F.R.G.S., read an exhaustive paper "On the Geographical Distribution and Migrations of Animals on the Northern Shores and Lands of the Hudson's Bay Company, &c." He said his intention in preparing the paper was to supplement in some degree the admirable writings and descriptions of his late distinguished friend, Sir J. Richardson, because he had had opportunities of visiting places which that excellent zoologist could not reach. One of the first things that struck a stranger was the regularity of the dates of arrival of migrating birds in the spring at certain localities in America. The further they went west the wild fowl made their appearance earlier in the same latitude. At Fort Confidence, although further north than Repulse Bay, the geese arrived sixteen days earlier. Indians, both at Moose and on the Mackenzie river, some thousands of miles apart, told him that a small finch, which always made its appearance about the same time, took a passage northwards on the backs of the geese. He had never ocular proof of this, yet he could find no good reason for Indians making such a statement if it were false. The principal geese which visited Moose in the spring were of three kinds—the snow, the Edwards or blue-winged, and the Canada goose. In describing their habits he said the geese returned from their breeding places early in September, and spent about six weeks feeding in the marshes. It was evident that the snow and Edwards' goose made a very large flight (without resting) to winter quarters when they left Hudson's Bay, because for some days before starting they appeared to eat nothing, and spent nearly all their time on the water. Their stomachs and intestines were perfectly empty, in this respect resembling salmon before commencing the arduous work of ascending a rapid river to spawn. The Canada goose, which rested on its southward flight, did not make any such preparation.

Report on Underground Temperatures.

Prof. J. D. Everett read the "Report of the Committee on Underground Temperatures." The principal novelty was the proposal to make observations in filled-up bores by a thermo-electric method. Two wires, one of iron and the other of copper, each covered with guttapercha, were to be joined at both ends, where a portion would be left uncovered. One junction would be buried in the bore, while the other would remain above ground, available for observation. A current would flow through the circuit composed of these two wires whenever the two junctions were at unequal temperatures, and the observer would immerse the accessible junction in a basin of water containing a thermometer, and would regulate the temperature of the water until he found by a galvanometer that no current passed. He would then know that the temperature of the water as indicated by the thermometer was the same as that of the buried junction.

Report on Coal-Gas.

Mr. T. Wills, F.C.S., read the first part of a report from a committee consisting of Dr. Wallace, Glasgow; Professor Dittmann, Glasgow; and Mr. T. Wills, F.C.S., which had been appointed for the purpose of reporting "On the Best Means of Developing the Light from Coal Gas." This part of the report was by Dr. Wallace, and referred to cannel gas, the standard quality of which was assumed to be 26 candles. This is the quality delivered by most of the Scottish gas companies, while in London the illuminating power is 16 candles, in Liverpool, Manchester, and Carlisle, 20 candles, and in most of the other cities in England and Ireland about 14 candles. The report gave a tabulated series of results obtained with different kinds of burners—rat-tail, union or fish-tail, bat-wing, and argand; and also the influence of globes of different sizes, shapes, and materials. Dr. Wallace is strongly in favour of cannel rather than common gas, on account of its comparatively small influence on the atmosphere of apartments, and the smaller proportion of sulphur it contains. He also strongly advocates the burning of gas at a comparatively low pressure, and the use of district governors to equalise the pressure in different levels of towns, and of regulators in houses and street lamps to give the exact pressure calculated to give the best photometric results. Prof. Roscoe asked was it not the fact that globes diminished the illuminating power of gas? Dr. Wallace stated that by placing a globe round the light it diminished the light by 10 per cent.

Spectrum Analysis.

Mr. G. Johnstone Stoney communicated the results of long investigation by himself and Prof. J. Emerson Reynolds "On the Spectrum of Chloro-Chromic Anhydride." He described the kinetic theory of gas molecules darting about and continually striking against each other, but besides these he said there were internal motions within the molecules, which in many cases were either periodic or quasi-periodic. The evidence of this was obtained from the spectra of gases. For many years he had been engaged in searching for cases of harmonic motion in gas, and, with the assistance of Prof. Reynolds, he had obtained the positions of 105 lines in the spectrum of chloro-chromic anhydride, which proved to be harmonics of one particular motion. The spectrum was shown at the conversazione. The time of one of the oscillations had been measured to the eight-hundred-thousand-millionth part of a second.

Sugar in the Nectar of Flowers.

Mr. Alex. S. Wilson, M.A., B.Sc., Glasgow, read a paper "On the Amounts of Sugar contained in the Nectar of various Flowers." Nectar, he said, is the sweet-tasting fluid secreted within the cups of flowers, and is intended to provide an inducement to cause insects to visit the flowers. These insects confer great benefit on the flowers by assuring their cross fertilisation, bringing pollen from other plants and depositing it on their stigmas. The result of this is that the plant is enabled to produce seeds of much greater vigour than it otherwise would. The saccharine fluid is usually contained in the most secluded portion of the flower, in order that it may be protected from rain, for, owing to the solubility and the diffusibility of sugar, were it not so protected it would speedily be transferred to parts of the plant where it could be obtained by the insects without them serving the plant in the way of cross fertilisation. The colour, odour, and marking of flowers enable insects to find the nectar more easily. The importance of these insects will be apparent from the smallness of the amounts of sugar found in the flowers experimented on by Mr. Wilson. Flowers of fuschia yielded a total of 7·59 mm. of sugar—1·69 of this was fruit sugar, and 5·9 apparently cane sugar. Of red clover each head gave a total of 7·93 mm.—fruit 5·95, apparent cane sugar 1·98. On each head of clover there are nearly 60 distinct florets. Calculating from these results there was the astonishing industry of the bee brought out in an extraordinary manner, for in order to obtain the kilog. of sugar 7,500,000 flowers must be sucked. As honey contained roughly about 75 per cent. of sugar, a bee has then to make two and a half millions of visits in order to collect a fund of honey. It was rather a curious fact that nectar should contain cane sugar, seeing that honey never did—indeed, were a vendor to sell honey containing cane sugar, he would probably be prosecuted under the Adulteration Act. A change must therefore take place while the sugar is in the bee's possession—possibly through the action of the juices with which it comes in contact while in the honey-bag. As nectar is acid in its reaction, it is, however, possible that the process of inversion may take place spontaneously.

Estimation of Mineral Oil or Paraffin Wax in Mixture with other Oils or Fats.

Dr. William Thomson, F.R.S.E., said that mixed oils were now often used for lubricating purposes, and a common mixture, composed of mineral oil with some animal, vegetable, or fish oils, was extensively used, and it was an important point to be able by analysis to determine the amount of mineral oil which such mixture contained, and, as he could find no published process to effect this, he devised the following, which he found by repeated tests to give very accurate results:—He boiled some of the sample with an alcoholic solution of caustic soda, which converted all the animal, vegetable, or fish oils into soap. This was then mixed with sand, and heated and washed with petroleum spirit, distilled at a temperature under 190° F. This dissolves out the mineral oil, leaving the soap insoluble. The spirit is now distilled off from the spirit solution of mineral oil, at a temperature not exceeding 220° F., and the residue of mineral oil weighed and calculated on the weight of the original mixed oil taken.

The Habits of the Field Vole.

Sir Walter Elliott made a few observations on the annual increase of the common vole (*Arvicola agrestis*) of late years. In the spring of 1876 they appeared in such numbers in the hill pasture farms of the Border districts between England and Scotland, and parts of Yorkshire and Wensleydale, as to destroy the grazing ground on which the sheep depended in spring, causing serious loss to the farmers by impoverishment and death of stock. The shepherds destroyed as many as they could, without sensibly diminishing their numbers, although assisted by birds and beasts of prey—hawks, buzzards, owls, weazles, foxes, &c. At the same time that the vole was doing such mischief, another species (*arvicola arvalis*), not known in England, made its appearance in Hungary, and attacked the corn fields, which it had done to a less degree in two or three previous years, and this year they attacked the wheat fields of Moldavia. Many instances are recorded of great damage done by them, both in England and Scotland, by destroying plantations, of which Mr. Jesse described a notable instance in New Forest and Dean Forest some time ago. These examples prove that they do not confine their attacks to pastures and woods, and it is possible that they might under favourable circumstances betake themselves to our corn fields. It is therefore worth consideration whether our game-preservers should not be more forbearing towards the hawks, owls, and weazels, which are nearly exterminated in many places, although they live almost entirely on these and other small creatures.

The Logical Machine.

The Rev. Robert Harley, F.R.S., Vice-Master of Mill Hill School, read a paper on "The Stanhope 'Demonstrator,' or Logical Machine." The author

ed that towards the close of the last century a
cal instrument was constructed by Charles,
d Earl of Stanhope. Earl Stanhope is known to
nce chiefly by his printing-press, microscope
, arithmetical machine, monochord, and steam-
t, but of his logical speculations, which occupied
thoughts for 30 years, and of his curious con-
ance for working logical problems, called by
the "Demonstrator," nothing has been known.
. Harley noticed that Stanhope anticipated
rge Bentham, Sir William Hamilton, George
le, and others, in his quantification of the pre-
ate, and notably De Morgan's rule for the
nerically definite syllogism. Stanhope stated the
as applicable to all syllogistic reasoning, and
constructed his "Demonstrator" for the
hanical working of the rule. Some amusement
caused by Mr. Harley giving examples of
cal deductions. The instrument ocularly de-
strated that if most men in a certain company
e coats, and most men in the same company
e waistcoats, therefore some in the company
e both coats and waistcoats. It does not seem
l to very difficult and complicated questions,
nearly so powerful as Professor Jevon's logical
hine, which, before the discovery of the "De-
strator," was supposed to be the first invention
this direction; but to the earl belongs the
our of being the first, so far as is known, to at-
pt the performance of logical inference by
hanical means.

A New Method of Alkalimetry.

r. Louis Siebold, F.C.S., Manchester, read a
r "On a New Method of Alkalimetry." The
recommended consisted in the reverse applica-
of Liebig's process for estimating hydrocyanic
, and was based on the fact that the volumetric
rmination of an alkaline cyanide by means of
r nitrate was in no wise affected by the presence
ee hydrocyanic acid. From the volume of silver
tion used the quantity of alkali might be as
ily calculated as that of the cyanogen. From ·5
ne grain of the potassium or sodium carbonate
ld be dissolved in about 100 c.c. of distilled
er, the solution mixed with an excess of hydro-
ic acid, and then deci-normal solution of silver
ate added from a burette until a permanent
escence is produced. Whereas, under ordinary
umstances hydrocyanic acid was incapable of
mposing alkaline carbonates, it effected a com-
e decomposition in the presence of silver nitrate.
mixture did not require boiling, and the whole
ation might be performed within a few minutes.
fter the end of the titration, the mixture were
d and the addition of deci-normal solution of
r nitrate proceeded with, this time using potas-
chromate as an indicator, the volume of silver
tion required to insure complete precipitation of
silver cyanide would be exactly equal to that
in the first titration. This second reaction
ht then, if desired, be used, as a check on the
rmination. In the presence of chloride, the
me of silver solution used in the second experi-
t would be greater than that used in the first,
difference between the two being exactly that
ired to precipitate the chloride. In this manner
termination of the chloride might be readily
bined with that of the alkaline carbonate. Dr.
old quoted results showing the great accuracy of
process.

Exploration at Kent's Cave.

r. Pengelly read the report of the explorations
ied on at Kent's Cave since July, 1877, and
bited a number of specimens of jaw-bones and
h of the hyena, of the bear, some flint instru-
ts, and a remarkable quartzite discovered in the
during last year. The only objects of interest
d in the chamber were four pieces of bone which
rred at depths exceeding a foot, and a lump of
e of manganese. The recess near the junction
e two reaches was, in proportion to its capacity,
h more productive. Some tools were found in
r parts of the cave, and Mr. Pengelly considers
ifficult to understand how the tools found their
to a branch of the cavern so remote from the
wn entrances, and occupying so high a level.
problem was apparently insoluble except on the
thesis that the workmen are approaching an
ance hitherto unknown; and as this supposition
been forced on the minds of the superintendents
ther and independent facts, they believe it to be
desirable to settle the question, if possible, as
do not doubt it would give a definiteness to the
anation of some of the cavern phenomena. Prof.
d Dawkins said the exploration was a great feat
ngineering. It was a well-known fact that
rally in such cases they found Arctic animals
ciated with animals that were now only to be
d in warm climates, and the probable cause was
there was a great stretch of land over the greater
of the Mediterranean area, from the North of
ca over the region of Europe, until it finally
hed Great Britain, and even Ireland. This would
d a means of migration to animals northward
southward, according to the season. This was
shown by the Pyrenees, and so on through
many, until they arrived at this country. In the
byshire caves, of which he was one of the com-
ee, there was found a sequence of events very
h the same, as exemplified in the deposits in
t's Cave, and he now wished to make what he
ld call his recantation.

SCIENTIFIC NEWS.

THE meeting of the British Association in Dublin must be regarded as a success so far as attendance is concerned, the numbers present being nearly equal to the Glasgow meeting, and in excess of the Bristol return. Thanks to Dr. Haughton the sections were comfortably and compactly located in Trinity College, so that it was easy to get from one section to another. After sixteen years' service, the assistant-general secretary, Mr. G. Griffith, M.A., retires at the close of the present session, but remains an ex-officio member of council. Mr. J. H. Gordon will take up his duties. The addresses in the sections were not characterised by any novelty or brilliancy; the president's fell flat, and was heard only by those in his immediate neighbourhood. The principal defect was their length, while some erred in being mere text-book exercises. The address in chemistry which we publish on p. 595, and that on economic science and statistics, were, however, free from these defects, while the lecture by Mr. G. J. Romanes, on "animal intelligence," was probably the most interesting feature of the meeting.

Next year the Association is to meet at Sheffield, at Swansea in 1880, and at York in 1881. The first meeting was held at that city in 1831, under the presidency of Earl Fitzwilliam, and was attended by 353 members and associates. In 1838, the attendance reached 2,400 at Newcastle-on-Tyne, and in 1863, at the same place, the largest number of attendances at any meeting of the Association was obtained. The president elect is Mr. G. T. Allman, F.R.S.

Medal-giving at exhibitions will fall into disrepute if greater care is not taken in making the awards. Loud complaints come from Paris as to the treatment accorded to certain English exhibitors, and the mischievous "joke" of putting emery into the bearings of the engine driving the English machinery is again brought up. Mr. Edison is to have no reward for his phonograph. The jury on instruments of precision would not recognise it as belonging to their class, and referred it to the class of telegraphy for a medal. The telegraphists refused to examine it, declaring it was no use in telegraphy. That decision seems most extraordinary, however much opinions may differ as to what are instruments of precision. It will perhaps help to put exhibition medals on their proper footing, if the most remarkable invention of modern times is refused even a certificate of merit. The authorities should invent a new class for Mr. Edison's phonograph.

At a recent exhibition of gas apparatus in this country the judges appointed were so incompetent that some of the firms to whom medals were awarded have declined to receive them. At this exhibition a medal was awarded to a stove which, though on the list, was not in the building at the time of judging, and was moreover not of the class for which the medal was offered! One of the judges actually asked what was the meaning of a Bunsen or atmospheric burner!

A compressed air locomotive for use in mines has been put down at the Pensher pit, Durham. The frame is about 6ft. long, carrying a reservoir 2ft. in diameter, capable of holding 20 cubic feet of air. The pressure when ready is 200lb. on the square inch, but the valve could be adjusted to cut off at a quarter of the stroke, and the engines, which have cylinders 4in. by 8in., will work until the pressure is reduced below 80lb. The machine weighs about 14cwt. and is capable of hauling three tons along a level line. All the gear is of the simplest possible construction.

The report of the Science and Art Department has been presented to Parliament, and was no doubt attentively studied by our legislators. We are told that no fewer than 5,000 candidates will probably present themselves next May for examination in physiography, as the new subject is called, but why the officials should go out of their way to forecast the future, we cannot imagine, unless they have some doubt about the new "science." The average amount paid to teachers was £26 10s., and the number of teachers paid was 1,565. Some of the statements are curiously worded: "The total number of persons" who attended the institutions and exhibitions in connection with the Department, was 4,261,639. There may have been that number of "visitors," but they were, we venture to think, scarcely all different persons.

The mention of the Loan Collection in the report brings to mind the fact that the electrotype copies of the Magdeburg hemispheres, and other interesting relics of that exhibition, were on view at Dublin during the meeting of the British Association!

Several prospectuses have been issued of new companies to be quartered on Cyprus, including a Cyprus Hotel and Club; and a fortnightly steam service has been commenced between Liverpool and the island.

A bicyclist has travelled from Kilmarnock to London, and back. The longest run in one day, was from Morpeth to Edinburgh, 112 miles. Two young Frenchmen, however, in the spring, traversed about 3,000 miles on bicycles, travelling over the greater part of France, and through considerable portions of Switzerland and Italy. The time was six weeks.

Keely has a rival! A Mr. Winters has invented or discovered cold steam, and is exhibiting the apparatus in Brooklyn. A 10in. hydraulic cylinder works direct on to a 4in. cylinder in which the new motor is generated. The water is obtained from the street main, and has a pressure of 35lb. The "gas" has neither heat, odour, nor colour; but Mr. Winters is kind enough to explain that a very large quantity of water is required. The "gas" is, however, superior to compressed air, because no heat is produced in compressing it, and it exhausts without freezing. If the gas is run through coal-tar, it forms an illuminating agent, having a dark blue flame. The new motive power can be introduced into factories at "half the expense of steam;" but nothing is said as to the cost per horse power of this "new motor."

The route for the canal to connect the Atlantic and Pacific Oceans would appear to have been definitively settled, as a convention has been concluded between the United States of Colombia and the International Society. The construction of the canal will accordingly be attempted between Aspinwall and Panama, although the American engineers and M. de Lesseps were in favour of the route through Nicaragua.

The Villa Thuret, with its splendid gardens at Antibes, near Cannes, has been presented to the French nation by a relative of the late owner. It is to be maintained as an experimental garden for scientific and horticultural purposes, under the management of M. Naudin. It is open to botanists and students of all nations, all the resources of the place being placed at their disposal. Students who obtain a recommendation from a well-known man of science, or who are themselves well known, will meet with a warm welcome and gratuitous lodging for six weeks.

The directors of the Polytechnic are about to make an alteration in the science department of that institution. They are about to separate the laboratory from the rest of the institution, and to establish a high-class school of practical science in all its branches. From a number of candidates who have applied for the occupancy of the laboratory and rooms adjoining, the directors have selected Dr. Edward B. Aveling, who intends forthwith to establish classes for practical instruction in all the science subjects required for the University, Government, and other examinations.

The lower greensand has just been penetrated at the dockyard at Chatham by a boring conducted by Messrs. Docwra and Son. The stratum was reached at a depth of 903ft. from the surface, and the water has risen so high as to overflow the top of the well. A year ago the boring had been carried down to a considerable depth in the chalk, when the character of the water was unsatisfactory, being brackish. The authorities then consulted Prof. Ramsay, the director-general of the Geological Survey, as to the probability of reaching the lower greensand if an attempt were made to penetrate the gault. The opinion given was decidedly in favour of the effort, the dip of the lower greensand in the Maidstone area being in the direction of Chatham. The boring was continued, and the anticipations expressed appear to have been verified. Some years ago Messrs. Docwra and Son tapped the lower greensand at Chatham, but as the boring was very small it became choked with sand. The lower greensand has also been found, somewhat recently, at Loughton, in the district of Epping Forest, a supply of water being obtained at a depth of 1,092ft.

The Lords of the Committee of Council on Education have determined to award bronze medals to students who obtain a first class in honours in any subject of science at the May examinations.

The Coffee Public-house Association, 40, Charing-cross, announce that they are enabled by one of their members to offer a prize of £200 for an essay on the providing, on an adequate scale, of halls or other places of resort and recreation for the working classes, the arrangement to include the sale of refreshments but not of intoxicating drinks, so as to supply the requirements of the people in that respect and to realise a profit to meet at least current expenses. The object of the donor of the prize is not only to draw general attention to this subject, but also to elicit suggestions as to the agency by which an undertaking of such magnitude may be most suitably and effectively carried out. The date fixed for sending in manuscripts is March 1st, 1879.

USEFUL AND SCIENTIFIC NOTES.

Niello.—This consists of nine parts silver, one part copper, one part lead, and one part bismuth, which are melted together, and saturated with sulphur. This mixture produces the gorgeous blue which has often been erroneously spoken of as steel blue.

Peat.—The Montague Paper Co., Turner's Falls, have been, says an American paper, burning green peat successfully under their boilers set with the Jarvis patent furnaces, but as soon as the owners of peat bogs in that vicinity found it could be burned successfully without drying, they raised the price so high that the mill has gone back to screenings again. Peat land in the New England States is not worth, on an average, over £1 per acre. It costs about 2s. per cord to dig and haul peat when within a mile of the mill. Three cords of green peat, burned by the Jarvis process, are equal to one ton of the best soft coal, and the economy over anthracite coal is from 30 to 40 per cent. Every mill having peat lands near at hand can supply their own fuel at a small expense, as the peat is not dried but used as dug, with a little soft coal mixed.

Depth to which Roots Penetrate.—Mr. Foote, in Massachusetts, has traced the tap root of a common red clover plant downward to the perpendicular depth of nearly 5ft. The Hon. J. Stanton Gould followed out the roots of Indian corn to the depth of 7ft., and states that onions sometimes extend their roots downward to the depth of 3ft.; lucerne, 15ft. Hon. Geo. Geddes sent to the Museum of the New York State Society a clover plant that had a root 4ft. 2in. in length. Louis Walkhoff traced the roots of a beet plant downward 4ft., where they entered a drain pipe. Professor Schubart found the roots of rye, beans, and garden peas to extend about 4ft. downward; of winter wheat, 7ft. in a light subsoil, and 47 days after planting. The roots of clover one year old were 3½ft. long; those of two year old plants 4in. longer.

Pearl Life Assurance Company.—The fourteenth annual general meeting of this company was held on August 9th. The annual premium income on 115,650 new policies issued during the above period amounts to £62,035 7s. 9d, and is the largest new premium income yet reached by the company. 3,403 claims, grants, and endowments fell in during the above period and were promptly met, several arising through lives lost in those sad and lamentable disasters which occurred at the Blantyre and Haydock collieries, and on board her Majesty's ship the Eurydice. The reserve fund is gradually augmenting each year, and with capital paid up amounts to £20,821 7s. 5d. Finding that many of the industrial middle classes are deterred from making any provision through the agency of assurance—fearing that at some future period they may be unable to continue their premiums—the directors have had a table constructed with the view of meeting this objection by giving a paid-up policy for 30 per cent. of the premiums paid as a fixed equitable *surrender value, providing the policy has been in force three years, and the premiums have been paid during that time.*

LETTERS TO THE EDITOR

[We do not hold ourselves responsible for the opinions of our correspondents. The Editor respectfully requests that all communications should be drawn up as briefly as possible.]

All communications should be addressed to the Editor of the English Mechanic, 31, *Tavistock-street, Covent-garden, W.C.*

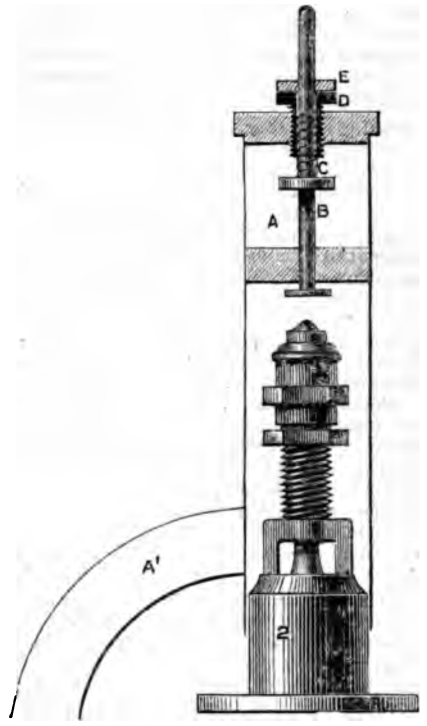
All Cheques and Post-office Orders to be made Payable to J. Passmore Edwards.

*** *In order to facilitate reference, Correspondents, when speaking of any Letter previously inserted, will oblige by mentioning the number of the Letter, as well as the page on which it appears.*

"I would have everyone write what he knows, and as much as he knows, but no more; and that not in this only, but in all other subjects: For such a person may have some particular knowledge and experience of the nature of such a person or such a fountain, that as to other things, knows no more than what everybody does, and yet, to keep a clutter with this little pittance of his, will undertake to write the whole body of physicks: a vice from whence great inconveniences derive their original." —*Montaigne's Essays.*

DALE'S IMPROVEMENT ON THE HYDRAULIC RAM.

[14731.]—The Dorset Industrial Exhibition, which has been a great success, is now over, and I herewith enclose tracing, &c., of an improvement on the hydraulic ram exhibited by me there, which I have invented for my own use, and which I hope will interest the readers of the English Mechanic. Why do not other exhibitors at the above exhibition give illustrations of their inventions for the benefit of your numerous readers?



The invention consists chiefly in a tube, A, fitting on to the pulse valve-box of a ram (which has been turned slightly tapering), having a smaller tube A' at its side to conduct the waste water to a drain; in the centre of the large tube is a spindle, B, which is fixed down by a spring, C, whose tension is regulated by the screw, D, and the length of stroke by nut, E. The ram to which this invention has been applied stands on a table in the house, and water can be drawn from the rising pipe near the ram, as the spring, C, prevents the pulse-valve remaining in its seat; the ram was supplied by Messrs. C. Churchill and Co., of London, is beautifully made, and raises the water for a steam-engine and other purposes. If these rams were better known I think they would be more used, as they only cost 36s., and I think many rams with the same size rising pipe are sold for from £5 to £8.

E. R. Dale, Mem. Soc. Arts, &c.

THE PLANET JUPITER.

[14732.]—Did any of our readers observe Jupiter on the night of the 7th inst.? It was a most interesting object, with the satellite and its shadow on his disc, apparently threaded on a very narrow dotted and dark band. In moments of still air, power 150 and 200 on a 10in. speculum, definition was for a short time very good, and the shadow was remarkably sharp and well defined, black and clear as a clean full stop on white paper; the satellite itself was not nearly so sharp or black.

The lower (in the telescope) part of the equatorial band was most vividly coloured. Starting from the central part, it commenced with a slaty tint, increasing gradually into a warmer tone, till it appeared as a glowing *brilliant* coppery red, and again changing into lighter red, fading out till it seemed like a rainbow fading from the orange, through to pale yellow, to end in a decided yellow, blending with the general whiteness of the light band below it, after which came the fine dark and dotted band on which the satellite and its shadow were apparently threaded.

The lower pole was more dark and marked than the upper, and of a slaty tint. The upper edge of the equatorial band was exhibited with its frequently notched appearance, and there was a dark line running diagonally at an angle of about 10°.

Having never before observed a band so strongly coloured I write a hasty line to draw attention to it.

G. Calver.

ELECTRO-GILDING.

[14733.]—"A gilding solution should always be worked hot." In common with other correspondents I have given this advice time after time, and when I dabbled in gilding a few years since I observed the same routine, following the example of professional gilders. I stated a week or two since that I thought a good deposit could be obtained with a cold solution (that is, at the ordinary temperature). I have to-day tried what a cold solution would do, with a very satisfactory result, and with far less trouble and annoyance than I experienced with what I must term the old method. When using a hot solution I always had a little trouble in getting the bath into working order. One great fault is in the use of too large and too strong a battery. The general run of small articles requires a very small and weak battery. I used to-day a Daniel battery, and the articles gilt included brass, silver, and platinum, and a few minutes sufficed to bring them to a splendid colour. The anode was a piece of 16-carat gold, kept under the blowpipe for about 15 minutes (without borax) in order to discharge as much of the copper as possible—the silver, of course, remaining. This was rolled to 1in. in length, and about ½in. broad, and one of the articles gilt was about six times this size. The bath was made with about 10 grains of chloride of gold dissolved in three-quarters of a pint of ordinary water, and about ½oz. of cyanide of potassium thrown in. The zinc for the battery measured 3½in. × 2in.; this I placed in a flat porous cell, which was then filled with a strong solution of common salt. The copper (an old card plate) was a little larger, and was placed by the side of a porous cell in a solution of sulphate of copper (no acid). Thick copper (bell) wires were soldered to both zinc and copper. The articles should be scratch-brushed with common porter. I find nothing to equal this. A rotary scratch-brush will turn out the best work. The brush should revolve in a zinc-lined box, with a reservoir on the top for the porter, which runs on to the brush from a small indiarubber tube. It escapes from a hole in the bottom of the box, and is then poured back again for use.

I have given every detail, as I have been lately accused of only telling half my story. I wish to mention another matter. Some people I know buy the English Mechanic *to read*. There are others who don't use it for that purpose, or they would not send queries which have been answered within a month or two; but perhaps "Economical" (query 33709) sends an occasional query, and duly buys the paper in which he expects to find his information.

Os.

THE ANASTATIC PROCESS.

[14734.]—This process is a modification of zincography, insomuch as that in the latter transfers have to be drawn or otherwise specially prepared in suitable ink, while in the former a direct transfer to a zinc plate can be made from any design or printed matter executed in a fatty ink; it can be used either for copying freshly printed matter, where the ink still retains its greasiness, or for reproducing old prints in which the ink has become hard and set. As the former is obviously the most useful, I will detail it first.

If dirty, the print may be cleaned by means of bread crumb; then to soften the ink, the print is put to soak in a 3 per cent. solution of strontic acid, kept at a temperature of about 83°C.; the necessary time for soaking can be found by experimenting on a piece of margin or extraneous matter, cutting off a small piece, drying it, then damping with nitric acid as hereafter described, and then observing whether it gives a set off on being rubbed against another piece of paper with the thumb nail. The length of time may vary from ten minutes to an hour and a half. When the print is removed from the solution it is thoroughly and carefully washed with hot water, superfluous moisture being absorbed by blotting paper; it is then laid face downwards on a few layers of blotting paper, and the back well brushed with a 20 per cent. solution of nitric acid until the paper is evenly and thoroughly soaked; it dried between successive sheets of blotting The zinc plate is prepared much the same or zincography, with the exception of grain- ead of this it is rubbed with Water of Ayr id finally polished with pumice powder. In ring, much stronger pressure is required zincography; indeed, theoretically, a copper- inting press should be used, but in practice tho press will be found to answer almost as fter having adjusted the pressure, place the e downwards on the plate, and immediately irmly and evenly through the press. An tion of 30 seconds after the print is put on would be fatal to success.

the print is peeled off, the plate is sponged th unsoured gum water; water is then d on, and it is gently washed with a clean emove any adherent particles of paper, the on the plate is then rubbed over with a of lithographic ink, thin varnish, and ter, by means of a fine sponge, care being have an excess of gum water to prevent ng up." When sufficient ink has adhered to the plate is flushed with water under the is then slightly etched with phosphoric acid -water solution (a receipt for which I gave ious letter), diluted with its bulk of water; is next rolled up with printing ink and re- ith the normal solution. It is now ready for can either be printed from in a litho press, be etched by the paniconographic method already described, and then printed typo- lly.

paring freshly printed matter the print is saturated with the nitric acid solution, all manipulation being the same, with the , perhaps, of rather less pressure in trans-

Ernest A. Nuth.

UTOMATIC REED ORGANS.

.]—There is no novelty in the principle h the "automatic reed organ," recently in New York, and described at page 514, ucted. An instrument similar in principle bited at the first Crystal Palace in 1851. It d an "Autophon, or improved organ," and ined is a copy of the printed description as handed by the exhibitor to inquirers.

[*Copy.*]

OPHON, OR IMPROVED ORGAN. — The is an improvement on the organ, patented . Dawson, organ-builder, 395, Strand, by ersons, although unskilled in music, may any piece they desire on the organ. The tunes rforated sheets of mill-board. These being ed into the instrument, the performer has turn a handle, and the tune is executed the finish of a skilful organist. This not being connected with the action that e bellows, gives the performer the oppor- dwelling any length of time on a particular , and renders the autophon admirably for chanting, singing classes, &c. The , having the chromatic scale, is not confined r limited to tunes like the barrel-organ. It r an approach to the finger organ that few would distinguish it from one unless they working of it. The autophon, like the an be made of any size or compass, but in nce of the simplicity of its internal con- , at about 20 per cent. less than the organ. phon of sufficient power for a small church, d case, gilt pipe front, 3ft. wide, 2ft. deep, high, with 4 stops, stop diapason (8ft. C), pason, principal, dulciana, 40 guineas. An n, in stained case, gilt pipe front, 4ft. wide, deep, 9ft. high, with 4 stops, stop diapason , open diapason, principal, dulciana, 60

The patentee supplies 40 tunes with a 40 instrument, and 60 tunes with a 60 guinea nt. Any number of tunes, which a pur- if he wishes, may have set from his own nent, may afterwards be obtained at 6d. per nd for the larger instruments at 1s. per

George Tommy.

ntrose-terrace, Argyll-road, Bristol.

EW MUSICAL NOTATION.

.]—It seems strange that C. Lark (let. 14703) ay that he has not found learners experience fficulty with regard to the up and down." e of the chief merits of the sol-fa system of is the use of the "modulator," or its pic- aracter. Yet when the pupils have to read ic there is nothing pictorial about it; they st entirely to memory. I doubt if there is , competent to judge, who will dispute the ity of sol-fa, when properly taught, over the lished" notation, at any rate for simple vocal but I doubt if it be possible to understand it instruction; whereas I know people who, instruction, have been able to follow music in the latter, through its showing its rise . Further, it is no uncommon thing to find k which distinguishes *the octave misplaced* or omitted. C. Lark says this is the fault of the printer. True, yet such accident could not occur in either the "New Musical Notation" or in the "Established."

Dandie Dinmont.

CENTRING WORK FOR THE LATHE.

(*Continued from p.* 550.)

[14737.]—While discussing methods of centring I think the cone guide worth description. I had not centre-punched a dozen rods before it occurred to me that if I used a guide for the centre punch to slide in, with a hollow cone to bring the punch just over the centre of the end of the rod, it would facilitate the operation, and I have no doubt this is about the first idea that occurs to most learners, when, finding the difficulty of centring by eye, they look around them for mechanical assistance.

Conical guides such as referred to are sold by some of the tool-vendors, but are little used by the professional turner; and although I commenced to make such a punch and guide, it lay for years unfinished, for I found my increasing experience fast reconciling my mind to the first-mentioned methods, especially considering the very varied use of the scribing method, compared with the limited application of the cone guide. But when I considered that the punching operation could be dispensed with altogether if I used the same cone guide for the end of the rod, but with the centre punch replaced by a drill, the cone guide again came into favour. This arrangement is illustrated by Fig. 1. This must be similar to the method described on page 309, thus—"I have seen lots of light work from 1¼in. down, centred by sticking one end into a hollow V-shaped socket live centre, without putting a dog on one end or stopping the lathe at all." It is only necessary that the end of the rod to be centred should be kept in close contact with the cone at starting, for as soon as the drill has entered the work the guide may be allowed to revolve with the drill, used on a drill in the lathe, with the work fed against it by right-hand centre. It is truly the quickest of all centring methods, but from a little awkwardness in holding the guide and the work in the same hand, it has not had the use I anticipated. I then tried the original idea, and used the same cone guide with a sliding centre punch, which I found very simple to use. The only thing to observe is, that the punch is in line with the rod to be centred. Both these methods are quick and simple to use, but they depend for their accuracy upon the roundness of the extreme ends of the work.

FIG. 1

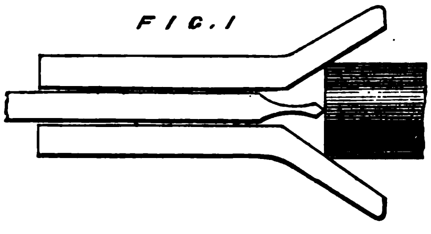
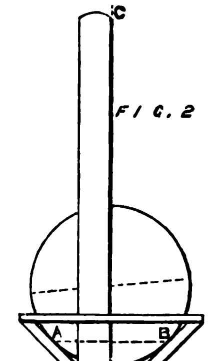


FIG. 2



Another method which may appear very attractive to the learner is by use of the so-called "centre-square," Fig. 2, which, considering its varied uses, is a very ingenious little contrivance.

Its application to centring depends upon the following geometrical considerations. Any straight line bisecting a chord at right angles, must lie on a diameter, and as all diameters pass through the centre, the point of intersection of two diameters must be the centre of the circle.

Upon applying this square its angular block finds two bearing points upon the circumference of the work; the straight line that may be imagined to connect these two bearing points is a chord of the circular end of the work, and the right-hand edge of C D is a straight line bisecting the imaginary chord, A B, at right angles. All to be done is to make a scratch as close alongside of C D as possible; then shift the square roughly about quarter of a circle, and scratch again—the intersection of these scratches is the point to be centre-punched and drilled. This method will find the centre of work that is truly round with facility; but unfortunately for its application, like cone guides, and even more so, it again depends for its accuracy upon the state of the extreme ends of the work to be centred.

Cushman's elaborate centring apparatus, p. 333, may suggest to some the use of their scroll chucks for centring. By putting a guide for a sliding centre-punch concentric, with a scroll chuck, they might make such an apparatus, which, I venture to think, would be of more extensive application than Cushman's; for, as it could be used horizontally, variation in the length of the work would be of no consequence, and the objectionable method of hammering the end of the work would be avoided; but it would never be a time-saving process when you have only one or two pieces to centre at a time. And I should consider the mechanism of a scroll chuck far too expensive to be worn out in so extravagant a manner.

Although I have not exhausted the little subject of centring, I think I have written quite as much as the subject deserves. Now we are on the point I should be glad to hear if any other correspondents have other methods worthy the attention of the amateur. I am inclined to think (conversely to custom) that cone guides are more worthy of the attention of manufacturers than of amateurs, for they are time-saving appliances, only applicable to special cases. The little square, Fig. 2, is a desideratum, for although its application to centring is very limited, its form is strong, and it can be used for all purposes that an ordinary small set square can, also for short mitres of 45°, and for most cases where a T-square is used. But the scribing method of centring is universal in its application, and from the very varied and accurate way it assists in so many other measuring operations, some sort of a scribing block deserves a place in every amateur turner's workshop.

A. E. Dancaster.

ASCENDING LIGHTNING.

[14738.]—In the first paragraph of his letter (14651) your able correspondent, "A Fellow of the Astronomical Society," states that during a thunderstorm in the neighbourhood of Tunbridge Wells he "very distinctly saw one flash of lightning strike upwards from the earth into a dark lowering cloud poised at some distance above it," and he remarks that "theoretically, of course, this is a phenomenon which not unfrequently occurs."

I once saw a similar phenomenon when standing with a friend during a thunderstorm at an upper window of his house in the country. A vivid flash appeared to shoot upwards a few hundred yards in front, from the very part of a meadow at which I was looking, and was instantly followed by a tremendous clap of thunder. My companion said he had distinctly seen the flash, but did not notice anything unusual about it, except that it was straight and nearly vertical. He was, however, not looking at the meadow, but at a wood on the hill beyond. The difference of our impressions seemed to us unaccountable.

Since that time the subject has occasionally occupied my thoughts, and I am now of opinion that ascending lightning is a mere illusion, and due entirely to the eyes of the observer happening to be directed to that part of the landscape at which the discharge occurs, and that it is no proof of the earth having been charged positively.

Wheatstone proved that the duration of the electric spark is about 1-24000 of a second, and he also showed by means of a revolving wheel, that the duration of the lightning flash is little more, and cannot exceed a minute fraction of the thousandth part of a second. The moment of time it continues visible to us—about the tenth of a second—is therefore hundreds of times greater than its actual duration. Now, is it credible that we can judge by the eye of the direction of motion in a case like this—that we can see the progress of the end of a flash of lightning?

The idea seems absurd, yet this feat must be performed before we can know with certainty whether a flash has travelled in this or that direction.

The following simple experiment will serve to illustrate the argument:—Place before the ball of the prime conductor of a good electrical machine another ball of equal size connected with a discharging train, and so adjust their distance apart that on steadily working the machine distinct zigzag sparks shall pass across the interval. Now, let several persons attentively watch the balls, and say from which of them each spark proceeds. Opinions are pretty sure to differ, but the following rule will be found to have no exceptions:—*The spark appears distinctly to issue from that ball to which the attention of the observer is directed.* It is worthy of note that the end of the spark next the negative ball is the brighter and thicker.

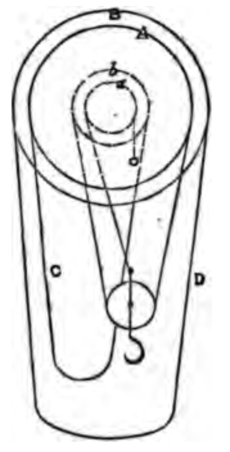
Let me, in conclusion, acknowledge the pleasure and instruction I have derived from the excellent letters of "F.R.A.S."

J. T. M.

COMPOUND PULLEY BLOCK—OBLIGATIONS OF WRITERS TO READERS.

[14739.]—I HAVE seen Mr. Jewsbury's model. If, studying his block from this, some little attention is required to grasp its action, how much more consideration must be given when that action has to be got at from a drawing only? This, however, is nothing to Mr. Jewsbury. In his letter of May 3 he gives the construction and some observations upon his block, but no demonstration of its action, though he winds up his letter with a "it will now be seen how the power is gained," just as if demonstration had preceded.

In his letter of May 31 Mr. Jewsbury should have said:—By rotating the pulley, B, a sufficient number of times, the pulley, A, "will" make one rotation, instead of saying "till" it makes one rotation, and should have gone on to make this plain by "particularly describing and ascertaining" the action of his block. If he had done this there had been no need that it should be done for him, as I now endeavour to do, taking lowering by the block first. Suppose a weight, W, to be hung to the bottom sheave or "snatch-block," and suppose the pulley, A *a*, to be held stationary. Then suppose the pulley, B *b*, to be rotated, say, several revolutions, in direction opposite to that of the hands of a watch, and then itself to become stationary by a power, P, being applied at D to the endless chain, D. It is manifest that by the rotation of B *b* there will be an unwinding of chain from *b*, and that this chain unwound from *b* will become so much slack chain on each side of the snatch-block, and that W will be left hanging by the single chain over *a*. If now A *a* be supposed let go, W will come down with a run, and, acting by the chain over *a* (that chain being of course of ample length), will turn A *a* also in direction opposite to that of the hands of a watch, and will turn it, until, by its motion and the fall of the snatch-block, the slack chain on each side of the snatch-block is caught up, and becomes taut like the chain over *a*, further fall of W being arrested by the stationary B *b*.



Examining more closely how the slack chain has been caught up, it is evident that the lowering of the snatch-block and the rotation of A have somehow between them taken all of it up; and, as a length of it equal to double the fall of the snatch-block is accounted for by that falling, the snatch-block being a movable pulley, that the rest of it must have been wound up on the right-hand side of the snatch-block by the pulley A. The catching up of the slack chain has here been with a jerk. If, however, A *a* had been free to rotate, as it is normally, while B *b* went through its supposed several revolutions, the slack chain would have been taken up as fast as it was made—that is to say, there never would have been any slack chain at all, as a little further consideration will show. The condition of the block after the supposed sudden fall of W is that of equilibrium. W is hanging by three portions of chain, and *b*, from which one of these portions proceeds, is prevented from rotating by P at D. Supposing P slightly loosened there will no longer be equilibrium. The strain on the chain from *b* will turn *b*, and A *a* will follow as the snatch-block lowers; will follow because if it did not there would be strain on the chain to *a*, and none on the chain to A; the following being at such speed as will always keep these two portions of chain on the strain, for any slack on the chain to *a* will be instantly pulled up by the chain to A on the other side of its centre, and vice versâ, and this action will continue so long as P is less than is required for equilibrium—that is, so long as lowering continues.

Now, as to raising by the block. Starting from the position of equilibrium, suppose P increased so that B *b* rotates in direction of the hands of a watch. If A *a* were immovable the rotation of B *b* would produce slackening of the chain over *a*. As, however, A *a* is free to rotate, and does rotate, also in *direction of the hands of a watch*, all such slackening *is taken up as fast as produced*, the amount of A *a*'s rotation being such as to always keep the chains taut.

Of the above description of the action of his block Mr. Jewsbury may say, "I could have said that, if I'd only thought of it." Certainly he could, and should. He had the block before him to write from, and ought not to have left others to do his work. To write is to ask to be read, and the fact of writing implies a desire to instruct, so that a writer defeats himself when he does not write perspicuously. He should bear in mind that what may be very simple to him, because he knows it, is not yet, but has to become, simple to those whom he addresses; that, as he writes from knowledge, his is an easy task as compared with that of those who have to attain to his knowledge; and as the finding out his meaning when he writes obscurely cannot be gone through by one of his readers for them all, but devolves on each of them individually, his sin is correspondingly not in one lump against ali, but is against each individually, in that on the part of each time is wasted that cannot be restored.

Coming back to Mr. Jewsbury's block. Having mastered its action, we can go to the figures. Mr. Jewsbury writes (July 19) as though I had disputed his figures. I never even examined them. All that I wished to convey to him was that they were quite a secondary matter. Of course they are perfectly correct, and they will now aid us in further examination of the block. As far as possible I will here employ Mr. Jewsbury's own words of May 31, not, however, as he has put them, but as he ought to have put them. As they stand they are unmethodical, and bother rather than aid. Let them read thus: By rotating the pulley, B, in direction of the hands of a watch, a sufficient number of times to raise W 1ft., the small pulley, *a*, must evidently have taken up 1ft. of the single chain—that is, A *a* must have gone through one rotation. Now, let us see what has taken place, and what movement of chain has to be accounted for. First of all, in consequence of the shortening by 1ft. of the loop in which the snatch-block hangs, 2ft. of chain has to be accounted for (1ft. double chain mark). Next, the rotation of A *a* has passed 4ft. of chain over the pulley, A—that is, 6ft. of chain has been slackened out to raise W 1ft. As, however, when W has been raised, there is no slack chain at all, this 6ft. must have been taken up by *b*. But the taking up of 6ft. of chain by *b* means six revolutions of B *b*—that is, means the passing over B of 24ft. of the endless hand-chain, B being to *b* as 4 is to 1—that is, for every 1ft. rise of W the circumference of B has to pass through 24ft., which means a power of 24 to 1.

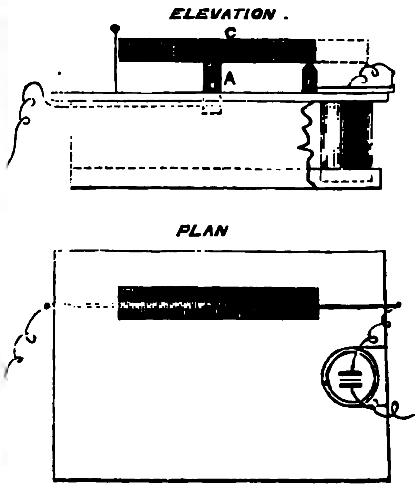
Having had my say as regards the shortcomings of Mr. Jewsbury's description of his block, I can now speak freely of the block itself, and declare that I consider the arrangement an exceedingly ingenious one. But it certainly wants his contrivance that he speaks of for making the block self-sustaining. The enormous loss of power in the ordinary differential pulley-block is, I hold, amply atoned for by its possessing this peculiarity. No matter that when a man is using this block, he is using an apparatus that offers him in theory an advantage of, say, 30 to 1, but gives him actually only about 10 to 1, and that the self-sustaining means really an imperfection. The complete control that he obtains through it over a weight he is raising is of much more consequence to him than is a loss of power of which he is practically unconscious. Speaking of this block Mr. Jewsbury further writes crudely: He says that "when the load is being raised an equal portion is always sustained by the quick or power mover." Now, in the ordinary differential pulley-block, which is the "quick or power mover?" Does he or does he not mean the double sheave? And, if he does, what about an "equal" portion being sustained by it? I am not asking these questions specially for reply, but only by way of calling Mr. Jewsbury's attention to his phraseology, with the view that the description of his contrivance for self-sustaining, and of his new pulley-block, which he promises in a future number, and that I look forward to with interest, may be all-sufficient for its purpose.

Aliquando.

A MICRO-BATTERY FOR THE MICROPHONE.

[14740.]—HAVING, like many of your readers, been seriously afflicted with microphonomania, and having made some half a dozen of those interesting instruments, including the pile microphone as devised by Mr. Lancaster, I last week made some experiments with different forms of battery, and on showing my production to a friend he declared it had all the appearance of a joke.

My first acquaintance with the microphone was in connection with a single cell of Smee's battery. I then added a battery composed of 3 copper and 3 zinc plates, 3in. by 2¼in., with blotting-paper between the plates, without any other result than that of transmitting and reproducing the sounds as before. I then worked for some weeks with the copper and zinc alone until I made the pile microphone, with a slab of carbon and zinc plate, 4in. by 2in. Finding this gave tolerable results, but somewhat difficult to adjust for sounds varying in amplitude from the tramp of a fly to the flute, and human voice, I went back to the first principles as explained by the inventor, Professor Hughes, and have now completed a microphone and battery which may possibly interest those who are working in the same field as myself. With this view I will inclose a drawing of my arrangement of microphone and battery, which leaves little to be desired except the power of hearing an ordinary conversation carried on in its presence, which I have not yet accomplished, although I can hear the tick of my observatory clock, which is some 6ft. from the microphone, the length of line wire about 180ft. Having discontinued the use of the pile microphone, I bound the carbon slab and zinc plate together with blotting-paper and immersed them in dilute sulphuric acid, the result being a very excellent battery. I then tried the experiment of tyeing together in like manner a piece of ordinary zinc plate, ¼in. wide and 3in. long, to a stick of gas carbon ¼in. square, with similar success, and in this manner I gradually reduced the length and thickness until I arrived at what I thought would be the minimum. This consisted of a piece of gas carbon ⅛in. square and 5-16in. long, a piece of amalgamated zinc and blotting-paper same length and breadth, with two short lengths of No. 24 copper wire, flattened to lie against the zinc and carbon; the whole being bound together with a piece of thread. With this miniature battery worked in a cell not larger than an ordinary quill pen, the most delicate sounds were audible. One of my cells consisted of a lady's thimble, but I have since substituted the lower end of a small homœopathic medicine bottle, with a block of gas carbon 3-16in. square and ¼in. long, which is more convenient to handle than the battery I have inclosed for your inspection, and which appears equal in effect to a block of carbon 4in. by 2in. by ⅜. Now the question is, what is the amount of battery power in this insignificant combination? Can it be said to have any power beyond that of forming an electric connection?



Since writing the above I have placed a speck of carbon the size of a pin's head, with a similar piece of zinc, between the ends of two copper wires, thus: ———-- ——— and connected the same in the ordinary way with the microphone, and the result was most satisfactory, the tick of my watch being heard as before stated. I have therefore ventured to name this battery

THE MICRO BATTERY.—The form of microphone used is that shown in the accompanying figure, which represents a plan and elevation of the microphone and battery cell, drawn to a scale of half the original size. When transmitting delicate sounds the block of carbon is placed as shown in elevation, *i.e.* just on the balance; but when louder sound or talking is required, the carbon block is placed in some such position as that shown by dotted lines, and the positions being indicated by a gauge, such as a pin stuck in the table to indicate the limit of extreme delicacy, which is often attained by moving the block C on A, as on a pivot.

Lake, Sandown, I.W. **Wm. Binns.**

THE MICROPHONE.

[14741.]—WHILE experimenting with the various forms of microphone, I was much troubled in all cases, particularly in that of speaking, and in a lesser degree in the transmission of musical sounds, by a constant blurring. After some consideration I came to the conclusion that this blurring was produced by the transmission of vibrations from the floor and other sound-conducting media through the table upon which the microphone rested. In order to remedy this defect, I suspended the instrument by a cord from the ceiling—this cord consisting of two parts united by an indiarubber ring in order to lessen any possible vibration in that direction.

neans all blurring is obviated—speech and sounds from the lowest to the highest notes ard without the slightest jar or confusion. rument I have found best adapted for this ıent is Prof. Hughes' balance form. But ıed another which transmits musical notes at distinctness, upon which I am now nting, and hope to describe in a future

Frank Cheetham.

ıgton, Manchester, August 15, 1878.

THE PARIS EXHIBITION.

.]—When I left London for the Paris Ex- fondly hoped to find there many varieties ones and microphones, and perhaps also im- ıts in the phonograph.

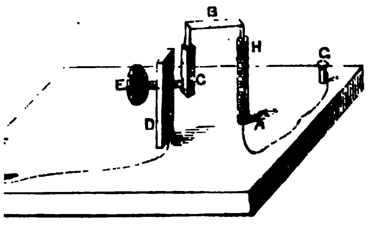
s point I was disappointed. There is only ophone to be seen in the whole exhibition, one in a case containing scientific toys.

microphone represents, however, a new ınd is worth the attention of our numerous (See illustration).

netal rod fixed vertically on a base-board, at the top, *h*, to admit of a strong steel , bent twice at right angles. The further ıis spring is riveted into a square rod of n. The point of a regulating screw, with head, plays against the carbon block, and city of the spring, under different degrees rature, offers resistances which can very regulated at will.

elephones are sold in the exhibition at 12 pair. Mr. Gray has a good stall of his telephones. He promises, by means of ıments to duplex any line or cable, and to an extraordinary number of messages either given time. Edison's carbon telephone ers are also offered for sale.

ceiver Edison uses now a very neat-looking and telephone, manufactured by Phelps, in k. To-day I had a chance to experiment rbon telephone, and obtained very distinct on of unusual intensity.



ıwest and most perfect form of Edison's ansmitter is an instrument of the shape of in. diameter and 1¼in. thickness, the case de of cast-iron; the vibrating membrane is 1-16in. thick (Mr. Edison's agent told s so thick that it did not allow of vibration

ıl kind of phonograph is exhibited, and 200 francs, or eight pounds apiece. It is ınd and all, in cast-iron. I will describe my next letter. No phonograph with k or fly-wheel, or any kind of regulator for to be seen.

entific friends will perhaps kindly allow me few unscientific remarks for the use of o the exhibition.

s full of strangers just now, and the prices are exorbitant in the centre of the town. ked to pay 5 francs a day for a badly-fur- om in the fifth story. I then went to the of Paris, the genteel suburbs of St. nd Vincennes, and found there a nice and m on the first floor for 14 francs a week; ess is Hôtel de l'Etoile, Rue du Levant, s. A tram takes you direct from here to rre, passing on the way the fortifications, Thrône, with two high columns bearing ıes of Louis Philippe and Henry IV., the of Juillet, the river Seine, with its pretty teamers, fine bridges, and comfortable establishments, the new Hotel de Ville, &c. who are limited in their expenditure should board at their hotel nor dine *à la carte*. place to dine at is the Palais Royal, where kfasts are served at 2 francs per head, and t 2 francs 50c. (two shillings).

Wiesendanger.

]—I send you a few notes of some things h may interest your readers, and will send e, though I cannot undertake to write with y, as other duties which I came here to pro- ust be attended to by preference. One of striking things about the Exposition is the ram, by means of which visitors are the top of one of the Trocadéro towers. r (there are two alike) is some 250ft. in nd the piston of the ram consists of a cylinder which reaches *from the bottom to the gallery* near the top. Its diameter is 18in. or thereabouts, and of course it has been numerously joined. A stage with glazed sides is fitted on the top, and 40 or 50 people are rammed up all at once. It is a surprising piece of hydraulic engineering, and when we consider that it involves a cylinder beneath of about 200ft. or more in length we must regard it as a very large affair. Its working is extremely smooth, and seemingly all that could reasonably be desired. Speaking of long cylinders reminds me of the cranes which are used in unloading certain of the Paris flats. Instead of having a short cylinder working a winch, in the usual way, they have a cylinder about 12ft. long, which works directly on the chain. One stroke of the piston is required and up goes the stuff, all the usual wheelwork being dispensed with.

"Going up" brings one to the great captive balloon of the Tuileries, which carries up 30 persons at each ascent to an elevation of the third part of a mile. The balloon has a diameter of about 120ft.; its shape is strictly spherical. It is inflated with pure dry hydrogen, and has a lifting power of 50,000lb. A 300-horse power engine controls the cable and winds down the immense machine. Its total cost has been £20,000. The constructor is M. Giffard (of injector fame), and he claims that his balloon is absolutely impermeable by the gas, impenetrable to rain, and utterly defiant of all storms. Seven different films enter into the construction of the bag—three of pure indiarubber, one of muslin, and three of linen cloth, varnished with linseed oil. The whole is painted and varnished also on the outer side. Considering all this care, and the small outer surface in comparison with the space inclosed, the leakage must be small. It has been inflated now to my knowledge for upwards of a month. Surely this is the kind of ship for geographical research. You might go round the world two or three times before you lost your gas. When I first read of balloons for Arctic exploration I thought little of the plan, but I am well assured, after what I have so often seen, that they afford the proper means, and I should only be too glad to accept a berth in Giffard's car. The balloon is fitted with a splendid aneroid, and with thermometers and other instruments for observation. Giffard is a man of large calibre of mind, and the details of his great balloon reflect on him much credit. Models of the balloon in rough are sold in the inclosure of the Tuileries for 15d. They are covered with a net, provided with a car, inflated with hydrogen, and have a very fair ascending force.

Speaking of "going up" reminds me of the flying toys which, however, I saw in England before I left. They are very common here, and seem to demonstrate that rapidity of action is at any rate one of the things required for the navigation of the air.

Paris, August 12. **D. Winstanley.**

THE LAWS AND PRINCIPLES OF ACOUSTICS IN REFERENCE TO THE TELEPHONE, MICROPHONE, &c.

[14744.]—Mr. A. Smith, in his letter (14659, p. 524), has astonished me to a degree which I cannot express. He states that heat and light pass through space where there is no vibratory matter. I might have waited till Mr. Smith sent his "subsequent and more general communication," but I thought it proper to draw his attention to the importance of the above assertion. On the structure of primary matter I have a book in which, on p. 350, it is proved, at least to me, that primary matter consists of "hollow elastic shells, or globules, spherical when taken singly, and like the soap bubble, polyhedral over all their surface of contact, and without interstices between them when in clusters or masses," &c. This book was published in 1862, and bears the title "Gedanken über die Naturkraft, von A. Gether. In commission vor Ferdinand Schmidt in Oldenburg." May I ask Mr. A. Smith whether he has read this book? The author of it is an intimate friend of mine, and it is natural that I should feel some interest in the matter. **J. W. Schucht.**

THE "ALL ENGLAND" ADJUSTABLE CRANK, &c.

[14745.]—The discussion on bicycle topics has been somewhat slack lately I am sorry to see, but I suppose more riding than writing is being done at this season of the year. Some months back, in reply to a query as to the working of the "All England" crank, I stated that they would not act. I am now, however, pleased to be able to contradict my former statement, as I have had a pair now in my possession for the past two months, and must really congratulate Messrs. Boult Bros. on the neatness, simplicity, and real usefulness of their production, for every one knows the increased steadiness, speed, and comfort, as well as appearance, gained by driving a short crank on a good level road; but the counterbalancing fact is also equally well known, that on coming to a hill of any moment, or meeting a heade wind, the grinding and strain to propel the machine is something terrific; riders, therefore, in general take one of the two extremes—they either use a short crank, and walk up every hill they meet with if they are lazily inclined, or they go in for a good 6in. of crank leverage, and ride up everything, putting up with the inconvenience on the level. By the use, however, of Messrs. Boult's contrivance the rider is enabled to enjoy the advantages of both methods without their corresponding drawbacks, for he can drive as short a crank as he likes on the level and down inclines, and can, on coming to a hill, let out the pedal to its full length without dismounting, by a simple pressure of the toe. Riders will at once see the advantages thus obtained, and will no doubt be glad to hear that still further improvements in their construction are contemplated shortly.

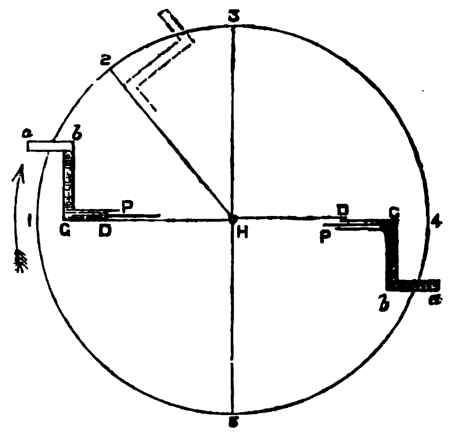
Those of "ours" who read my letter descriptive of my machine will possibly be interested to know that the "Superb" has found other admirers than myself, for it was awarded the silver medal at the Dorset County Industrial Exhibition, recently held at Weymouth, and I must say is well worthy of it.

56in. Superb.

FLY-WHEELS.

[14746.]—I have thought it possible that some improvements might be made upon fly-wheels. The present heavy fly-wheels of fixed engines, especially when connected with much machinery, accumulate not only a store of power but often a store of mischief.

It frequently happens that the breakage of one wheel in the machinery causes the breakage of a number of others, owing to the immense accumulated force of the ponderous fly-wheel, which cannot be stopped till damage is done and perhaps loss of life caused. Some of your scientific readers will perhaps give their opinions as to the utility of the following:—Let 1, 3, 4, 5 be the outline of a fly-wheel, vertical, H the centre; the wheel, say 20ft. diameter. Attached to it are two right-angled similar cylinders, *a*, *b*, *c*, *d*, one at position 1 and the other at 4, each having a piston, P. Length of each cylinder from *b* to *c* is 36in., and the parts *a b* and *c d* each 24in. Each cylinder to be filled with mercury sufficient to fill *a*, *b*, *c*. The wheel revolves in the direction of the arrow. Then every time the cylinders reach the horizontal position, 1 and 4 as shown, the mercury will fall in that at 1 from *a b* (as it were) into *c d*, pushing the piston, P, from *c* to *d*, and thereby transferring the weight of mercury that was in *a b* 2ft. nearer the axis, leaving *a b* a vacuum. The mercury in *a b* of the cylinder opposite will remain until arriving at position 1. Thus there will always be a preponderance at 4 whenever the cylinders arrive at the position shown, which will be twice in a revolution. When each cylinder arrives at 2, there being no longer an altitude of 30in. of silver on the piston, it ascends by atmospheric pressure, again filling *a b* automatically. The larger the section of the cylinders the greater the preponderance at 4. Still the wheel would be light compared with those in use, and would need but little accumulative force, and therefore would be easily stopped. The position of cylinders as shown would of course correspond with dead points of engine. The cylinders also may be of different form. The wheel would be expensive as to mercury, but more so are break-downs of machinery.



Norfolk.

CLUBBING OF THE BRASSICÆ.

[14747.]—My having never found a club on a cabbage plant without larvæ, is, as "Saul Rymea" remarks (14684, p. 547), only negative evidence, and does not upset the fact of his having found clubs without any insect visible in them. I, however, still think that the evidence, though negative, is in favour of my opinion, that the disease described in M. Woronin's memoir as being prevalent in Russia, is distinct from the disease prevalent here, and generally known by the name of clubbing. "Saul Rymea" may possibly have come on a few instances of the disease described by M. Woronin, or of something similar, but if so I do not think it proves much. I have never found larvæ exactly like those in the clubs, in either the stalks or mid-ribs. I only mention this as a fact in answer to "Saul Rymea's" question; it proves nothing. My entertaining a different opinion from "Saul Rymea" on this subject is of very little practical importance; but I hope very much that his letter will have the effect of turning the attention of properly qualified practical microscopists to the investigation of the matter. I should take very great interest in having it cleared up, and if it is satisfactorily cleared up I would care very little whether my opinion turned out to be right or wrong; for the present I adhere to it.

G. J. H.

ON THE IDENTIFICATION OF ORGANIC SUBSTANCES.

[14748.]—I NOTICE in Mr. Clements' excellent contribution on "The Identification of Organic Substances," that one or two errors have crept in which will require correction. On page 551, when talking of the re-agents useful in detecting organic substances, he says that brucine gives a red colour with strong H_2SO_4. Now, it is quite true that brucine gives a faint rose with that re-agent, but it is more probable that strong HNO_3 is meant, as this re-agent gives a bright red colour with that alkaloid.

Again, he says, "If a little potassic bichromate is added to strychnine it will give a dark purple colour." This it certainly will not do, unless some strong H_2SO_4 be previously added, in which case either manganic dioxide or plumbic dioxide (the latter containing a trace of free HNO_3), may be substituted for the bichromate.

I also notice that dextrine and gallic acid are classed among the substances insoluble in cold water. Both of these substances are soluble in cold water, and the former more so than the latter.

Carbon.

PEACOCKS AND RED ADMIRALS.

[14749.]—YOUNG entomologists requiring a quantity of these beautiful but very common insects, will now find them in the caterpillar state, feeding on the common nettle. Although they both feed on the same plant, they should on no account be put together in the same cage to feed; the peacock will choose a young and tender nettle, while the admiral gives preference to a rough, dusty, and scrubby-looking plant.

Again, the red admiral is a very quiet fellow in all his habits—in fact, he positively dislikes moving about at all. This is the reason why he should be kept separate from the peacocks, which will run over the cage day and night, and if they come across an admiral caterpillar that is changing into the pupa state, they keep walking over and over him, and seem to annoy him all they can, and mostly wind up by spinning a web all over him. The breeding cage should be about 2ft. 6in. high by 12in. square. Put the nettles in a large-mouthed bottle, put paper round the bottle to assist them to get their food. The peacock will require fresh nettles every day; the admiral every four days. Keep the cage very clean.

Chelt.

THE LAND QUESTION AND INCREASED COSTS.

[14750.]—IT is not given to every one to distinguish between the post hoc and the propter hoc. Still fewer people can understand the old question, "What is a pound?" Therefore we must distinguish between the two statements of "Looker On," 14711, p. 576, "that buildings now cost twice what they did 30 years ago," which may be true but then it does not follow that it is "entirely in consequence of higher wages for less work." This last is merely "Looker On's" personal deduction. But granting that, too, it does not follow that this is a reasonable cause of complaint against the working classes, for they have a most unquestionable right to seek to improve their position.

We have also complaints, as from S. Mayer, 14710, p. 576, that "workmen know very well that they are no better off than before." That is, that the rise in wages of late years has not conduced to the advantage of the workman as they expected. This likewise is to a great extent true.

In all these great debateable questions, in fact, there is truth and also right upon both or many sides, and the acrimony which arises in their discussion is due to the fact that few are able, and fewer still willing, to look at the truth which the other side maintains. If this discussion goes on, and I have anything to say in it, I suppose I shall share the usual fate of those who impartially examine all sides; but that is of no consequence—so I will just now quote myself writing six years ago in the flush of supposed prosperity (Vol. XVI., p. 116): "All this is the result foreseen by those who know anything of political economy, and who warned the leaders of the working classes of what *would result from the strikes* and the effort to raise *wages instead of reducing the cost of* production. The rise must end in becoming general, and the result is that by the time wages are doubled the cost of living is equally doubled; the internal relations of the country are therefore unaltered, except to the injury of those who cannot increase their incomes; but the powers of the country as to external trade are greatly injured, resulting in what will surely follow the present conditions—a terrible reaction, much suffering, and probable social and political disturbances."

These consequences we are now experiencing. The trade and social disturbances we have enough of—the probable political ones have yet to come, but come they will, and very much of the political jugglery we have been witnessing for the last two or three years is nothing but an attempt to draw off attention, just as in France they used to get up or make believe to get up a foreign war or excitement, when the pent-up social forces threatened inconvenience to the ruling powers.

The fundamental error committed by most people is the measuring values by "money." Now, while mankind are apt to think money the one thing needful, and at all events the one thing most certain and stable in the world, the real truth is that there is nothing more unreliable as a test, or which more steadily lowers in value. This is the real truth, not that houses have increased in cost by wages (fairly or unfairly) paid to workmen, but that the money standard—the almighty dollar or pound—is not worth what it was. This truth I must leave to another time to open out.

Sigma.

THE MONOPOLY OF LAND AND THE SCARCITY OF HOUSES FOR THE WORKING CLASSES.

[14751.]—THIS subject, first introduced by me into the columns of the ENGLISH MECHANIC, has now assumed a broader base than I at first anticipated. To give space in "ours" such as would be necessary to discuss the "land question" in a very limited way is more than should be asked for by any correspondent, but that particular part of the question to which I called the attention of your readers may be referred to in a briefer way; and by doing so some valuable facts may be elicited from other localities where the high rents demanded for building lots prevents the profitable investment of money in building houses for the working class.

"Ruin," in his reply to my letter, seems to have a very limited and comfortable idea of monopoly. "Because we see daily in the pages of every newspaper in the kingdom advertisements offering land for sale" he would have us to understand that there cannot be of necessity any monopoly in the article. He admits that articles of manufacture protected by patent give a valuable monopoly to the patentee, preventing others from manufacturing like articles, although such might be done equally as well and supplied to the public at a lower figure. But here I must remind him that letters patent, like land, are a valuable marketable commodity, and are daily offered for sale in the same way, so that the logical conclusion from his own style of argument is that a patent right gives no monopoly, as it can be purchased at any time in the open market for a fair price, such stock changing hands every day, and its value depending upon the demand for the article patented, and protection from competition insured. "Ruin," I presume, scarcely needs to be told that there are monopolies and monopolies, some secured by legal enactments, others by casual circumstances over which we have full control; and the special monopoly in land, which gives to individual possessors the right to do with a limited commodity as self-interests or fancy may suggest, irrespective of the interests of others.

Perhaps "Ruin" would understand the nature of such a monopoly as this if he were to visit some of Scotland's fairest glens and straths, by the Highland Dee or the dashing Spey, where red deer multiply instead of men, and royal stags dot the hill-sides in the places where pleasant and comfortable cottages ought to be. Or let him pay a visit to some of our little towns and villages in the north and make inquiry respecting the price and conditions of suitable lots for dwelling-houses for working men. To say that such lots are coveted by the working classes, or that they would steal them like the possible "broom-seller" if they had the chance, is simply an impudent insult, a kind of purse-proud language which intelligent workmen can afford to laugh at.

Would "Ruin" be surprised to learn that there are wealthy land proprietors in Aberdeenshire who have refused good offers of rent for the privilege of opening granite quarries on their estates. The reason given for such refusal being "quarrymen are such a poaching set, a few of them in the neighbourhood would destroy the game, and your offer of rent would not be equivalent to the loss."

Is there any known monopoly in the kingdom that acts with such injurious effect as this on the interests of trade and the development of legitimate and valuable industry?

The imperial proprietors of the Highlands of Scotland prefer deer before sheep that the royal sport of deer-stalking may be enjoyed by a few, either being preferred to humanity, which, say the proprietors, brings with it a poor's rate, trades-unions, and a discontented and ungrateful peasantry.

Imperialism and the doctrines of Malthus are strongly believed in by the landed aristocracy of our country. "They toil not, neither do they spin," but let them remember that "it is the last straw which breaks the camel's back," and that the most patient must find a limit of endurance.

Pioneer.

INCREASE OF POPULATION—ANTIQUITY OF MAN.

[14752.]—I DO not wish to take up much of your space, but I should be much obliged if you will publish a few lines in reply to Mr. Steel's criticism of my letter. He says, "100 millions × 2,850 equal 13 millions × 21·923." So it does nearly, but he further states that the third term or 13 millions equals the difference between the first term, 100 millions, and the present total, 1,400 millions. This is clearly incorrect, as the difference is 1,300 millions, and this will make his answer entirely wrong.

I cannot see at present of what use his proportion is, and the only way I know to get the ratio and time is by geometrical progression. Thus having the first term 100 millions, and the last 1,400 millions, time 2,850 years, to get the rate of increase per century we should say 100,000,000 $R^{28\cdot5}$ equals 1,400,000,000, or $R^{28\frac{1}{2}} = 14$; find now the logarithm of 14. which is 1·146128; divide this by 28½, and the quotient is ·0402153, the log. of the ratio per century; proceeding with this to get the time required for the increase from 2 persons to 100 millions, we say ·0402153 × t equals the logarithm of $\frac{100,000,000}{2}$. Therefore, 7·6989700, the log. of 50 millions, divided by ·0402153, gives the time—viz., 19.144 years; add this to 2,850, and we have 21,994 years as the answer.

I was not aware of any difference between chronological and geological man, and regard both as the same species, and the ancestors of the present generation. If Mr. Steel thinks differently, perhaps he will state when geological man ceased to exist, and chronological man commenced.

B. Riley.

MICROSCOPICAL—THE SPIDER.

[14753.]—A LITTLE being—himself one of the most interesting creatures the microscopist can contemplate—is one of the best assistants the microscopist has in preparing entomological specimens. This most skilful rival of Mr. Norman is [illegible] none other than the common spider, who weaves hi[illegible] nets in the mouldings of our ceilings, and establishe[illegible]s his [illegible] in the corners of our window panes. If we examine the webs woven over the windows of a store-room, or any other little-used apartment, we [illegible] will find it a very insect golgotha. Here are the [illegible] heads, trunks, claws, wings, &c., of hosts of flies [illegible] beetles, all more or less dry and transparent—[illegible] juices, the tit-bits, having been nicely sucked up [illegible] carefully picked off. If provisions have been pl[illegible] ful Mr. Spider becomes fastidious, and has sh[illegible] the bodies off his net, only taking some c[illegible] morsels, but if game is scarce then does he ca[illegible] investigate and break up the carcase as industr[illegible] as perhaps the reader would disjoint a lobster [illegible] no doubt he eats out the juices with the raptu[illegible] gourmand over a marrow-bone. Shrouded [illegible] nets in the least conspicuous place is the sp[illegible] parlour, an apartment lined with silken tap[illegible] and having two doors. Here he frequently [illegible] in his catch, that he may more leisurely enjoy [illegible] feast; and here his telephone lines inform him [illegible] the tramp of a fly is on his web, or announce [illegible] perplexed trumpeting of an entangled bluebottle. Now there are among spiders certain vagabonds who, wasting their substance in riotous living, [illegible] becoming too lazy to spin, tramp about robbing and murdering their fellow-spiders, and respectable individuals who build cosy parlours and become so fat and indolent that they neither shake the dust off their nets nor yet sweep away the garbage from their doors, become an easy prey to those depraved, hungry tramps, who steal on them like thieves in the night, who, after feasting on the bodies of their too-luxurious victims, either keep possession of the cosy premises, or, still following their vagrant instincts, again set off in search of new marauding adventures.

Amongst the various insects and parts of insects the microscopist will find nothing to interest him more than the skeletons of those well-fed [illegible] fellows, who, doubtless, have met death in the manner I suggest; and, having found his spider, the next thing is to close the forceps gently on it, and lift the body and limbs gently through the web and rubbish. The upper plate of the body holding the eyes is generally detached, and must not be left behind. The next step is to put all into a vessel of turpentine, which not only makes the parts more transparent, but also renders them tougher. If our desire is to mount a leg, sever it off with a pair of scissors, found that the effect of the wrought-iron blocks was very great, but on examination it was shown that the wrought-iron brake blocks had torn small pieces out of the tires, while on the other hand the cast-iron blocks did not do any damage to the tires, as they were left quite smooth.

If the co-operation of the different railway companies can be obtained, Captain Galton proposes to fit the cylinders, or sacks and brake pipes, of the various continuous brakes at present in use, to the experimental van.

By this means every information will be ascertained, and the relative merits of the different brakes conclusively proved.

Another point which is receiving great attention is that of the *vis viva* of the wheels themselves. When a train is running, two distinct operations have to be performed by the brakes before it is stopped. The first is to arrest the forward motion of the train; and the second, to arrest the *vis viva* of the revolving wheels.

The *vis viva* of a railway wheel is equal to that which would accumulate in a body of the same weight, moving at a speed, equal to that of the circumference of a circle revolving at the same rate as the wheel, and having a radius equal to the wheel's radius of gyration.

When running at 60 miles an hour, or 88 feet per second, the *vis viva* of each wheel will be found to be very nearly 54,000 foot-pounds. As the *vis viva* varies with the velocity, it will be seen that it has to be calculated, for every experiment made. I am very glad to have heard that Captain Galton intends to try some experiments by running the trains upon parallel lines, as I mentioned in my last letter, page 552. A few days running of trains, side by side, would settle this difficult brake question.

Such a trial would show at once to all observers which brake was the best, far more conclusively than by separate trials.

August 15th. C. E. S.

DEEP-SEA SOUNDING.

[14756.]—A LETTER (14090, p. 550) signed "R. J. Leckey," and dated from "Scientific Club," has just attracted my attention. In it the writer falls foul of a paragraph at page 529, which gives a short summary of the principal results of a line of soundings taken by Commander W. S. Sehly, U.S.N., from Africa to Brazil, viâ St. Helena, because he thinks that the term "abrupt" used in it tends it mislead. The passage in which the obnoxious word occurs is, "after leaving the coast of Africa there is an abrupt descent of 900 fathoms in the first 60 miles, deepening up to 3,000 fathoms in a distance of about 700 miles." Now I think that this is not at all calculated to mislead any one who reads it, or as to form a distinct idea in their minds of what it means. The idea which it is calculated to convey seems to me to be this: in the first 60 miles there is a descent of 900 fathoms—that is at the average rate of 15 fathoms in a mile, or in 880 fathoms, or to go farther 1 in 58·66, as Mr. Leckey accurately calculates. It also, I think, conveys the idea that somewhere within that distance of 60 miles from shore the descent is more abrupt than that average rate, and that then in the next 640 miles or so the descent is about 2,100 fathoms—that is at an average rate of 3·3 fathoms in a mile, or about 1 in 268. By what mental process Mr. Leckey comes to the conclusion that the term "abrupt" is applied to the latter rate of descent I cannot conceive. The plain meaning is, that this latter rate is the very reverse of abrupt, and that the descent in the first 60 miles from shore is relatively abrupt, in comparison with the much slower rate of descent after that distance. Though some American scientific and *soi-disant* scientific men are undoubtedly rather fond of "high faluting," in common with some of their "confieres" at this side of the Atlantic, the scientific officers of the United States Navy are, as a body, as little open to that imputation as any body of scientific men in the world, not even excepting the "Scientific Club." Mr. Leckey winds up his letter with the aphorism, "truth invariably defeats its object." But, though he evidently thinks this exceedingly wise, and intends it to be very telling, I cannot form the least idea either of its meaning in the abstract or of its application in the present instance. Would not the old "Magna est veritas et prevalebit" be more to the purpose, or even "Ars longa—vita brevis" of Dr. Butts?

August 13th. G. J. H.

Internal Magnetism.—M. J. M. Gaugain, from experiments upon steel tubes and nuclei, concludes that the changes of magnetism which are produced, under the influence of heat, in a solid steel bar, do not differ from those which are produced, under the same influence, in a system composed of a tube and a nucleus. Both seem to depend on the inverse *magnetism developed* by the mutual reaction of *consecutive layers, either of the bar or of the system.*

REPLIES TO QUERIES.

*** *In their answers, Correspondents are respectfully requested to mention, in each instance, the title and number of the query asked.*

[33079.]—**To Watch Jobbers (U.Q.).**—Will "Amateur," who replied on page 555, give details of the tool he mentions, as the material shops I deal with know nothing about such a tool?—COUNTRY JOBBER.

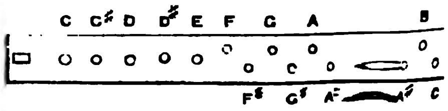
[33151.]—**Drying Oils.**—One meaning of the word remove is undoubtedly "to cause not to be," but it is not the most usual. I don't think any one would have taken this to be "S. L.'s" meaning. There are substances of a fatty character in oil which "driers" precipitate, and the removal of these (I use the word in its more general sense) should, theoretically, make the oil dry better, and I think that oil deprived of these substances does actually dry a little better; but I thought "S. L." meant to credit this action of "driers" with the whole improved drying power of boiled oil over raw. If litharge is added to oil it makes the latter dry. If it is abstracted it causes it not to dry. Does "S. L." hold that the presence of litharge causes the removal of the non-drying properties, and its abstraction their return? Can he explain the oil-drying theory more fully? Copperas and umber are driers, yet I don't think the former dissolves at all, and the latter but very partially. Any information on this obscure subject will be very interesting.—DANDIE DINMONT.

[33150.]—**Cupola.**—I am very much obliged to "F. W. S." for his answer to my letter, containing advice as to where I may obtain so much useful information. The cases he quotes would indicate considerable room for improvement in the management of the cupola (judging from my own results), and would also show what I have all along thought, that no particular attention has been paid to the economical working of the cupola. Of course, in my last I only gave the theoretical amount of coke necessary to melt the iron. The extra coke must be added that is necessary to melt the ash and limestone, and to provide for the waste heat passing up the chimney. Still, I am of opinion that with hot blast, say at 500° F., we ought to do with much less coke.—CUPOLA.

[33156.]—**Cupola.**—I think that the amount of metal you melt in your cupola in proportion to the coke used is rather satisfactory. I should like to know your authority for stating that "Carbon develops 12,906 units of heat in combustion to CO_2, and that cast iron requires 478 units to melt it." In the foundry I am connected with we tested the last truck of coke we used, and found we used 4cwt. 1qr. 3lb. of coke to the ton of finished castings. Our cupola is about 28in. diameter for about 5ft. 9in. in height, and then is enlarged to 42in. diameter for about 7ft. in height. Our tuyeres, 2 in number, are situate 30in. from bottom, and are 6in. diameter; we use a Root's blower (No. 4).—J. C——Y.

[33368.]—**Hay Fever.**—Be hay fever what it may I think that "F. W. S." may congratulate himself upon the phase of development on which it has now entered as likely to obviate some serious trouble in the shape of heart disease, which would have been the most probable result not far in the future. All he can now do is to let the elimination of this "stringy phlegm" have its course, as any attempt to stop its flow would be followed by some very unpleasant consequences in the shape of permanent bronchitis, or worse. Act upon the throat as much as possible by gargling night and morning, as well as at frequent intervals, with the chlorate of potash solution, and having some also in a bottle, from which you sip it in a few drops, just sufficient to be absorbed by the tissues in passing down the throat. This will facilitate the separation and passage upwards of the fibrinous secretion, which has a tendency to become again plastic on contact with the air in respiration, and it is this replasticity which is the bronchitis. Where the standard of animal heat is very low, so that the secretion "sets" as it issues upon the cell walls of the lungs, then it is the "spasmodic asthma" described by C. F. Tootal. The solution of this fibrinous matter absorbs a great amount of heat, which is rendered latent in the process. As few persons have any excess of this important vital principle, it has to be withdrawn from the body, for which digestion, transpiration, and other important functions upon which the health of the body depends, have to suffer. If this be felt, recourse must be had to some "pure" stimulant in aid—that is, some remedy which creates the heat by the decomposition of its own elements, and not by astringing (condensing) the tissues themselves, and so setting free this latent heat. This is merely "robbing Peter to pay Paul." And as Peter always insists, with more or less pertinacity, for the return of his due, it is generally the source of much after uneasiness and disturbance in the house (of life). This pure stimulus may be got from the guaiacum (or "lignum vitæ," as it got named for this property), the formula for the compound decoction of which I gave in a former letter. This is safe and simple. It will also be found in the coca. This is the line of treatment to be adopted, which may possibly have to be persevered in for some time, as the continuance of such a disease for 21 years will have accumulated a considerable amount of what should have been excreta during that period. With me the "grand effort" occupied 8 months, and I am just finishing up what has been a loathsome case of skin disease, which has taken me 18 months, and that the third attempt. As to quinine, it affords no permanent benefit: it merely reproduces the concretion, thus palliating the symptoms by consolidating the disease, to reappear with greater force at the next season. As to the paraffin, it is said to be held in high estimation by the Seneca Indians for rheumatism. Under the name of "Petroleum, Oil of Peter," it is described in the "New London Dispensatory," of Salmon (1682), as "of wonderful power in comforting and supporting the nerves." And the rectified spirit is "good for wounds, boils, and ulcers, and mixed with spirits of wine, of singular good use against the palsy and numbness of the limbs, as also gout." According to a correspondent of the *Times* it was, or is, the practice in the oil districts of Pennsylvania to dip a glass in the oil and drink it off as a remedy for all diseases. It was much in use in the United States army in the treatment of wounds. Stevenson's "Cholera and its Cures" has it also in its list of remedies, and I was told the other day of its being so used with success. Also of the [illegible] in gout. In recommending it, in my last, for [illegible] use, I had doubt of any possible detriment to the eyes, and so kept back my letter till I had tried it. I found in the result the deposit of a good deal of "false membrane" in the nostrils (the fibrinous matter of the bronchitis in the throat and the "gummy secretion" of the hay fever). It [illegible] no soreness, and seemed to relieve the sight [illegible] than otherwise from the precipitation of the irritating atoms in the lachrymal secretions. In [illegible] this deposition to the nose we are avoiding the more dangerous probability of its taking place in the eye, and so forming "cataract," or in the [illegible] itself, to the risk of opacity and subsequent blindness. These results are what I am repeatedly [illegible] hearing of the effects of the lead and zinc lotion [illegible] recommended by C. F. Tootal (page 531). Let me [illegible], therefore, earnestly dissuade my readers from his [illegible] prescription. Nothing will beat cold-water bathing, [illegible] or pads at most a little vinegar. I never used any other [illegible] cold water myself, night and morning, [illegible] using them hardly for 43 years, often night and [illegible] I found them still capable of clearly defining [illegible] of Big Ben from the tower of the Crystal [illegible] said to be seven miles. As a rubefacient [illegible]ent, the benzoline application to the nostrils [illegible] be without useful collateral results as [illegible] important organs of sight, I am glad that "F. [illegible] has made such happy use of my simple [illegible] suggestion already. As to rheumatism it must be [illegible] remembered that the use of rheumatism is to dissolve [illegible] solids this same fibrinous or stringy phlegm [illegible] has to be transferred to the lungs for "e[illegible] elimination. But its course is beset with difficulties [illegible] as "drug" impediments. Interiorly it [illegible] then [illegible] the source of serious disease of the heart [illegible] and [illegible] organs, causing indigestion, consumption, [illegible] and (in elimination) bronchitis. In this [illegible] is [illegible] we can soon serve "notice to quit" upon it. [illegible] other phases are very embarrassing. W[illegible] What [illegible] absorption of the paraffin may neutrali[illegible] humour and its coagulative tendencies, I [illegible] I can [illegible] till further experiment. Under these circumstances [illegible] the [illegible] I should recommend its use only till [illegible] relieved, and not push the humoral decomposition [illegible] completion. It may be that the oil miners [illegible] in thus drinking the oil, and so counteracting [illegible] quent internal congestion. But I want [illegible] evidence before I can conscientiously recommend such use of it. Can any reader throw any light [illegible] such experience?—INCOG.

[33396.]—**Organ.**—I should have answered [illegible] query sooner; but I thought some practical [illegible] would have taken it up. As it had an answer [illegible] will do querist no good, I inclose a diagram [illegible]



will help him a bit. It is the C octave [illegible] of a [illegible] the bottom notes being in a single [illegible] row, and higher notes in a double row. A slide [illegible] with all notes in a single row would have to [illegible] be 9ft. long.—A. STEAD.

[33444.]—**Galvanised Iron Laundry Boiler.**—I think "Zinc" would find a wip[illegible] with a [illegible] dipped in petroleum the best thing [illegible] remove the soap. There is nothing like copper af[illegible] all for this purpose.—J. S.

[33449.]—**Russian Tansy.**—Some [illegible] of this are ground in London every week. It may be obtained [illegible] of the wholesale druggists. I cannot give an [illegible] direction.—S. M.

[33450.]—**Cleopatra's Needle.**—I suppose what the *Times* penny-a-liner meant was [illegible] the centre line of the trunnions on which the obelisk will turn was, respectively, 28ft. from the base [illegible] and 40ft. from the top of the obelisk, which would thus be about balanced. The obelisk has been cut [illegible] where it is [illegible] base, and the pieces are for sale. I be[illegible] that the inscriptions are to be recut [illegible] deepen[illegible] climate [illegible] perfect absurdity; and owing to the [illegible] Syenite must be protected by a coa[illegible]

Would it be possible to build a tight boat without the two skins? Since sending in my query, I have thought a raking mast stepped very near the stem, and fitted with a leg of mutton sail and boom, would be handy. A small jigger aft would insure a very good weather helm. "Gimcrack" only mentions two templates. Would this be better than three? My idea is to have the centre board working on a pivot, with a rope leading aft to haul it up by. Will "Gimcrack" kindly answer these questions, and oblige—W. A. R.

[33628.]—**Diving.**—When a man dives he makes an effort to keep his arms fixed in the most natural and convenient position. If his arms were left to dangle listlessly he would not only present a ridiculous figure, but could not control his course in the air. He would probably fall into the water sideways or turn an involuntary somersault, and when under water he would be helpless to steer his course for some seconds, or until he had brought his arms forward to enable him to make the necessary strokes. A man, therefore, places his hands above his head in diving—(1) Because he can't well help doing so, any more than a dog can help using his tail to steady his course when running. It is natural to do so. (2) Because in that position he is ready the instant he entered the water to steer his course, and to control his motions. (3) Many other accidental but secondarily important conveniences follow also, some of which "Law Student" has enumerated.—Serendib.

[33632.]—**Electricity.**—I am sorry I had forgotten to answer query 33173, and now hasten to do so. Cut up 20 plates of carbon, 2in. long by 1¼in. wide and ¼in. thick; cut up an equal quantity of zincs, then mount them in couples, with a brass casting or a thin piece of brass bent round so as to hang on the edges of the cells. The 20 couples, when done, will require 20 cells; and these can be made out of guttapercha. Make first one long cell—long enough to hold the lot—and then make guttapercha divisions to go between the couples. Thus you will have 20 couples, and, by having them all screwed to one long rod of wood, it will be easy for you to lift them out when not in use. The cells should be charged with sulphuric acid, 1 part; sulphuret of mercury, ½ part; water, 20 parts. Two wires should be attached to the terminals, and should be connected to two tubes having carbon blocks in them or sponges—the former preferred. One of these should be applied to the back of the neck, in the hollow just below the projection in the occipital bone—the other should be moved over affected parts slowly; and this should be done every morning and night, about a quarter of an hour each time.—W. J. Lancaster.

[33639.]—**Spectacles.**—I am afraid ordinary spectacles will not be of much use to you. You have already consulted an oculist and several physicians, and apparently have received no benefit; then you insert a query, thinking to get the relief you have not yet obtained. Now, can you give me an answer to the following queries:—1. How long have you suffered from this weakness? 2. Can you account at all for it from any illness you remember? 3. Has your employment been such as to cause a strain of any kind? 4. Will you tell me how far you can read this answer away in daylight, and how near with, first the right eye, then the left, then both eyes, and when the print is held perpendicular? Turn the paper round while looking with each eye (after measuring), and note whether the print appears brighter in any particular angle. In the meantime don't use any eye lotions or wear coloured glasses of any kind, but bathe your eyes night and morning with lukewarm spring water, gradually cooling it until it is quite cold. Bathe them for ten minutes or so every morning, and five minutes at night.—W. J. Lancaster.

[33639.]—**Spectacles.**—I trust my experience may be of use. As a boy at school, when trying by the light of a tallow candle to make up for hours lost at play, sight used to fail me. Some years later, plan-drawing by day, and a necessity for burning midnight oil, again warned me that there was something wrong with my eyes. In the field my eyesight was almost very good; but about this time, in practising for a rifle match, I found the left eye served me best, and took to firing from left shoulder. At 30 years of age newspaper-reading even by day was difficult, as after reading a few lines dimness would come on, and a short rest be necessary. At 33 I resolved to try at a competitive examination for special employment, and for 16 working days had read for at least 10 hours daily. The struggle was awful, but by keeping my eyes steadily fixed on the page the dimness would gradually disappear, and I could once more read, but the book seemed much further off, and the print very small, though quite clear and distinct. Any interruption, or sometimes the careless turning over of a page, would necessitate a short rest and a fresh struggle. Spectacles had the effect that "Optics" describes, and it was better to do without them. Though successful at the examination, I found it impossible to carry on the studies which had to follow, and in the year 1869 I went up to London to get the best advice possible, but without any real hope, as 6 years before I had consulted a leading oculist, who, after the few minutes he could spare me, said there was nothing to be done but to spare my eyes as much as possible. Messrs. Carpenter and Motley told me that the *gentleman I wished te see was out of town, but strongly advised me to go to Mr. Carter, who at* that time was not much occupied with private practice. I went, and after a most kind, patient, and exhaustive examination, lasting near two hours, he said that a slight paleness or want of colour in the right eye was the only abnormal condition he could discover, and that he could only conclude from certain practical tests he had made that if I used the left eye only with a slightly convex glass—No. 18, I think—I should be able to do all ordinary work. I am sorry to say I went away unbelieving, thinking I had already tried using one eye only, but I bought the glasses at Carpenter's, having the sight glass duly darkened. Seated in the train with heavy heart I bought a *Standard* for the fatal experiment. I read a few lines—no dimness, all was clear, and so pleasant; a few more, and then my hand shook, my brain seemed to whirl, I was altogether in a strangely excited state, seeing every letter of the smallest print, but not understanding a word. Hope and visions of the future sprang from each word, which want of brain power alone prevented realisation of. In a year I had to use a slightly stronger glass, and now have one of 10in. focus for left eye only, leaving the right eye quite uncovered. The failure of my sight was not due to different focal lengths of the eyes, nor to weakness of the muscles called into play when the sight of both eyes is, as it were, concentrated on a point near them, but apparently from strain entailed on left eye by the false image or outline of every object as seen by the right eye. I found in trying to read unknown words with right eye alone, that small portions of each word looked at were really not seen except by moving book or eye; and consequently double letters—double "s" especially—always puzzled me.—C. H. B.

[33652.]—**Means of Determining Temperature of Iron Cylinder.**—I must know the temperature you wish to obtain before I can give you the information you require. Let me know to within, say, 20°, and I will tell you how to proceed.—W. J. Lancaster.

[33657.—**Bees.**—Why does A. F. Parish want to kill his bees, when he can easily take the honey, and still save them? And, if the season has been no better in England than it has been here, they will be worth much more than the honey. If he will send me his address I will write to him, and give him a few hints as to how to remove them and put them into hives. I have removed them from all sorts of places, including hollow trees, holes in walls, roof of a house, down a chimney, and never had any difficulty. They will return to a place where they have once been, and I always do all I can to induce them to do so. Let me know if you have any hives, if so, what kind? Can you get at the bees easily, and how are they situated? and make it a rule never to kill a bee. I could hardly give you instructions in a letter to these pages without knowing more particulars.—H. Atharley, Carnota, Alemguer, Portugal.

[33663.]—**Etching on Copper.**—"Etching and Etchers," by P. G. Hamerton (editor of *Portfolio*) Macmillan, 1868, is a comprehensive work on etching. It contains many illustrations. There was a cheaper edition issued in 1875, I think. All information about it can, of course, be obtained from *Portfolio* Office, 54, Fleet-street, London. "The Art of Etching on Copper," by Alfred Ashley, Illustrated. London: J. and D. A. Darling, Bishopsgate-street. This is a short but practical treatise on etching. The names and addresses of persons supplying everything necessary to the practice of the art is given in this work. Spoiled plates can be replaned several times if necessary, at a small cost. I should think it would be advantageous to see examples of the work of the best etchers of the day in such publications as *L'Art*, *L'Eau Forte*, and the *Portfolio*.—R. O.

[33667.]—**Marine Engines.**—"B. A. H." should study well Reed's "Engineer's Handbook, "Main and Brown on the Steam Engine," and Ainsley's "Guide to the Board of Trade Examinations."—Wear Engineer.

[33672.]—**Copying Mouldings.**—The profile of mouldings may be got by pressing a strip of sheet lead against the moulding, and then carefully removing the strip to a sheet of paper, and tracing the form with a sharp-pointed pencil.—Gimcrack.

[33676.]—**Working Men at the Paris Exhibition.**—The cheapest way to Paris is by way of London, St. Katherine Wharf, Boulogne, and Northern Railway of France, 28s., there and back. Next cheapest is viâ Newhaven and Dieppe, from London Bridge or Victoria, 30s., there and back. Next viâ Folkestone and Boulogne, 31s. 6d., there and back—all third class. The first route is the slowest, and very rarely enables the traveller to arrive in Paris before dark. For a week's stay the best part of the city to lodge in would, I think, be near the Northern Railway terminus. A party of 2 or 4—one of them speaking French with tolerable fluency—would get a lodging, even in Exhibition time, for, say, 2 francs per bed per night—near the the sky certainly; but as very little time need be spent in the lodgings, and one or two ascents per day suffice, this does not matter. All about Paris yellow bills hang at the doorposts, with the inscription "Chambre meublée à louer"—this means furnished bedroom to let. "Appartement à louer" means a set of rooms, often with cooking accommodation, to let. Service—that is, bed-making, &c.—is generally extra: the price should be bargained for. Meals may be got everywhere. The "crêmeries" correspond nearly to London coffee-shops in prices as well as in the provisions supplied. Coffee,
cocoa (called chocolate), chops (cotele
(bifteks), boiled beef (bouilli), and
(bouillon). Dining-rooms at all prices
price affiche is posted up. Everywher
expects his penny per head; if more th
are expended twopence—that is, 10 and
The 10 and 5 centime pieces resemble an
nearly to our penny and halfpenny, and,
as freely in London as in Paris, and
Omnibuses travel all over Paris; fare
—three-halfpence—inside double. Get,
stopping places, an omnibus guide, 30c
the routes. Five days' sight-seeing wo
day for the Exhibition; one day for
Notre Dame, the Morgue (behind Notr
Law Courts (Palais de Justice), Sain
and the Luxembourg Palais; one day f
Sèvres and Versailles, taking the river
St. Cloud, walking through the park
taking rail thence to Versailles, and
Paris in time for late dinner; one day
museums (Cluny, Artillerie, Arts et
and churches—St. Etienne, Magdale
Chapelle Expiatoire, Russian church;
for the streets, boulevards, parks, garde
Père la Chaise, from the high ground
good view of the city may be had. Brea
nine substantially. Get a "brioche," or
at midday, and dine late. The evenin
passed at the Hippodrome, or Cirque de l'I
Concert Musical, or one of the cafés cha
in the Champs Elysées, the last free as t
but "consommation" obligatory, so tha
of each entertainment is about the sa
1f. 50c. Floating swimming baths on
from 2½d. to 6d. entrance; extra for dra
pulsory), towel, and attendant, but you
your own towel and drawers. Cool drin
street stalls, 15 to 20 centimes—cafés thr
times as much, and the inevitable waiter,
beer 4d. a glass, wine at the wine-shops
half siphon (= a bottle) of soda-water, 2½
hawked about the streets as in London.
10 francs a day should cover everythin
journey. The tourist agents offer 5 days,
board and lodging, for £3 3s., but this d
clude amusements nor wine, nor any
breakfast and dinner, and omnibus far
Crack.

[More information on this subject will
amongst the letters.—Ed.]

[33678.]—**Chiming-Clock Repeater**
chimney clocks are not often made in thi
now, and could not be made to order for
£25. The usual charge for these clocks
Gothic oak cases is from 30 to 40 guineas.
English quarter repeater gold keyless
justed, would cost fully £75. But a Gen
of this kind can be bought for much le
offered one of excellent quality some ti
£50; but it was stated at the same time
to great depression of trade it was offered
very slightly over cost.—Betelgeux.

[33680.]—**Magic Lantern Canvas.**—
of linen, 9ft. wide, then cut into two, an
seam well made. This will give you a
sheet. Have a close texture fine linen, a
all round the edges. See that the linen
before being joined.—W. J. Lancaster.

[33682.]—**Cleaning and Bronzi**
Stands.—This question, in various form
answered scores of times. Refer to the
"Bronzing," &c.—W. J. Lancaster.

[33689.]—**Setting Common Slide**
setting steam-engine supply valves, whe
drop valves, the piston-rod in horizont
the connecting-rod, guide-blocks, and
vertical engines, require to be taken int
tion. The usual plan is to give the val
cient to compensate for the extra wei
creased area of cylinder.—Lancashire

[33690.]—**Waterproof Covering.**—
vise cinders, saturated with hot tar, laid
and a thin covering of gravel placed on
is then rolled smooth.—Progresso.

[33691.]—**Cider.**—If "E. G. P., Li
fond of sweet cider he must not keep
year. The taste of cider after a year o
a roughness, which "E. G. P." may n
myself prefer cider about 6 months
course, taste varies. I have now the
of a 30 gallon cask of cider a few years
bottled part in champagne bottles, put
bottle a small piece of loaf sugar, and
a raisin instead. In a fortnight after
as lively as could be wished, and quite as
nary champagne. "E. G. P." must no
half to keep a very great length of time a
the other half, for the reason that air
into the barrel. A shilling to 1s. 6d.
about the usual price.—Idem.

[33692.]—**Lambertype.**—Reduced t
limits this is simply "covering the nega
sides with a sheet of specially-prepare
which, by treating it with paraffin or ot
then subjecting it to very heavy (hydrau
pressure the "grain" of the paper is a
nated. This paper is then "retouched
simple manner, the sheet on the plain
negative in a broad massive style by
"stump," and some fine adhesive pow
blacklead, for the broad lights and shad
high lights, &c., are then touched in w

pencil on the paper which is on the ıf the glass. It is claimed that this can ı on a greatly-enlarged negative, in a by any one acquainted with drawing or The patentee claims and describes many in enlarging, and it is difficult for one licensee to tell exactly what is covered t. It is, however, now in the hands of e Company, who make special tissues s for it, which are only supplied to the d a great many "dodges" have been the working of it which, I believe, are ı the license. I should be glad to see it " our" columns, as it is very interesting mber of readers.—FINEM RESPICE.

agnet.—You can make such a magnet, be expensive. You would have to make agnet of a large size, and use from 8 to o the work, and this means consider- Let me know for what purpose you e the magnet, then I will give you rking.—W. J. LANCASTER.

idland Expresses.—On page 560 ' asks, "Will any one give the booked e of the 8 o'clock p.m. express from Pancras) to Edinburgh?" I cannot time right through, but will do so to

	Arr.	Dep.
ras	...	8.0
... ...	9.5 ...	9.8
... ...	10.13 ...	10.18
... ...	10.46 ...	10.49
... ...	11.40 ...	11.46
on	12.23 ...	12 33
... ...	12.57 ...	1.0
... ...	1.28 ...	1.35
... ...	3.30 ...	—

cannot give the time throughout, but E. S." will do so.—JOSEPH GREEN.

heshire Lines Railway.—This rail- ead-quarters are Liverpool, is the joint be Midland. Great Northern, and Man field, and Lincolnshire Railway Com- s managed by a joint committee of the ies. The Cheshire Lines' Committee's ı line commences at Liverpool (Central runs through Warrington (Central), eviot Dale), Woodley, to Godley Junc- I.S. and L. main line. The Manchester l Extension joins the main line at and runs to the New Central Station at The Cheshire Midland Section joins ter, South Junction, and Altrincham Altrincham, and goes to Knutsford, d Chester (Northgate), with branches d Sandbach. The local traffic on these d by the M. S. and L. Company. The pany work their own through traffic while the Great Northern trains are e Sheffield Company. The line from on on the M. S. and L. main line, odley, Romiley, Marple, New Mills s the Midland line), to Hayfield, with omiley to Stockport, and another from shburys, on the M. S. and L. main line, roperty of the Midland and Sheffield nd is managed by a joint committee C.) of these companies. The Midland at present constructing a new line nden on the C. L. C. main line to Old the C. L. C. Manchester branch, so as run their Manchester traffic into the Station now building at Manchester.—

orse-shoe Telephone.—My horse- elephone consists of three 6in. magnets er. Two soft iron cores are soldered galvanised iron, which is clamped on The bobbins are 1in. in diameter, and t 50 yards of No. 36 insulated wire hole is fitted into a box 8in. × 5in. × rcular hole at one end about 3in. in er this is screwed a piece of ferrotype is no fixed mouthpiece, but the box , and has the phonograph transmitting on the centre of diaphragm, thereby h sounds as a watch or tuning fork; t available for hearing, singing, or N. MASTERS.

ining.—The angle of inclination of 30°, it is equivalent to 20·78in. to the re the distance (or length of the that is) from a point 25yds. vertically bottom to one on the same level as the which said point it is required to drive 3·3yds. The square on the hypothenuse l triangles is equal to the squares on the es; therefore, $\sqrt{(43{\cdot}3)^2 - (25)^2} = 35{\cdot}3$, he base or heading required to cut the .

rain on Crank Pin.—

$$\frac{\text{m in lb.} \times \text{speed of rope in ft. per min.}}{\text{ed of piston in feet per min.}}$$

b. on piston—*e.g.*, mean strain in lb. —PERDU.

E.R. Locomotives.—The S.E.R. n by double-frame single engines, fitted h's double fire-box and outside bear- wheels:—

	ft.	in.
Diameter of cylinder (16)	1	4
Stroke of piston (22)	1	10
Diameter of D.W.'s	7	0
Diameter of T.W.'s	4	0
Diameter of L.W.'s	4	6

Heating surface, 1,105 square feet.
Boiler pressure, 120lb.

—STRAIGHT LINK.

[33709.]—**Electrotyping Insects.**—Dip your subject in sulphate of copper.—PROGESSO.

[33709.]—**Electrotyping Insects.**—Dissolve 1oz. of nitrate of silver in a mixture of 5oz. spirits of wine and 5oz. liquor ammoniæ. Dip insect several times, and let it dry each time. Put some bits of sulphide of iron and iron tacks in a small evaporating basin, pour in diluted sulphuric acid, and cover the basin with paper, to prevent splashing. Now put the basin on the bottom of some vessel (jam-pot), suspend the prepared insect over the basin, and cover the vessel with a saucer or plate. In the atmosphere of hydrogen and sulphuretted hydrogen the silver is reduced to a metallic state, and forms an exceedingly good conducting film.—ANGLO-DANE.

[33710.]—**Cupola Furnace.**—I have had considerable experience in building cupolas for foundry purposes, but have never built one so small as 12in. or 13in. square. However, I will give the dimensions I think it ought to be. The height from tuyeres to bottom of charging-door ought not to be less than 6ft., and from tuyere to the bottom of the furnace about 18in. If pig iron is to be melted, he will have to break it into pieces as small as possible, and charge it into the furnace in about 2cwt. charges. He will have to make provision for drawing the furnace at night, or when done casting. This he may easily do by leaving an opening at one side at the bottom, say 12in. square, which may be stopped up the usual way when the cupola is working. The cupola need not be more than 9in. thick (one brick), but it would be all the better if it was braced every 3ft. with bolts and binders, as the heat may crack the bricks and render it unsafe.—CUPOLA.

[33713.]—**Mechanical Stoker.**—The best mechanical stoker I am acquainted with is that known as Henderson's Patent. Its chief merit lies in the extremely small cost for repairs. It can be seen in almost any cotton mill in Lancashire; it is well known in Liverpool and Manchester; so that should Mr. R. be near these districts he could easily see one for himself. I have had one in use for over three years, and it has not cost me 30s. for repairs, there is so little about it to get wrong, the whole of the mechanism being outside the furnace. Small coal will produce as much steam as the best lump coal if properly burnt; and the only way to do it is to use some form of mechanical stoker. The great defect of most stoking machines is the great cost necessary to keep them in repair. With Henderson's stoker applied to, say, 10 boilers in a row, the whole could be kept going by not more than three men. I have no interest in their manufacture or sale.—CUPOLA.

[33716.]—**Etching on Glass.**—Use hydrofluoric acid, protecting the parts you don't want etched with guttapercha dissolved in turpentine.—W. A. R.

[33718.]—**Softening Cast Iron.**—Heat the casting red hot, then cover it up in fine ashes, and let it remain there until cool. I have seen many softened in this way.—W. E.

[33721.]—**Chromos.**—"Gems of Art," after Birket Foster, are copyright. The right belongs to G. P. McQueen, of Great Marlborough-street. Chromos being very expensive things to get up, no publisher would risk his time and capital in their production unprotected by copyright.—B. F.

[33723.]—**Bachelor of Music.**—"A London Undergraduate" cannot do better than get Sedley Taylor's "Sound and Music" (Macmillan) and Ellis's translation of Helmholtz's "Die Lehre von den Tonenpfindungen" (Longmans)—these works being recommended by the authorities for the Cambridge Mus. Bac. examination, which as far as acoustics and kindred subjects are concerned, resembles that for the London University. I need hardly suggest the well-known Tyndall "On Sound," or Dr. Woolhouse's "Essay on Musical Intervals, Harmonics, &c.," in addition, as well as the recently published No. 11 of Novello's "Musical Primers"—viz., "The Scientific Basis of Music," by Dr. Stone. For history I recommend Sir John Hawkins's "General History of the Science and Practice of Music," Novello's new guinea edition, and Ritter's "History of Music from the Christian Era to the Present Time" (Reeves).—NE SUTOR.

[33724.]—**Hens and Eggs.**—A hen will only exceptionally lay every day, and certainly not in winter time. There is great difference in different hens. Some will lay three days, and rest one; some will lay for ten days, and then rest two. By sensible management a good fowl will lay 150 eggs in a twelvemonth, and, by a wise selection, a great bulk of them in winter time. As a hen consumes 1½d. of food per week, fowl-keeping gives a return of cent. per cent. of expenses, besides the pleasure of keeping them, and the certainty of always getting new-laid eggs which are new laid. If "S. M." wishes, I will, with our Editor's permission, give him every information about profitable fowl-keeping, even when no grass run can be got at. I have six hens and a cock, and my hens commenced laying on Christmas-day. Up to this day they have laid 140 eggs each, and there is still nearly 5 months left of the year for them to get through moulting, &c. They have never seen a turf in their life.—ANGLO-DANE.

[33725.]—**Personalities.**—A very concise answer to this question is—When an opponent leaves the subject to attack the writer. In all the various discussions which have taken place in the ENGLISH MECHANIC I have invariably observed that it is the loser in an argument who makes use of personalities and declines further correspondence. Therefore "personalities" are always an indication of a very weak cause.—A.

[33728.]—**Thunder and Lightning.**—In the reply on page 585 in your last issue, in the example given for calculating the distance of an electrical discharge, yards are named instead of feet. This might mislead "A Tyro" if not corrected.—MANCHESTER.

[33731.]—**Barometer as a Weather Guide.**—When the atmospheric pressure decreases the barometer sinks, and the mass of air of course expands, in obedience to the "Law of Boyle," and, assuming the air to have previously possessed a certain degree of heat—say, per cubic foot—an equal bulk of it at the supposititious diminished pressure will clearly also possess diminished heat. Now, for every particular degree of temperature the air can hold in suspension a certain quantity of aqueous vapour (or steam of low temperature and elastic tension), and no more. When thus charged it is said to be saturated, and that particular temperature denotes what is termed the dew point. If, then, a cloud so saturated be cooled considerably in ascending through a stratum of colder air of considerable depth, or if, in consequence of rapidly-decreasing atmospheric pressure, it attain a great altitude (and thus similarly become cooled), the excess of watery vapour will appear either as rain, dew, snow, or hail, according to circumstances—the air, in fact, must perforce "let off steam" until the point of saturation is reached corresponding with such lessened temperature. Conversely, when the glass rises, it shows an increase of pressure; each cubic foot of air is now possessed of a greater degree of heat, and consequently is capable of holding more water than in the former case. It is therefore probable that evaporation from the sea may proceed for a long time, and yet all the moisture so formed be stored up literally "against a rainy day." Vessels sailing under the tropics frequently encounter terrific winds, and yet not a drop of rain, along with a rapidly-falling barometer. Personally speaking, I should not incline to place very much reliance on the rise and fall of the barometer alone—certainly not in the case of the ordinary domestic "wheel" instrument—but should examine simultaneously the temperature and ascertain the amount of vapour requisite to effect complete "saturation" at the precise time.—DOUGLAS SCOFFERN.

[33732.]—**A or An.**—Custom is not uniform, and the directions of our grammarians are frequently insufficient, and sometimes contradictory. *A* should be used: 1. Before consonants. 2. Before u long. 3. Before words which, though beginning with a vowel, commence with the consonantal sound of w or y. *An* should be used: 1. Before vowels. 2. Before u short. 3. Before silent h. 4. Before aspirated h when the accent is not on the first syllable. Examples:—A king, a usurper, a useful article, a venal occurrence, such a one, a one-pound note, a European; an apple, an urn, an heir, an hour, an honest man, an honourable man, an historian. Hence we should have a hospital, an hotel. There are four words beginning with silent h—viz., heir, hour, honest, honour, and their derivatives. Formerly several others were included in the list—humble, herb, humour, hospital, hostler. Most speakers now aspirate these words; but hostler is sometimes spelt without the h, though its derivation from the Latin *hospes* and *hospitale*, through the French, *hostel*, *hostelier* (now *hôtelier*), favours the retention of the h both in spelling and pronunciation. I frequently observe variations from the rules here given, and want of uniform practice exhibited in the same book, and even upon the same page. Oliver's "Botany," page 308, has "a herbarium"—quite right to aspirate the h, but the accent not being on the first syllable it should be "an herbarium."—J. N. D., Tuxford.

[33732.]—**"A or An?"**—The prefix "an" is undoubtedly "according to Cocker," *i e.*, grammatically correct, in each of the cases you name; the rule is generally applicable to all words commencing with a vowel, and in the special case of an initial "h" it is usual to drop, or nearly drop, the aspirate—*e g.*, "an 'ospital." Usage has not a little to do in regard to the distribution of the parts of speech.—DOUGLAS SCOFFERN.

[33734.]—**Sunstroke.**—It is probably due to the abnormally heightened temperature of the blood, and this may result either from the prolonged exposure to the direct rays of the sun, or by reason of undue indulgence in alcoholic liquors during the summer months. The blood evidently is first affected, the brain ultimately, and that is where the so-called "stroke" manifests itself. Probably, were any of "ours" to indulge in a course of protracted vinous debauchery (which may the Fates forefend!) at this season of the year, the result would be death by "sunstroke," and that, too, irrespective quite of any direct exposure to the solar rays. There appears to be good reason for believing that this complaint, like hydrophobia, results from a vitiated state of the blood, inducing a species of fermentation; but in the latter malady there is superadded the specific virus from the rabid animal.—Douglas Scoffern.

[33736.]—**Maple Sugar.**—Maple sugar is prepared by boiling the juice of the sugar maple (Acer saccharinum) and crystallising the syrup obtained. The juice is got by tapping the trees in spring with an inch auger, and fitting a spout of alder to each hole. A large tree will produce 30lb. or more of raw sugar having a slightly aromatic taste, but capable of being refined. The sugar maple thrives in Canada, Nova Scotia, and the United States as far south as Virginia, and attains a height of 80ft. In this country it rarely reaches a height of 20ft.—Gimcrack.

[33737.]—**Lobelia Cardinalis.**—Cut down your plants when done flowering; they will sprout up again next spring. Move every two years, when they may be propagated by dividing the roots. They like rich soil.—W. A. R.

[33740.]—**Balloon.**—You might employ moderately thick silk, making all seams good with india-rubber cement, covered over with flexible collodion, and a coating of varnish over all. I much doubt whether less than a figure of from 10 to 12ft. in height would answer the purpose at all, and even then it would scarcely carry other than the moderate sized cord, which might be passed through a ring in each heel, to enable the machine to preserve an upright position. The capacity could only be ascertained by first charging the figure with air by means of a bag of known dimensions, placed under a heavily-weighted board. The pressure at the gas works would undoubtedly suffice—being, I believe, equal to 2in. of mercury—but certainly not that from a private dwelling, as it is too weak, in consequence of friction in the mains; indeed, I find great difficulty in fully expanding an ordinary light balloon of a capacity equal to about 1·5 cubic feet. Under favourable circumstances, your figure might remain aloft about (if in the open air) eight or nine hours; but I much question if you would achieve so great a success. Why not charge with pure hydrogen? It could easily be supplied under considerable pressure by producing it from steam, being decomposed by being passed through a length of about a yard and a half of 1in. bore gas-pipe, containing some iron filings. The whole of the hydrogen is thus set free, and the operation merely needs a roughly-constructed brick furnace, by means of which the iron tube can be maintained at a red heat for a portion of its length, where the filings are situated.—Douglas Scoffern, St. John's-wood.

[33741.]—**Sea Fishing.**—You will not get any good fishing from the beach at Teignmouth. Good sport is to be had at Sidmouth or Seaton with bass, which are caught with a large artificial fly from the pier.—W. G. H. A.

[33745.]—**Coin Cabinet.**—Let "W. G." make each tray of two thicknesses of wood, boring completely through one with the centre-bit, and glueing the other underneath for the bottom. If care be taken in the boring, he will then not only have a smooth rim, but also a perfectly flat and smooth bottom. In boring a hole with centre-bit through a thin piece of wood I find it advantageous to bore from the top first, and when the point of bit shows through to turn the wood over, and finish from opposite side. This plan causes a clean hole.—J. L. E.

[33745.]—**Coin Cabinet.**—Having recently fitted up a coin cabinet successfully I would advise "W. G." to adopt my plan. Instead of cutting the holes in the wood I procured steel punches made to five different sizes—viz., 5, 6, 7, 9, 10, mionnet, and punched holes in thick white mounting board (known in the trade as 15 sheets), which I first covered with dark glazed paper. When the holes were all punched I glued dark blue cloth at the back of the cardboard, and then fixed the sheets on the wooden trays with a brass nail at each corner. Milled board will not do, as it is liable to crack when the holes are cut close together; in some of mine there is less than ⅛in. space between the holes. As the punches are rather expensive when made to order I shall be happy to lend "W. G." mine if he likes, and will send me his name and address with a reference or deposit. The advantages of my plan are obvious—time saved, precision, perfect shape, smooth bottom, and, lastly, the ease with which the arrangement can be altered, if desired, by substituting new and differently-punched cardboards on any of the trays.—B. R. S. Frost, Merthyr Tydfil.

[33745.]—**Coin Cabinet.**—Use a centre-bit with two scribing points and no inclined edge, and thin yellow pine equal the required depth of the holes, which will be cut right through. Glue on a second thickness for the bottom, which might be covered with cloth. Glue thin paper over the board in which the holes are to be made, and the edges will cut quite sharp and clean.—Gimcrack.

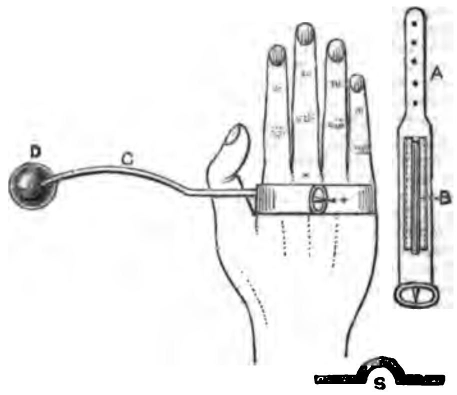
[33745.]—**Coin Cabinet.**—For this I should prefer to purchase thin wood, such as used for fretwork, or, if I had time, plane it up myself, bore the holes in one piece, and glue this to another. The glue should be cleaned out of the holes with a sponge and hot water, and they should be heavily weighted till dry. In boring the holes with a brace bore half through on one side, then turn the board and bore from the other side—this prevents the wood breaking away when the bit gets through; but I have seen (in shop windows) a tool that would answer the purpose much better than the ordinary boring bit. It is used in the brace. It consists of a knife edge, which can be adjusted at any distance (within the length of the bar on which it slides) from the centre, and from the look of it I should think it would cut a remarkably clean hole.—Os.

[33745.]—**Coin Cabinet.**—A centre-bit, if properly filed and sharpened, could be made to cut the holes in clean well-seasoned pine quite smoothly round the edges, and with the bottom tolerably smooth, and very nearly flat. Would it not be the better way to make the trays in two thicknesses—the upper one bored through, and the under one glued on for the bottom? Thin velvet or cloth could be put between, and would look neat, and save the coins from rubbing against the timber bottom when moving the trays or drawers.—G. J. H.

[33814.]—**Steel Stoves.**—"Housewife" should smear a little of Harrison's anti-corrosive paste on them. I have put steel things away with this preparation, and found them quite free from rust when wanted for use. It is advertised in this paper.—E. W. Alden.

[33746.]—**Shaky Writing.**—I have submitted a contrivance for the inspection of the Editor which he thinks would suit you, and should be happy to show it you if you will communicate with me direct (see my advt. on the back page).—Jack of All Trades.

[33746.]—**Shaky Writing.**—Proceed as follows: Get a strap made (A) to fit round your hand just below the knuckles, the buckle to be outside. A piece of leather, of which S is a section, about 2in. long, is sown to the strap at B; it will be on the palm side of the hand when the strap is put on. Then cut a piece of ¼ brass wire, about 12in. long, C, and put a lead or other metal ball on the end of same, 1¼ diameter, D. Put the other end in the place left at B, bending the rod or shortening the same, which will adjust itself as required, and with occasional guiding with your left hand, will enable you to write as you wish. I shall be happy to send you a sketch, if required, of a small contrivance that would help to hold the pen.—P. F. O.



[33746.]—**Shaky Writing.**—If "Kingston" will give his address to "M.," 4, St. Stephen's-terrace, Shepherd's-bush, London, "M." can send him the contrivance he requires.—M.

[33746.]—**Shaky Writing.**—The best and only antidote I know of for the effects of tobacco on the nervous system is tincture of ferric chloride, or generally known by druggists as tinct. ferri sesquichloride, from 10 to 20 minims (two drops are about one minim of a tincture) in a glass of sherry—or in water if alcoholic liquor is objected to—taken immediately after smoking, or other excessive use of tobacco, is a complete restorative. If you were to take this two or three times a day your shakiness would probably much diminish; but let me give one piece of advice, not to give up smoking, as at your age it would do no good; but don't smoke on an empty stomach. After a meal as much as you please.—Tobacco Manufacturer.

[33747.]—**Telegraph Line.**—Using one wire insulated, and the earth as the other, is quite correct. You would require about 190 posts, placing them, say, 65 yards apart; you may place them from 50 to 80 yards to suit circumstances. The holes should be dug lengthwise with the wire, and only broad enough to let the posts go in, or to allow the man to work. Depth of holes about 4ft. 6in., and dug like going down 3 stairs, so as not to remove more earth than necessary. 10ft. high from ground would do, but I should prefer them a few feet higher. Suppose a horseman unacquainted, or not noticing the wire, might result in serious consequences, as the wire would be lowest midway between the posts. Brown earthenware insulators are as good as any. No. 10 Birmingham wire gauge would suit for line wire, but if you have a quantity of the wire used for fencing by all means use it—it would do very nicely. The wire is tightened by means of a vice (Fig. 1, a, catch; b, ratchet wheel), to the tail end of which is attached a small winch. There is a short piece of wire placed on the pulley of the winch, and lapped round the post and the jaws of the vice tightened on to the line wire, which is then drawn to the required tightness by means of the winch. Fig. 2 shows spanner used in tightening vice and winding-up winch. Before commencing I would advise you to read the "Text-book of Telegraphy," by Preece and Sivewright. Should you require any other information I will freely give it.—John Earl Clark, Liverpool.

FIG. 1

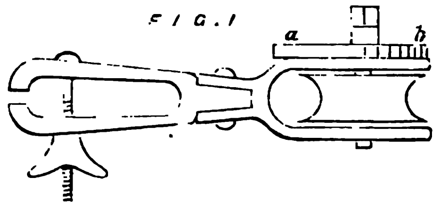
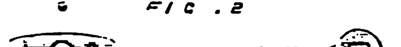


FIG. 2



[33749.]—**Plants.**—1. Selaginella Wildenovii might live in such a room as "Hilda T." alludes to, but I don't think the Adiantums or Gymnogramma would, because of the temperature—that would probably do—but on account of the dust and gases. "Hilda T." of course knows that the Selaginella is not a fern, and I give her the correct name probably. This is an an answer to 2 also. 3. Coleus plants will not live in such a room either. 4. It is a fact that plants give off carbonic acid at night, but I doubt if to an extent that could be injurious in a ventilated room. 5. "Hilda T." will have some difficulty in procuring one book containing copious information on all the points she requires.—J. T.

[33753.]—**Making Small Flag.**—Take a piece of black silk, square, and larger than the device, keep flat, and carefully draw on it outline of crest in French chalk or anything else that will make a clean line, then tack on to your flag, and get some machinist to double-stitch all round your outline with a very fine stitch (a boot-flowerer and vamper would do it for you), then with a pair of nail scissors cut away all superfluous silk close to outside stitch, and there's your flag.—Bosh Faker.

[33753.]—**Making Small Flag.**—The sailors cut out letters and designs, and stick them on to horse covers, &c. See also reply to "Turkey Red," p. 557. —Dundee.

[33753.]—**Making Small Flag.**—"Faber" must engage the assistance of some lady friend, who will, I have no doubt, kindly draw the crest in white chalk on black Persian silk, paste it down on white or yellow bunting, stitch through the white lines with a sewing-machine, and cut the black silk away to the stitching with her sharp embroidery scissors. If "Faber" wishes to have the crest on both sides of his flag a second piece of black silk should be applied on the reverse side of the bunting, and all three stitched through at one operation. If the crest has a dexter and sinister side it will be reversed on one side, but in flags the staff side is always taken as the dexter side.—Gimcrack.

[33754.]—**Map of English Canals.**—The best map is the Ordnance Survey. "Faber" will possibly be able to get from the Thames to the south either at Southampton, Portsmouth, or Littlehampton viâ the Wey and the Wey and Arun Canal. "Backsheesh" will probably have to be administered copiously at some of the locks and weirs. Probably an application to the canal compani would facilitate matters.—Gimcrack.

[33759.]—**Leclanche Cells.**—The only way find out if they are exhausted is to see if they capable of doing ordinary work. If worked out t should be opened, and the carbons examined to if the connection is sound between the carbons the lead caps. They can then be recharged wi mixture of about equal parts of carbon and pero of manganese, both coarsely powdered.—Sigma.

[33761.]—**Time at the Antipodes.**—In the put the time would be later than here—that i being 8 p.m., August 1st, here, it would be 8 a August 2nd, there; that is to say, at a point a l east of the most eastern part of New Zealand. reason is, that New Zealand and nearly all settlements have been reached by travelling ward, and so carrying the time on. But if trave go still further eastward to South America would find the time a day earlier, because Spaniards going westward prolonged their day. is the custom in travelling round the world to c two days the same (thus dropping one, or maki 48 hours long) on crossing 180° of longitud Sigma.

[33774.]—**Depositing Copper on Iron.**—To a regular coating on manufactured article battery and solution of cyanide of copper are ne sary. The thin film on iron wire is obtained passing the wire through a weak solution of co sulphate just before reaching the draw-plate. made adhesive by being burnished into the iro the act of drawing, and I believe the chief obje it is to render the drawing itself easier and destructive to the plates.—Sigma.

ure Coil.—The most suitable .e or two cells of the chloride of p by Gaiffe in ebonite tubes. A ıt be used for medical purposes, cks too percussive and violent.—

; **of Tank.**—If the querist means c engine at lb. 50," a pressure of h, his tank will need to be 100ft. ; approximately ½lb. pressure per ıtion.—Sigma.

ommon House Fly.—Perhaps able Creatures: the Earthworm iblished by Van Voorst, price t your correspondent's require- got the book at hand, and do not :ains all that "Musca Domes- t he could easily satisfy him- ;.—X.

ıatism.—As to diet all I can say that is digestible, and avoid digestion. This is, of course, rent people, and under different Bitter beer, and, I believe, all re to be avoided, but vinegar is ious in reasonable limits, as it is ferent ferment. Apples and all ficial, and lemons are one of the ıedies in the acute stages. I -juice is a useful article; at all constantly as a beverage under hey being well-known blood-

Prism for Field Glass.—Which rism or the water? In other er dirty? If so, "Faber" can ery.—F. C. Dennett.

Questions.—The case is not The primary question would be rs each of sufficient capacity to y? If so, the indicator would ssure, say 30lb., whether one or ause the pressure shown is per erefore independent of the total But with one boiler the indi- te more, as each stroke would the pressure more with one than er more fuel would be used with ı with one, because there would f radiation from the brickwork, pes, and occasional (and more blowing off at the valves. Of be two boilers, each capable of ıs to allow cleaning, repairs, &c., terrupting the work.—Sigma.

o and Daniell's Battery.— rong in the direction to put the lle and the zinc outside. The is the reverse, and is on the n, the best; but there is some- the other, in reducing the de- given area of zinc. Anything ised in the Minotto, layers of per, paper pulp, sawdust, or ly unsuited to electrotyping, al resistance is so great, and very slow.—Sigma.

Stains on Silver.—These are to sulphur in the air, from coal They will clean off with rubbing ıed with spirits of wine.—Sigma.

ERED QUERIES.

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tles of queries which remain unan- re inserted in this list, and if still ed four weeks afterwards. We trust er the list, and send what information of their fellow-contributors.

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QUERIES.

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[33831.]—**Sutlej Bridge.**—The gentleman who erected the above called on me recently with a letter from Colonel Peile, R.E. I omitted to obtain his address—will he kindly forward it?—J. K. P.

[33832.]—**Orange Cutting Machine.**—Can any reader tell me how to make a machine for cutting oranges for making marmalade?—D.

[33833.]—**Boat Building.**—Will some amateur boat-builder kindly give me full instructions and lines for building a 6ft. cutter, and also a small light sailing boat, to carry one person, decked like a canoe, but shorter and deeper, with one mast, 5½in. club?—De Benson.

[33834.]—**Bucket Lift.**—We have a 16in. bucket lift pumping from a mine 70 yards deep. The pump trees are 17in. diameter—*i.e.*, 1in. larger than the working barrel. Wishing to change the bucket we commenced by drawing the rods and bucket together, without letting the water out of the trees. The consequence was immediately the bucket was drawn up into the trees and the water began to pass from above, immense power seemed to generate, snapping the capstan chain in two, allowing the rods to fall back. Will any reader explain how this power is formed?—Pitman.

[33835.]—**Sizes of Books.**—Will some reader kindly inform me how to form an idea of the sizes of books at a glance? I am at a loss when I pick up a book to know whether it may be 12mo. or 8vo., or 4to. Is there any rule that I could learn? Perhaps a short table of the length and breath in inches could be given.—South Saxon.

[33836.]—**Painting Greenhouse.**—What is the best kind of paint for the inside and outside of a greenhouse—zincwhite or whitelead?—Wallasey.

[33837.]—**Absorbing the Heat Rays.**—I am making some experiments in a furnace that requires watching very closely, and find it very trying to the eyes. Will any of your readers kindly tell me what solution I can use, to look through, that will stop the heat rays without interfering with the coloured rays, and also how to make a vessel to hold the solution?—Furnace.

[33838.]—**Lighting Mines by Electricity.**—Would some electrical correspondent kindly inform me what attempts have been made to light mines by means of the electric spark passing through a vacuum, and where an account of these attempts is to be met with? Professor Tyndall ("Lessons in Electricity," p. 90) states that this mode of electric illumination was proposed by Grummert, a Pole, at a very early period, and that the notion has been revived in our day.—Vega.

[33839.]—**Engine Whistles.**—The letters of "C. E. S." respecting lamps on engines and vans are interesting to most readers, and I am inclined to think an insight into the different understandings conveyed by the different number of whistles given by railway engines would be generally esteemed. Perhaps "C. E. S." will enlighten us.—Idem.

[33840.]—**Gauging.**—I have seen a table of two columns—the first headed quotient, the second equivalent. The column of quotients begins at ·1 and ends at ·998. The equivalent column at ·037, and ends at ·99980. The numbers in the columns are opposite each other—thus, ·1 quotient opposite ·037 equivalent. Its use is for finding the ullage of spheroidal casks, or rather casks in the form of the middle frustum of a spheroid. The directions are divide the bung diameter by the wet inches, look for the quotient in that column, and opposite find in the second column an equivalent; multiply this equivalent by the contents of the cask and the product will be the ullage. Say 30·0 wet ÷ 32·0 bung = ·9375 or ·938; opposite this in equivalent column is ·981, which, multiplied by 100, the content, = 98 ullage. Would some one illustrate how the above table is constructed, and explain the terms quotient and equivalent, or name any book which would do so?—Anxious.

[33841.]—**Polishing Cross Grained Top of Box.**—Having turned a box about 3in. diameter—the wood looking very like tortoiseshell—I find I cannot French-polish the top, which, of course, is cross-grained. I have laboured for days, nay weeks, and always ended with a very high brilliancy, it is true, but not with a plate-glass surface, like to exaggerate the defect of my work. I can only compare it to the peel of an orange that has been rubbed to its greatest brilliancy. I have sized the wood, sometimes oiled it, and generally finished with much brilliancy, but always with the result described. I have used the finest glass-paper, cuttle fish, pumice powder sifted through muslin, and rotten stone applied with felt and oil. I have used plugs of cork covered with wool, with cotton, with fine flannel; I have used a hard plug and a soft plug, have pressed very lightly and I have pressed rather heavily. I have applied the polish by turning to the right only, and also by turning all manner of ways. I have used very little polish, and sometimes a great deal, still with the same unfortunate result. The side of the box is well enough. I send this with the hope of being set right, for I am clearly wrong somewhere.—Fix.

[33842.]—**Fastening Brass Union into Solid Lead Cistern.**—Can any of our subscribers tell me how to fasten a strong brass union into a solid lead cistern that is to hold vitriol or other strong acids, if by burning in or otherwise?—Young Plumber.

[33843.]—**Vulcanite.**—Will any of your readers inform me how to make vulcanite such as dentists use?—Reader.

[33844.]—**Extemporising.**—Wanted the title of a good work upon extempore playing for organists?—Deputy.

[33845.]—**Sea Salts.**—Will some one please tell me how to make sea salts for bathing purposes? I want as near an imitation of real sea-water as possible.—Concise.

[33846.]—**Phonograph.**—To Mr. Shelford Bidwell.—Please favour me with replies to the following:—1. What is the best way of mounting the brass cylinder on the spindle? I have tried to mount it by a piece of ½in. board in each end, but I could not make it run true. 2. How can I cut the ferrotype plate without buckling it?—Vercingetorix.

[33847.]—**Whitworth Scholarships.**—Intending to compete for a Whitworth scholarship next year, I should like some information respecting the work given the competitors in the "handicrafts" practical examination. The prospectus only gives the kind of work for the use of tools.—Vertingetorix.

[33848.]—**Staining Floors and House Repairs.**—I should be glad of directions for staining floors, what materials to obtain, and how to set to work. I also wish to colour walls, and wish for help, also advice as to best colour. As I am in the vein for repairing, I should like directions for restoring outside plaster. Would cement be better, and is it much dearer?—X.

[33849.]—**Mining Question.**—I shall be much obliged if any of your correspondents will favour me with information on the following subject, as I am about to put in pipes for a steam jet in a pit 100 fathoms in depth, the size of pipes being 1¾in. in diameter, and the size of the boiler that I am about to connect them to is 36ft. × 6ft., and pressure up to 40lb. Now what I want to know is if I should take the pipes down the whole way to the bottom of pit; as the shank is very wet what would be the best thing to protect them with, and also what advantage shall I gain by doing so, as far as ventilation is concerned?—W. R.

[33850.]—**Screw Propulsion.**—Could any reader kindly inform me the rate at which a screw-vessel is propelled proportionate to the revolutions of the screw? For instance, how many revolutions will be required of a screw, say, 10ft. in diameter, to propel a vessel one mile, and whether it would make any difference in the revolutions if the vessel carried 100 tons burden one time and 200 tons the other?—F. W. Smith.

[33851.]—**Nitrate of Silver.**—Wanted a simple process for separating nitrate of silver from nitrate of copper, so as to procure silver pure. Upon adding nitrate of silver to distilled water no opacity of any consequence appeared, but after standing 12 hours the solution became of a tranparent pinkish colour. On placing the solution in strong sunlight it turns colourless. Explanation requested. Water used was made from a tin-stile, as clean as possible, and the glasses containing solution were perfectly clean. Should any contributor take the trouble of answering above, it is requested he will be so good as to make use of the old chemical nomenclature.—T. C. B.

[33852.]—**Centrifugal Pump.**—In looking over the article "Pump" in "Tomlinson's Cyclopædia," published, I think, in 1854, I was surprised to find an otherwise excellent article concluded in the following words: "The centrifugal pump is also a useful adjunct to a water-wheel, to assist in keeping it at work by returning a portion of the water when the supply is short." To be useful in such a case it must return a greater quantity of water than that required to operate it, and, if so, then it will have the principle of a perpetual motion; but in the course of the article it is remarked that when most effective the centrifugal pump yields a duty of 70 per cent., and I believe the best water-wheels only yield a duty of about 70 per cent., so that the centrifugal pump, driven by a water-wheel, would not be able to return more than 49 per cent. of the water required to drive it, so that instead of being "a useful adjunct" it would be found to be a worse than useless incumbrance. Is it possible that an eminently scientific man like Mr. Tomlinson really believed the pump to be "a useful adjunct," or are we to regard the sentence as another curiosity of literature?—W. H. B.

[33853.]—**Horse-shoe Electro-magnet.**—With a given length and size of wire, which of the three following methods of coiling it around the soft iron core will give the best results as to lifting power, the battery current in all cases being the same? 1st. To distribute the coil evenly from one pole to the other as in the "Soulo magnet." 2nd. To concentrate all the wire, in the form of short reels, as near to the poles as possible. 3rd. To place all the wire, in the form of one short reel, half-way between the poles.—W. H. B.

[33854.]—**Magnetism.**—If by the vibration of the diaphragm or armature in front of a bar magnet, as in the Bell transmitting telephone, the intensity of the magnetism is caused to vary or fluctuate rapidly, so as to induce an undulatory current in a reel of wire on the pole near the armature, would a reel placed on the other or distant end of the magnet be similarly affected? I am aware that some hold the opinion that the vibration of the armature has a direct influence on the coil, and is an aid to the magnet in inducing the current. But putting that direct influence aside, is a rapid variation or fluctuation of the intensity of magnetism at one end or pole attended by an immediate corresponding variation at the other pole and to the same degree?—W. H. B.

[33855.]—**Thermo-electric Generator.**—Can any correspondent give particulars of M. Clamond's thermo-electric generator? I believe one was shown at the Leeds Exhibition in 1875 or '76, and was stated to be capable of producing currents of high tension or of quantity.—W. H. B.

[33856.]—**Curriers' Dubbin.**—Will some reader of the English Mechanic give a recipe for making curriers' dubbin?—J. D.

[33857.]—**Skeleton Ferns.**—Will some one please give me some practical information on the production of skeleton leaves by the chloride of lime process? I want to skeletonise some fern fronds.—Adiantum.

[33858.]—**Lowering Tone of Bell.**—How can I lower the tone of a common brass room-bell?—J. Kirkland.

[33859.]—**Tuning Fork.**—Are all tuning forks the same or "concert pitch?"—W. A. R.

[33860.]—**Magnetic Filters.**—Can any of "ours" give me a description of a magnetic filter?—J. N. Masters, Rye.

[33861.]—**Object-glass of Telescope.**—I have had a small three-draw telescope by Dollond given me, but something is wrong with the object-glass, which consists of two double convex lenses lying loosely on each other in their bed. Can any of your readers advise me how to put it right?—Wallaby.

[33862.]—**Mixed Gases for Lantern.**—I propose to fill a single bag with the mixed gases, and run it through a burner made of stout steel wire 2in. in length and bored through the centre, the diameter of bore being

1-64th of an inch. Will some practical man say whether the bore would be large enough to whiten the lime ball and whether the arrangement would be a safe one?—L.

[33863.]—**Apparent Divergence of the Sun's Rays.**—Will some scientific correspondent inform me to what the apparent divergence of rays in what are popularly called Jacob's ladders is due? I mean the effect produced by a break of sunshine through a generally clouded sky; a most picturesque effect is produced by the apparent divergence of rays. I say apparent, for it cannot be real, although it appears so, as the sun would give, of course, parallel rays. Still it is difficult to persuade oneself, after all allowance for perspective, &c., that the divergence is not actual. Will some one enlighten me?—L.

[33864.]—**Patents.**—The opinion of any reader competent to judge on patent transactions will greatly oblige. A, not having sufficient confidence in his own resources, forms a partnership with B, for the purpose of developing an invention. B is a sleeping partner only, being no engineer, and has never yet signed the partnership papers; consequently A has been legally responsible for everything. A has devoted 1¾ years to developing his invention; he has met with successive unexpected failures, but has at last succeeded in producing a patent of far greater value than at first anticipated, and of launching the same advantageously. During the time of uncertainty, by force of circumstances he was absolutely obliged to advance half of all cash paid, but had no idea at starting he would be called upon to do so; but the total liabilities at that time were as much as 3½ times greater than cash found by B (that is including value of his own services, which he reckoned at two-thirds of the salary he received in his last situation). After the success was proved A took out foreign patents, but finding that B expected share in same agreed to throw them into common partnership. Since that date B has paid an amount equal to that paid by A (exclusive, therefore, of value of A's services). It is now found that they misunderstood the terms of verbal agreement, but due to no fault of A's, who was anxious from first for the agreement to be in writing. It is required, therefore, to fix definitely the proportion of the two shares relatively to each other in such a way as can be considered fair to each party, and outside opinion will be very gratefully received by—A and B.

[33865.]—**Rowing.**—Can any one explain the reason (if any) why sailors, boatmen, and professional salt water rowers in general, usually pull their oars with the blades at an angle which is often 45° or more with the perpendicular? River rowers, on the other hand, keep theirs quite vertical, and this seems the proper position for effect. I have not noticed that the roughness or smoothness of the water has anything to do with it.—Citrus.

[33866.]—**Lifting.**—I shall esteem it a favour if some brother correspondent will inform me how to make, at little cost, a contrivance for practising lifting, so as to be able to have the weight increased a little at a time, and that it may take up very little room?—L. J. Joyner.

[33867.]—**Patent Law Question.**—The patentee of a machine finds that one of the perfecting details—which, however, is not included in his patent specification, but was subsequently added—has been adopted as the principle of a less complete machine and patented, being sold at a lower cost. There is no reason to suspect piracy, the circumstance being probably accidental. It is not yet ascertained if the date of the latter patent is subsequent to the addition of the improvement to the former. The exact mechanical arrangement is not the same in both, though the principle is, and bearing a similar resemblance to part of an old and lapsed patent. What is the law?—J. D.

[33868.]—**Debtor Abroad.**—A person having contracted a debt with me to the amount of £18 odd has since gone to France or Belgium—the latter place, I think. How can I recover this? The person is able to pay it.—Creditor.

[33869.]—**Trespassers.**—Two men trespassed by crossing my corn field, and when stopped refused to pay for the damage or give their addresses, saying that they were not legally bound to, and that I could not detain them. Have I no remedy?—Sussex Farmer.

[33870.]—**Forge.**—Will any one inform me whether an ordinary forge fire (blacksmith's) can be constructed so as to consume part of its own smoke? Your correspondent being the owner of a blacksmith's forge has received notice from board of works to the effect that the fire-place (forge) is not constructed so as to consume the smoke as far as practicable.—Hercules.

[33872.]—**Pebble Stones.**—Will some fellow-reader tell me what is the composition (chemically) of the small, smooth, white pebble stones which are found in gravel sand? A chemical analysis would be much esteemed.—W. P.

[33873.]—**Pancratic Eyepiece.**—Can any one tell me how to calculate the power of the equivalent lens of a pancratic eyepiece.—Light.

[33874.]—**Lightning Conductor.**—Can any reader tell me the best and cheapest way to make and apply a lightning conductor to a small house on a lawn with a large tree in front and another at side?—H. W. W.

[33875.]—**Spiders' Lines.**—I should be very much obliged for a little information regarding the "spider-lines" employed by astronomers. Are they artificial or portions of a spider's web? If the latter what species produces them?—X.

[33876.]—**Redier's Telemeter.**—Can any one tell me what sort of an instrument Redier's telemeter is?—X.

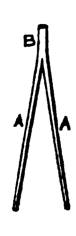
[33877.]—**Microphone for Deafness.**—I have a friend who is very deaf, and I should like to make a microphone which could be placed on the table or mantelpiece that would magnify the voice sufficiently for him to hear through a telephone the conversation that was going on in the room. If any one would say if such a thing can be made, and how to make it, he would confer a great boon to those similarly afflicted. My friend can hear through an ordinary string telephone, but that is of no use for hearing the general conversation.—W. B.

[33878.]—**Electrical Indicator to Show the Rotation of the Earth.**—In No. 697, p. 518, there is a description of the above machine, and as I am thinking of making one I should be greatly obliged to any of our readers who would give me the size and weight of wheel, size of wire and magnets, and any other hints that would help an amateur. At present I think of suspending it with silk, with the wires dipping into a cup and ring of mercury. Could Foucault's pendulum experiment be made at home with a clock weight and 10 or 12 feet of wire? I do not want to mark the roof if it would be of no use.—M. M. R.

[33879.]—**Photographic.**—Will some subscriber inform me whether there is any way of doctoring the collodion so that it will not float off the glasses when washing the finished picture, causing great annoyance? I am aware that albumen in a weak solution floated over the plates before coating is a remedy, but this would not pay the photographer, who produces a picture on glass, with frame, &c., for 6d.—Hastrew.

[33880.]—**L. and N.W. Engines.**—Could "Itzaex" tell me how it is that the Helvellyn, President, and Dædalus are of the same class as the Tamerlane, Lucifer, &c., as the Helvellyn, President, and Dædalus have got raised fireboxes and lock safety-valves, with brass covers, but I am not quite certain about the Dædalus having the lock-valve; and the Helvellyn and President have something, a valve, I suppose, between the dome and safety-valve. What is it? The other morning I saw a 7ft. 6in. single, No. 61, but I could not make out whether the name was Phosphorus or Prosperous. Could "Itzaex" or "Egeria" say which it is? What sort of an engine is the John Ramsbottom, and what number is it? Is there an engine named John Hammerton; if so, what sort?—Tamerlane.

[33881.]—**Bicycle Fork.**—Will any reader tell me if a bicycle front-fork can be made out of a piece of taper tube by cutting it up the centre, as per rough sketch enclosed, to within 2in. or 3in. of the top, for the steering to be fixed to? If so, what sort of tubing would be best, how to split it up, the best sort of steering, and handle, &c.? I should also be greatly obliged for information as to how a bicycle can be painted, the best sort of paint to use, &c., also how to polish a bicycle all bright. How can the bearings be fastened on to the fork? In fact anything that will help me in the above matter will much oblige. Please not to refer to back numbers, as I have only just the last week begun to take the English Mechanic and cannot get back numbers. Explanation of sketch:—AA is the fork, B the part I propose to fix the steering into.—W. H. B.



[33882.]—**Lens Grinding.**—Will some fellow lover of science help me out of the following difficulties?—I have been amusing myself with the attempt to make a 3in. achromatic lens. I am well acquainted with the mathematical part of the subject, but find myself unable to get a sufficiently correct spherical surface on my glasses. I have ground the tools together with emery of different finenesses, and ground the lens—which, by the bye, is of the same diameter as the tools—on the tools with degrees of emery, the last being so fine that an hour's grinding would not efface the trial polish of about ¼in. of the surface made with a little bit of pitch covered with rouge. My difficulty is this: I always find that the polish commences in the middle of the lens, and extends gradually to the edges. Is it that my tools are not large enough, and that the edges of the lens should not pass off the tool in polishing? And yet, if it is possible to grind two brass tools of the same diameter to a true spherical form, it should be equally possible to polish a glass of the same diameter without altering its figure. I cover the tool with pitch, hardened with resin and dry wheaten flour, and cut it into small squares, and am very particular—by pouring warm water on it, and working the other tool over it, to get a true figure. It is the same when I cover the tool with fine linen rag. Are my tools in error, for in working with cross strokes the centre is always being ground, whilst the edges alternately escape? But this seems an insurmountable obstacle to the attainment of a true surface at all. Please kindly tell me the way the practical opticians proceed? Is it possible to grind glass with emery so fine that it shall appear almost as if polished?—Polisher.

[33883.]—**Liquid Ammonia Direct from Gas Liquor.**—Will any reader give particulars of the process, on a manufacturing scale, for producing liquid ammonia direct from gas liquor? Also what plant is required, and dimensions for working up 200 tons gas liquor?—W. T. Kerr.

[33884.]—**Polishing Pinions of Watch.**—Will any reader tell me what kind of a polisher is necessary to polish a pinion, and how to mix the diamantine?—Fagan.

[33885.]—**Sulphur Casts of Medals.**—Would Giuseppe Denzi, or any one else who really knows, give me plain and full directions for making sulphur casts of medals, like the sets of medallion casts of the Napoleon medals made in Italy—I believe in Rome? I have tried every way I can think of, and though I have sometimes succeeded very well—success was the exception, failure the rule. The casts I mean are very sharp in the finest details, and are of a uniform light lemon colour. I am very apt to have flaws, marks, and air bubbles in mine, and the colour is very uncertain, varying from a deep yellow to a grey or stone colour. The latter is not at all a bad colour, but I am not at all sure of obtaining it, and no two casts are exactly the same shade. They are also subject to having transparent or greasy-looking spots in them, which spoil them very much. My best specimens are decidedly good, but form small proportion of the whole. I wish to be able to do them with the same degree of certainty as plaster medallions (to which they are very much superior), and of a uniform colour or nearly so. I hope no one will answer this by telling me how they "think they might be done," but I shall be much obliged to any one who will tell me how they are done.—G. J. H.

[33886.]—**Removing Gilt Letters from Cloth.**—I wish to remove a portion of the gold lettering from the backs of some books bound in blue cloth. Will some chemical correspondent kindly tell me what to use, so that the gold may disappear and the colour of the cloth be preserved?—J. A. M.

[33887.]—**Magneto Electric Bell.**—I have been endeavouring to make a small electric bell, according to Zanni's patent, but I have only succeeded in getting the very faintest sound out of the bell. Can any of your correspondents give me information on the following points?—1. Will any good soft Swedish iron do for the magnet, or must the iron be specially prepared; if so, how prepared? 2. Does it make any difference at which end I commence or leave off the winding? 3. If I wind, say, left about, on one leg, should I wind left about or right about on the other leg? 4. Should the piece of metal to be attracted by the electro-magnet be soft iron, or steel, or what? 5. Is it of importance that the staff of the bobbins should be as thin as possible? 6. Should each layer on the bobbins be further insulated by paraffin or wax, &c.?—R. S. T., India.

[33888.]—**Enamelled Bricks.**—Can any reader give me full information about the composition of the white and coloured enamel for bricks, and the manner of putting it on?—Fire-brick.

[33889.]—**Speed of Locomotives.**—I have been much interested lately by reading the speeds of various railways given by our subscribers. Can any one give us the highest speed a locomotive (no matter what date or build) has ever accomplished? Any authentic information will be much valued by a—Six Footer.

[33890.]—**American 8-Day Striking Clock—Taking to Pieces, &c.**—I would here express my acknowledgments to "W. J. C.," p. 401; "G. J. H.," p. 452; "Seconds' Practical Watchmaker," p. 477, and "Furnace," p. 530, for their replies to my query, No. 33181. I fear that my Geneva (Shoulinie, maker) must be dying of old age: I purchased it in 1842. Would "Seconds' Practical Watchmaker" give me his assistance again? I took an American clock to my nearest town for repairs. I don't think there was much the matter with it, for when the pendulum was removed it would go like a racer. I fetched it myself on notice that it was ready. On setting it going the first thing I found was that my friend the watch and clock maker, not content with replacing the pendulum in the slit of the brass pin in which it works, had given the brass a bite with his pliers and broken the pendulum off short. Instead of securing the face as before, he had endeavoured to make it fast to a ½in. rim of ¾in. thick mahogany with coarse tacks 1in. long; and finally I discovered that the back was split in all possible directions by the coarse 2in. clasp nails used in fastening the clock to its case again. Well, my unfortunate clock is dirty, and clogged with linseed—for anything I know—oil. I have a good many tools, one sort and another, pliers, turnscrews, vices, files, &c., &c. Would "Seconds' Practical Watchmaker" tell me whether I might undertake, myself, to take the clock to pieces and clean it, and what oil I should use for the purpose? I should have trouble with the mainspring unless I get a little information hereon. I believe I understand the escapement. I have five clocks in the house, and they have, as far as I can see, at least three varieties of escapement among them. I have learnt something already from "Seconds' Practical Watchmaker."—J. L. H. S.

[33891.]—**German Musical Publication.**—Can any reader inform me of the best German musical publication (monthly), the price, and how I can subscribe to the same?—J. H.

[33892.]—**Varnish for Rollers.**—Could any of our readers give directions for a good varnish for rubbing rollers—one that will not crack?—Roller Coverer.

[33893.]—**Piccolo.**—Will any musical reader inform me which is the best tutor for piccolo for 5 keys? Is the piccolo tuned to any particular key note? Also whether, by moving the cork, I can alter the pitch?—J. Rennie.

[33894.]—**Real Night.**—In No. 683, p. 155, column 2, it says—"There will be no real night after May 22, as the sun never descends 18° below the horizon subsequently to that date until July 21st, as it is not until that date that the sun will descend 18° below the northern horizon at midnight. (English Mechanic, No. 692, p. 386.) Will any of your correspondents kindly inform me what is the least distance below the horizon of the sun at midnight during this period, and when? In No. 688, p. 281, it speaks of the horizon at Greenwich—I presume, Observatory. Would the same correspondent tell me whether this horizon is from a spot at the sea level, or at what altitude therefrom, for perhaps buildings or natural inequalities of the surface of the ground must interfere with what would be the horizon on still water.—J. L. H. S.

[33895.]—**Cement.**—Will any one oblige with a good cement for piecing leather for roller covers?—Excelsior.

[33896.]—**Polishing Marble.**—I broke a marble chimney ornament the other day. After cementing it I found that the edges were not perfectly flush, so I rubbed them down true. Will any reader kindly tell me how to restore the polish?—J. L. H. S.

[33897.]—**Canaries.**—I have a young canary six weeks old, which already begins to chirp and whistle, after a manner. I am told it will never become a good songster unless it is taught by being placed with an older bird who can sing well. Is this so? And if I can get an opportunity—not a very easy matter—of placing it in the company of another bird, what is the best age at which to do so?—Kelby.

[33898.]—**Tire Fastening.**—Will any correspondent give a sketch of Mr. Kaselowsky's tire fastening, which has been tested and proved by experiments lately in Germany, giving the actual result of such tests and experiments, and the method adopted in proving their security?—Menelaus.

[33899.]—**Auxiliary Steam Vessels.**—Will some reader possessing experience in such matters kindly answer the following questions? Is there at present, or likely to be, an increasing demand for auxiliary steam yachts and vessels, and will the future vessels of the navy be masted, or is there a tendency to do away with sailing power? Does the propeller much retard vessels when under sail only, and is this considered a matter of much importance? What number of blades and form of propeller gives the highest rate of speed?—M. D.

SPHINX.

communications for the "Sphinx" should be to T. MITCHESON, B.A., *City of London School,* . *E.C.*

› the influx of mathematical correspondence a will be required for a satisfactory perusal and r insertion, the space allotted for the "Sphinx" ›sarily restricted.

Questions.

orrected.)—The difference between the squares › prime numbers is divisible by 24.

lorrected.)—Prove that

$$\log._{\epsilon} x = \frac{1}{n} . \overset{\infty}{\underset{m}{S}} \left(\frac{x^{mn} - 1}{(m x^n + 1)^m} \right).$$

'hat conditions must be fulfilled in order that ıst term in the expansion $(1 + x)^n$ may neither t nor the last?

hat is the equation to the spiral whose length is ²).—D. J. P.

ıe angles of two circular sectors of equal area, g a common chord (c), are as 3 : 1; show that rhich the arcs of the sectors include

$$= \frac{c^2}{6} \sqrt{3 + 2 \sqrt{3}}.$$

T.

ıow how to find the distance between two in- objects by means of a chain and pegs only, ny other instrument.—STUDENT.

ɔlve

$$(1) \quad 2x^2 - x - 2x\sqrt{1 - x^2} = 1\tfrac{1}{4};$$

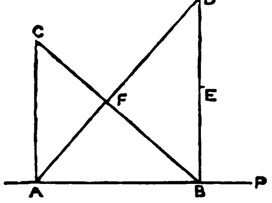
$$(2) \quad \sqrt{\frac{y^2 + 1}{y} + 1} = \sqrt{\frac{x + 9}{\sqrt{x}} + 3}$$

$$x (y + 1)^2 = 36 \left(y^2 + \frac{16}{9}\right).$$

T.

Solutions.

et A C = a, A B = y, B E = x; then B D = 2 x,



: A C = D B : A B or $y^2 = 2ax$; whence the ꞓ is a parabola.—L. S.

$^n - 1 = 0$, has the sum of its n roots = 0; for the second term the co-efficient of which = 0, the ıe roots with a contrary sign. Let $y = \frac{1}{x}$, then = 0, has also the sum of the roots = 0, but the $^n - 1 = 0$ are the reciprocals of the roots of = 0. Therefore, &c.—J. F. W.

'olve equation

$$)^2 y^4 + 6 y^4 + \frac{115}{6} y^3 + \frac{25}{2} y^2 + \frac{7}{2} y = \frac{5}{6}.$$

' be put into the form—

$$(y + 1)^6 - \frac{5}{6} (y + 1)^2 = 1;$$

he solution is obvious.—ANON.

$$x = \frac{1}{1+} \frac{1}{10+} \frac{1}{1+} \frac{1}{10+} \ . \ . \ .; \text{ therefore}$$

$$x = \frac{1}{1+} \frac{1}{10 + x} = \frac{10 + x}{11 + x};$$

$x^2 + 10x = 10$; $x = \sqrt{35} - 5$. Taking conver- the above continued fraction, we get successively

$$\frac{1}{1}, \frac{10}{11}, \frac{11}{12}, \frac{120}{131}, \frac{131}{143}, \text{ \&c.}$$

e the value of the fraction—that is, of $\sqrt{35} - 5$, between $\frac{120}{131}$ and $\frac{131}{143}$.—JAMES SEAFORD AND

lince α and β are roots of $x^2 - ax + b = 0$, the is satisfied by writing α or β for x.

$$\alpha^2 - a\alpha + b = 0, \text{ and } \beta^2 - a\beta + b = 0.$$

By substraction $\alpha^2 - \beta^2 - a(\alpha - \beta) = 0$.

$$(\alpha - \beta)(\alpha + \beta - a) = 0.$$

∴ If the equation is not a perfect square

$$\alpha - \beta = a.$$

ıbstituting in $\alpha^2 - a\alpha + b = 0$, we have

$$\alpha^2 - (\alpha + \beta)\alpha + b = 0 \text{ or } \alpha\beta = b.$$

Let α β be roots of $x^2 - 4x + 5$.

Then $\alpha + \beta = 4$, $\alpha\beta = 5$.

'hence $\alpha = 2 + \sqrt{-1}, \beta = 2 - \sqrt{-1}$,

l $\alpha^3 = 2 + 11\sqrt{-1}, \beta^3 = 2 - 11\sqrt{-1}$.

$$\therefore \alpha^3 + \beta^3 = 4, \ \alpha^3 \beta^3 = 125.$$

∴ Equation whose roots are α^3 and β^3 is

$$x^2 - 4x + 125.$$

SEAFORD.

777.—If U k denote $\int \frac{dx}{(1 + x^2)} k$, it is readily seen by differentiation that

$$U k + 1 = \frac{1}{2K} \frac{x}{(1 + x^2)} k + \frac{2k - 1}{2k} U k,$$
$$- 1$$

which formula, starting from U_1 = tan. x, gives successively U_2, U_3, &c. Expanding by the binomial theorem the second side of the identity

$$\left(\frac{4x^2 + 3}{1 + x^2}\right)^{\frac{1}{2}} = 2 \left\{1 - \frac{1}{4(1 + x^2)}\right\}^{\frac{1}{2}}$$

we get

$$\left(\frac{4x^2 + 3}{1 + x^2}\right)^{\frac{1}{2}} = 2 - \frac{a_1}{1 + x^2} - \frac{a_2}{(1 + x^2)^2} - . . - \frac{a k}{(1 + x^2)} k - . ...$$

where a_1, a_2, &c., are known constant co-efficients. Hence

$$\int \left(\frac{4x^2 + 3}{1 + x^2}\right)^{\frac{1}{2}} dx = \text{const.} + 2x - a_1 U_1 - a_2 U_2 - . . - a_k U_k - . . .$$

thus obtaining a convergent series for the proposed integral which our present powers of mathematical expression do not enable us to exhibit in a finite form.—LEIDHOLD.

Answers.

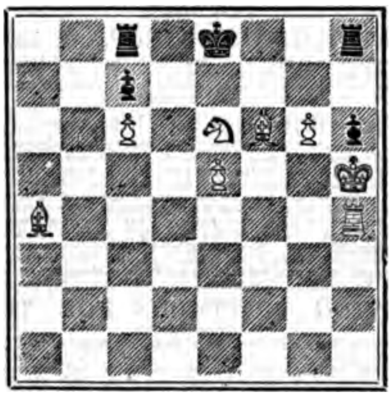
Amara, 767, 766, 769, 771, 772, 773; James Seaford, 773, 776, 767, 768, 769, 771, 772; H. J. W. B., 778; Leidhold, 777.

CHESS.

ALL Communications intended for this department must be addressed to J. PIERCE, Copthill House, Bedford.

PROBLEM CCCCXXXIX.—BY J. G. FINCH.

Black.



White.

White to play and mate in three moves.

SOLUTION TO 437.

White.	*Black.*
1. P to R 3.	1. R checks.
2. B takes R or B covers and disc. ch.	2. B covers (a).
3. Q to K R 5 mate.	
	(a) 2. R covers.
3. Q to K R 3 mate.	

NOTICE TO CORRESPONDENTS.

H. F. J.—Your solution to 437 is quite correct. It is better to give all Black's defences, though we do not always do so on account of the space they would occupy.

Homogeneous Cast Steel.—The discussions of Gautier and Euverte, upon the influence of silicium in iron, have led to a special investigation by F. Osann, who finds that a very small quantity of silicium offers the best protection against the undue oxidation of the carbon, and the consequent undesirable production of gas and blisters, which interfere with the solidity and homogeneity of steel.

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ANSWERS TO CORRESPONDENTS.

*** *All communications should be addressed to the* EDITOR *of the* ENGLISH MECHANIC, 31, *Tavistock-street, Covent Garden, W.C.*

HINTS TO CORRESPONDENTS.

1. Write on one side of the paper only, and put drawings for illustrations on separate pieces of paper. 2. Put titles to queries, and when answering queries put the numbers as well as the titles of the queries to which the replies refer. 3. No charge is made for inserting letters, queries, or replies. 4. Commercial letters, or queries, or replies are not inserted. 5. No question asking for educational or scientific information is answered through the post. 6. Letters sent to correspondents, under cover to the Editor, are not forwarded; and the names of correspondents are not given to inquirers.

The following are the initials, &c., of letters to hand up to Tuesday evening, August 20, and unacknowledged elsewhere:—

E. C. Stables.—T. Burstall.—H. P. Miles.—Lee and Hunt.—Singer and Co.—University College, Bristol.—W. Stanley.—Milo.—J. Briggs.—Cecilian.—Penance Point.—F. W. Shearing.—T. E. J.—J. K. P.—Old Papers.—Memb. Amateur.—Mechanical Society.—Deputy.—Analyst.—Cyprus.—Jib.—Vaughan Cornish.—Charles Cuthbert.—A Young Geologist.—Dyspnœa.—M. C. I.—Rubber.—Ink.—D. B.—W. E. H.—Finem Respice.—S. L. T.—8½in. O.G.—Isaac Fowler Ballard.—H. J. A.—Cuckoo.—Alpha Beta.—Ceres.—W. S. Travis.—W. G.—De Verre.—Xenos Clarke.—M. Dempster.—A. B. C. D.—L. S. Y.—Nave.—C. H. T.—S.—W. Draper.—Walker.—H. G.—R. B. W.—Science Student.—J. W.—Barman's Brother.—Trap Rock.—J. Steele.—Ordinates.—Young Mechanic.—Dundee.—Hairdresser.—F. R. A. S.—Wm. Cox.—Hesper.—Furnace Feeder.—Mechanical Stoker.—Clar.—Hosnikos.—Arthur L. Cooper.—E. F. G.—J. Milne and Son.—Omega.—Scribe.—G. T. M.—H. B.—W. W. B.—Glasgow.—Aeronaut.—Samuel Smith.—Bell.—Ne Sutor.—R. S. T., India.—Labor Omnia Vincit.—Fras. W. B.—Jack-of-All-Trades.—Dandie Dinmont.—W. W. C.—W. S. Franks.—X.—Would-be Inventor.—Chelt.—F. Morrell.—Querist.—East Anglian.

R. PARKS. (Bisulphide of carbon is manufactured by passing the vapour of sulphur over red-hot coke. It is a very volatile and inflammable liquid, largely used for purposes of industry. It can be obtained of most sellers of chemicals, but as it gives off a vapour which is very unpleasant, if not poisonous, you had better get some mixed in the paraffin oil by the chemist. When burnt in that manner it gives off sulphurous acid and carbonic acid in company with the products of the petroleum. The first is a powerful disinfectant.)—A WORKING MAN. (We know very little about the scheme, and are by no means in a hurry to take the course you seem disposed to adopt. The prize announcement has an advertising look about it—perfectly legitimate, possibly, but we feel at present hardly justified in advertising the affair gratis by inserting your query.)—WINE MERCHANT. (The querist asked how to put them on *without* a machine.)—J. W. (In reply to your second query—no.)—R. DOVER. (No one doubts the main facts stated in your letter, but the question after all is—"Will it pay"? The letters you refer to are a review of the various known systems, and occupy all the space we can devote to the subject at present.)—J. E. (We do not know; perhaps you can get some information from the agent-general for the colony, whose office is at 7, Westminster Chambers, London, S.W.)—DESIGN. (Any of the Art Schools; their addresses are given in the P.O. Directory. The master will recommend books.)—C. J. BONSER. (All will probably reply to the same effect, and very properly; we do not think you will gain your object unless you can make the personal acquaintance of some driver.)—TAFFY. (Numerous receipts for the first are given in back vols., and we really cannot repeat again. For the second try the following:—Sesquicarbonate of soda, 8oz.; tartaric acid, 7½oz.; pure chlorate of potash, 2½ drachms; well dry all the ingredients, and mix very intimately.)—IN PAIN. (Hundreds of recipes for the cure of toothache have been given. The following is as good as any, and we have ourselves frequently found it efficacious:—Tannin, 10 grains; gum mastic, ½ dram; carbolic acid, 10 drops; dissolve in ½oz. of sulphuric ether. Keep the preparation in a closely (glass) stoppered bottle, apply to the tooth on cotton wool, and well rub into the surrounding gums.)—HERMES. (1. By heating the ring, but you had better intrust it to a jeweller, or you will probably spoil it. 2. From Stanford or Wyld, both of Charing-cross. 3. With the "g" hard, we suppose, and the first diphthong sounded like "e," though as a proper name it may be pronounced differently by different people who bear it.)—AUTOS. (Not overlooked, but we cannot spare space for demonstrations of Euclid.)—SMOKER. (Alcohol will take out stains and dirt, but nothing will remove scorches.)—B. T. (We have not the space to spare, and besides it is impossible to reproduce such drawings well by wood engravings. You will find a very good figure subject for wall decoration, the subject of which is taken from "Ivanhoe," in to-day's *Building News*.)

VIOLINISTA, A. Duthie, Clerk, Omega, Student, J. C. P., S. P., E. F. G.—See indices to back vols.

E. M., F. S., Phonographicus, Jas. Adams.—Your queries are advts.

WILSON BATTY, South Saxon, J. A. M., J. N. D., Tuxford, L., J. L. E., I. F. Ballard, A. E. S., Progresso, J. F. Thompson, W. A. R., Anglo-Dane, T. E. J., C. C. Hawk, Perse, A. Stead, Perdu, Solomon Birkett, H. Palmer, Alex. Campbell, Finem Respice, and others have replied to queries already similarly answered.

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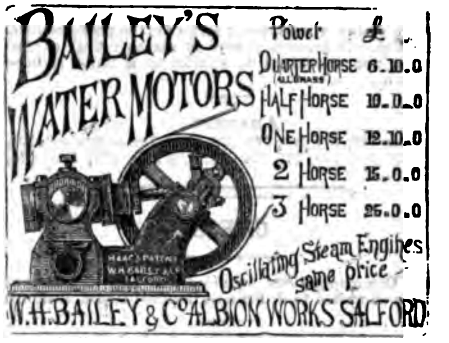
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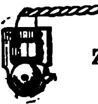

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ARTICLES.

THE MOON.*

THE Second Edition of Mr. Proctor's work on our Satellite is by no means a mere reprint of the first; for, while all the general account of the Moon's motions which was contained in the original edition reappears in the present one, the more recondite details of the Lunar theory, together with the more purely mathematical portion of the third chapter, is removed; to be reproduced (as our author tells us in his preface) as a separate volume under the title of the "Geometry of the Lunar Theory, Tides, Precession," &c. Thus both the size and the price of the work are reduced, and it assumes an essentially popular form. It must not, however, be supposed that the alterations made consist wholly in elision; for the concluding chapter on the Moon's Physical Condition has been recast and materially added to. The reader will thus have an opportunity of weighing the latest opinions of one of our most eminent English Astronomers on questions which are now exciting the greatest interest among all Students of Selenography. Mr. Proctor has been held, as we think most unjustifiably, to be a determined opponent of the idea that any perceptible physical change is in progress on the Moon's surface; but no one can read the sixth chapter of the work now under notice without seeing how unfounded such an opinion is. All our author demands is *evidence* of visible change. His contention, in fact, is that the mere alternation of the most violent extremes of temperature on the Lunar Globe must alone suffice to produce change. Whether, however, this can occur to a sufficient extent to be perceptible during the lifetime of any single observer may well be a question for discussion. In connection with this branch of the subject our author examines the observations which are alleged to afford proof of a cycle of change in the large and well-known walled-plain Plato, and shows in how very unphilosophical a manner such observations were conducted; and he goes on to indicate the only way in which a trustworthy determination of the increase or diminution of brightness (if any) in the floor of this formation could be definitely ascertained. He gives most valuable hints, too (pp. 295 et seq.), as to the effect of Libration in altering the aspect of objects upon the Moon's disc. These are illustrated by simple and intelligible diagrams, and should be read by all who are engaged in the telescopic examination of the Lunar surface.

In reviewing the original edition of "The Moon" (ENGLISH MECHANIC, Vol. XVII., p. 572), we took exception to the ridiculous insertion, in a Catalogue of Lunar Objects, of the names of a variety of utter nobodies in connection with certain previously undesignated Craters. We are glad to observe that these are now, one and all, eliminated from the List of 400 Craters, &c., among the tables at the end of the book. Our author has also done wisely in replacing the fearful and wonderful copy of Secchi's drawing of Copernicus, to which we took exception five years ago (loc. cit.), by the infinitely more beautiful and artistic delineation of the same Crater by Nasmyth. We can, though, scarcely flatter ourselves that these very manifest improvements are referable to our own criticism; inasmuch as a typographical error which we pointed out at the same time, as occurring on p. 83 of the First Edition, of "the Earth's Orbit" for the *Moon's*, reappears on p. 68 of the new one. Another improvement consists in the removal of the illustrated geometrical figures from lithographic plates, and their insertion as wood-cuts into the text. The illustrations proper consist of two excellent photographs of the Moon in her First and Last Quarters, a map of Bullialdus and its surrounding region by Schmidt; Nasmyth's beautiful drawing of Copernicus, of which we have previously spoken; a view of a very disturbed part of the Lunar surface by the same veteran observer; Lunar Landscapes under "Full" and "New Earth" shine respectively; and last, though by no means least, Webb's most valuable Chart of the Moon. We predict a wide circulation for Mr. Proctor's book in its present compact and amended form.

PROGRESS IN TELEGRAPHY.

AN interesting paper was read by Mr. Preece at the recent meeting of the British Association, the ostensible purpose of which was to give an account of the progress of telegraphic invention, whilst its effect was to apologise for the actions of the postal telegraph authorities. The questions brought prominently forward by Mr. Preece are not settled by his special pleading, able as it is, and it will not be surprising if his paper serves only to draw more attention to them than they might otherwise have received. The overpowering sensation produced by the telephone and other acoustic instruments that have followed in its wake has, says Mr. Preece, led many people to imagine that improvement in telegraphy has ceased, at least in this country. It has been frequently stated that since the transfer of the telegraphs to the State invention in that direction has left our shores and migrated to those of America, and it has been broadly hinted that the transfer has been mainly caused by the deadening influence of the Government monopoly. Such statements, says Mr. Preece, are made in ignorance of the facts; for greater improvements have been made in telegraphy during the past eight years than in any previous period of similar duration; and he avers that improvement has never been more active in this country than it has been since the Government managed the business. If it be true that more improvement has been witnessed during the past eight years than during any similar period, it does not necessarily follow that greater improvement still would not have been made if the Government had not had a monopoly of the telegraphs. Mr. Graham Bell tells us that although he has no wish to traverse the statement of Mr. Preece, that invention has not left the British isles, his personal experience of Government control is not very satisfactory. In the beginning of the year 1874 he invented a system of multiple telegraphy, by which 16 or 20 messages might be sent simultaneously on a single wire, and he submitted it to the authorities of the British telegraph department. In reply he received the usual formal acknowledgement, stating that the department would consider the invention at the expense of the inventor, and if it were thought worthy of adoption, the question of remuneration would be left entirely to the Postmaster-General. That reply settled the matter, and he brought out his invention in America, the ultimate result being the telephone, which, Mr. Preece informs us, has been found of no utility by the Post-office. This bare recital of facts brings us face to face with an anomaly in our patent laws. According to the letter of the law a patent is granted to an inventor on the ground that he has done something to benefit the community, and a limited monopoly is granted to him on the consideration that he fully describes his invention, which is to become the property of the nation at the expiration of a certain time. For this privilege the Government charges a considerable sum, and in fact makes a profit at first hand. The invention may be a success or not, the sum demanded is exactly the same; but beyond this, when the inventor comes upon the domain of a Government monopoly his reward is practically limited to whatever sum the department may choose to award. Here, then, we have a practical absurdity. The Government first of all secures a profit at the very commencement, and then claims a share, if not the whole, of the profits that may accrue from the brain-labour of the inventor. Looked at from the broadest aspect the patent law of this country says that a reward may be expected for a successful invention, but first of all the state must reap where it has not sown, and if the invention touches any monopoly of the state the reward depends entirely on the good nature of the head of the department affected. To encourage invention we first put a heavy price on protection, and then demand that we shall receive all the advantage at our own estimate. There may be, and doubtless are, good reasons why the State should maintain the right to adopt any invention; but surely it would be good policy to make the preliminary steps to acquiring protection easy even to those of limited means. At present a patent cannot be taken out much under £40, and that is a sum which, taking into account the value of the time occupied in introducing and almost forcing the invention, is practically prohibitive, so far as the large army of would-be inventors are concerned. When this difficulty is capped by the knowledge that the Government may utilise the invention without giving a proper price for it, the fact that a department has a monopoly of the means of utilising the invention at once materially discounts its commercial value. The consequence is, that there is no adequate inducement to discover improvements, and when they are discovered they are taken to other countries, where, as a rule, their inventors settle. Mr. Preece gives in his paper a table showing the number of patents applied for in this country during the last eight years, from 1870 to 1877, and the preceding eight, from 1862 to 1869, from which it appears that the annual average was 48¼ in the earlier period of eight years, and 52⅛ in the later term. Such figures as these are, however, most deceptive, for it is more than probable that, at least, one-half of the patents so enumerated are foreign ones, and in the majority of cases referred to really valuable inventions. In the discussion, however, Mr. Preece said that one of his special duties was to examine the propositions of inventors, and in 999 cases out of 1,000 they were absurd. We may well ask, then, what is the value of Mr. Preece's table?

Turning to the paper itself, however, we have a history, in brief, of the recent progress in telegraphy, and from this we learn that for receiving instruments, a modified form of the bell—the first sounder ever introduced—will probably in time supplant all the needles for ordinary work, while the fast-speed circuits will, of course, employ recorders. The ear will thus be relied upon instead of the eye. As regards batteries, the Leclanché and Fuller's are gradually replacing the Daniell. Dynamo-electric machines have been tried as sources of the current for telegraphic pur-

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* The Moon, Her Motions, Aspect, Scenery, and Physical Condition. By RICHARD A. PROCTOR. Second Edition. London: Longmans

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poses, but not at present with success, though it is desirable that so simple a form of energy as the motion of a steam-engine or of a turbine should be utilised; but a fair measure of success has followed an attempt to convert heat into electricity by means of Wray's modification of Clamond's thermo-electric pile. For many weeks 43 circuits were maintained in working order by one pile heated by gas jets. As a manufacturer of cables this country, of course, stands pre-eminent, and in the designing of transmitters our inventors can still hold their own. Varley's double-current system, working with polarised relays, has survived all others, but the keys employed to work it have been much improved, if not altogether revolutionised. Keys manipulated by hand cannot be made to send more than 45 words per minute, and, as the hand soon tires, the average rate of the best operator, says Mr. Preece, does not exceed 30 words per minute. Hand-keying is, of course, replaced by automatic senders on fast-speed circuits, and Mr. Preece, alluding to this branch of the art, pays a well-merited tribute to Alexander Bain, who introduced the system, unfortunately for him, before it was really wanted. Wheatstone's apparatus has been entirely remodelled and improved by the Post-office electricians: nothing remains but the original idea, and the machine now made by Mr. Stroh is one of the most perfect pieces of mechanism employed in any art. If that be true, and we do not doubt it, the ingenious mechanicians who so improved, or rather re-designed, the instrument should not be hidden under the general term of "Post-office electricians." According to Mr. Preece, the telephone bids fair some day to be of use in some branches of telegraphy, but its progress has been disappointingly small. Scores of improvements have been suggested or patented, but the instruments which Mr. Preece brought over from America last year remain the best in design, though they are not adapted for telegraph work, being too sensitive for practical use on existing lines. The "distinguishing feature that has characterised the improvements made by the Post-office officials has been in the direction of fast speed telegraphy, and it is not too much to say that they have more than quadrupled the working speed of wires." We are pleased to hear so good an account of the inventive faculties of the Post-office electricians, and hope they meet with their reward. There seems, however, to be some doubt in the matter; for although there are now nearly 200 circuits in England worked on the duplex system, Mr. J. B. Stearns, of America, was the first to make it a practical system, and Dr. Muirhead applied it to cables. So long ago as 1855 Siemens and others showed how two messages could be sent in the same direction at the same time (duplex telegraphy); and, when that system was combined with the diplex, quadruplex telegraphy was the result. Bosscha and Stark suggested it in 1855, and Mr. Heaviside repeated the suggestion in 1873, and according to Mr. Preece it was devised by Mr. Walby, a Post-office official at Dublin, in 1873. It was, however, patented in this country by Mr. Stearns in 1874; and was first practically utilised by Edison and Gerritt Smith in 1876; it is only now being introduced by our Post-office authorities. Amongst all the names mentioned by Mr. Preece we find only that of Mr. Walby as connected with our Post-office, and even he is not stated to be an "electrician;" so that what we ought perhaps to read is, that the Post-office officials adopt any improvements that are made and tested by others. Of all the *systems of fast speed* and multiplex tele*graphy the most valuable* and successful are the Wheatstone automatic and the quadruplex. The speed of the former, when worked duplex, is 200 words per minute; that of the latter, according to Mr. Preece, only 120, so that the automatic is more capacious than the quadruplex system. The two systems have been combined by the electricians of the Post-office, one side of the quadruplex being worked automatically, while the other is employed in the ordinary manner, so that the advantages of both are secured. These systems of fast speed and multiplex telegraphy have grown up in England under the fostering care of the Post-office since the transfer of the telegraphs to the State: therefore, says Mr. Preece, greater improvements have been made in telegraphy during the past eight years than in any previous period of similar duration. Necessity drove the Americans to the introduction of the quadruplex system, as it has driven us to the employment of the automatic. England stands prominent as the "home of the inventor." "While she can boast of Wheatstone, Cooke, Bain, Thomson, Clark, Varley, Fuller, &c., and Europe can boast of Gintl, Siemens, Frischen, Meyer, &c., America has her Morse, Hughes, Stearns, Edison, and Gray." So says Mr. Preece, but one is tempted to ask, if both England and Europe have an "&c.," whether America has not one, too—and, to come to the real point, whether the English inventors enumerated were before or after the telegraphs came under the control of the State? In 1868 the Western Union Telegraph Company engaged the services of Mr. Cromwell Varley, and they have, says Mr. Preece, "bettered their instruction." America has freely adopted our system of pneumatic telegraphy, our methods of testing, and Johnson's method of making iron wire. She has introduced automatic telegraphy, modified by Little and Edison, and is trying our superior batteries; so that, while we have not been slow to avail ourselves of American advances, our cousins, according to Mr. Preece, have equally availed themselves of our progress.

Telegraphy, whether for ordinary commercial or for railway purposes, is more highly developed in this country than in any other, and assuming that the Government monopoly does tend to check improvement, we must agree with Mr. Preece that the cable companies and the railway systems offer a tolerably large field for the inventor; but, rightly or wrongly, there is an idea that inventors are scurvily treated by Government departments; and from the time of Brunel down to that of Snider, facts warrant the idea. Mr. Preece tells us that he has no doubt the day of sixpenny telegrams will come, but under present circumstances it is impossible, because, as we understand him, the wires are now fully occupied. "Impossible" is a very strong word, and if invention is not dead, we shall expect the "Post-office electricians" to render a 6d. telegram not only a possibility but a reality.

ASTRONOMICAL NOTES FOR SEPTEMBER.

The Sun.

Day of Month.	Souths.	At Greenwich Mean Noon.		
		Right Ascension.	Declination.	Sidereal Time.
	h. m. s. a.m	h. m. s.	° ′ ″	h. m. s.
1	11 59 53·48 ,,	10 41 57	8 14 46N	10 42 3·89
6	11 58 16·12 ,,	11 0 3	6 24 11	11 1 46·66
11	11 56 33·24 ,,	11 18 3	4 31 1	11 21 29·43
16	11 54 47·53 ,,	11 36 0	2 35 52	11 41 12·19
21	11 53 1·79 ,,	11 53 57	0 39 25	12 0 54·96
26	11 51 18·59	[illegible]	1 17 39 S	12 20 37·73

At 4 a.m. on September 23rd, the Sun enters Libra; and Autumn is then supposed to commence. This is the theoretical epoch of the Equinox; but the closest approach to an equality of day and night will really occur on the 24th, when the Sun will be just 12h. 2m. above the horizon of Greenwich, and, of course, 11h. 58m. below it. The Zodiacal light may now be looked for in the East before sunrise. The same remarkable absence of spots, or other indications of Solar disturbance, continues.

The Moon

Enters her First Quarter at 8h. 25·7m. at night on September 3rd; and is Full at 3h. 49·4m. p.m. on the 11th. She will enter her Last Quarter at 6h. 30m. in the evening of the 19th; and be New at 2h. 10·3m. on the afternoon of the 26th. High tides may be looked for on the 26th and 27th.

Day of Month.	Moon's Age at Noon.	Souths.
	Days.	h. m.
1	4·3	3 42·4 p.m.
6	9·3	8 25·8 ,,
11	14·3	12 5·0 ,,
16	19·3	2 50·6 a.m.
21	24·3	7 13·3 ,,
26	29·3	11 39·6 ,,

Either the Full Moon of September, or that of October in 1878, is equally entitled to be considered as the so-called "Harvest Moon;" which, at the time of its opposition, rises at nearly the same hour for two or three nights running. The Moon will be in conjunction with Jupiter at 11 a.m. on the 7th; with Saturn at 9 p.m. on the 12th; with Mercury at 11 a.m. on the 25th; and simultaneously with Venus; and, lastly, with Mars at 1 p.m. on the 26th.

Occultations of (and Near Approaches to) Fixed Stars by the Moon.

Day of Month.	Name of Star.	Mag.	Disappearance.	Moon's Limb.	Angle from N. Point.	Angle from Vertex.	Re-appearance.	Moon's Limb.	Angle from N. Point.	Angle from Vertex.
			h. m.		°	°	h. m.		°	°
5	φ Sagittarii	3½	10 47 p.m.	Dark	47	75	‡11 20 p.m.	Bright	347	18
6	h¹ Sagittarii	6	7 31 ,,	Dark	81	72	8 44 ,,	Bright	316	319
9	B.A.C. 7697	6½	†12 2 ,,	NW	216	229				
11	B.A.C. 7986	6	2 8 a.m.	Dark*	60	86	2 39 a.m.	Bright	7	86
15	26 Arietis	6	†10 49 p.m.	NW by N	207	167				
18	χ¹ Tauri	5½	†3 39 a.m.	S by E	13	357				
20	ω Geminorum	6	†10 43 p.m.	S	357	325				
21	48 Geminorum	6	2 30 a.m.	Bright	20	340	3 7 ,,	Dark	320	277

† Near approaches. ‡ Star below the horizon. * But apparently bright.

Mercury

Is an Evening Star up to the 16th, at 7 a.m. on which day he comes into inferior conjunction with the Sun. He will be well placed for the observer before sunrise towards the end of the month.

;ht .sion.	Declination.	Souths.
m.		h. m.
33·8	1° 56′·3 S	0 51·6 p.m.
21·1	0 19·7	0 19·3 „
4·5	2 30·1N	11 43·1 a.m.
52·7	5 24·1	11 11·7 „
53·4	7 2·3	10 52·7 „
7·9	6 48·3	10 47·5 „

m-like path described wholly in a
ı in Leo. Although Mercury will
r to any conspicuous fixed Star, he
ıjunction with Mars at 9 a.m. on
h Venus at 10 a.m. on the 25th;
2 p.m. on the 30th.

Venus

Star during the whole of Septem-
now an angular diameter of less
ıd is approaching to a circle in
;hat her interest as a telescopic
ı has been for some time waning,
'ery small indeed.

;ht sion.	Declination North.	Souths.
m.		h. m.
9·5	17° 4′·0	10 27·7 a.m.
34·0	15 22·1	10 32·5 „
58·2	13 29·4	10 36·9 „
22·0	11 27·1	10 41·0 „
45·5	9 16·7	10 44·7 „
8·7	6 59·5	10 48·3 „

ıus from a barren part of Cancer,
ravel through the whole width of
ı 11th and 12th the planet will be
ıf Regulus, and about 1° N. of ρ
e 17th. She will further be in the
pic field with χ Leonis on the 24th.
:ion with Mercury on the 25th and
e been referred to above in connec-
ıt planet.

Mars

onjunction with the Sun at Noon
his conjunction with Mercury on
ıeen previously spoken of.

Minor Planets

uno are in a fairly good position
'ver during September; the former
opposition with the Sun on the
herefore give short ephemerides of

Pallas.

ght nsion.	Declination	Souths.
m.		h. m.
8·5	0° 8′·8 N	11 57·0 p.m.
1·0	2 6·6 S	11 10·2 „
54·1	4 20·5	10 24·0 „

ıng as a yellowish 7th mag. Star,
ı the retrograde arc indicated in the
meris in that very barren region
rius and Pisces are conterminous.

Juno

ght ›nsion.	Declination South.	Souths.
m.		h. m.
13·3	5° 56′·4	11 1·8 p.m.
6·8	7 47·5	10 16·0 „
2·2	9 28·1	9 32·2 „

from a point to the S.E. of γ in
uno will travel through that con-
ı a south-westerly direction. She is
itude less than Pallas.

Jupiter,

Whose position in the heavens gets worse and worse, should be looked for as soon after dark as possible. No observations of delicate detail on his surface, however, can reasonably be expected when even his meridian altitude scarcely exceeds 17°.

Day of Month.	Right Ascension.	Declination South.	Souths.
	h. m.		h. m.
1	20 1·3	21° 14′·3	9 17·7 p.m.
6	20 0·0	21 18·0	8 56·8 „
11	19 59·1	21 20·8	8 36·2 „
16	19 58·5	21 22·6	8 15·9 „
21	19 58·2	21 23·4	7 55·9 „
26	19 58·2	21 23·2	7 36·3 „

Jupiter will thus remain almost stationary in the sky in that blank region to the W.S.W. of π, ρ, and σ Capricorni.

Jupiter's Satellites.

Day of Month	Satellite.	Phenomenon.	—
			h. m. s.
1	*IV*	*Oc R*	7 13 0 p.m.
1	IV	Ec D	10 58 34 „
1	I	Oc D	11 3 0 „
2	I	Tr I	8 11 0 „
2	I	Sh I	9 5 0 „
2	I	Tr E	10 31 0 „
2	I	Sh E	11 25 0 „
3	I	Ec R	8 43 16 „
3	III	Oc R	9 8 0 „
3	III	Ec D	9 18 4 „
3	*III*	*Ec R*	12 46 53 „
4	II	Tr I	10 3 0 „
4	II	Sh I	11 55 0 „
4	*II*	*Tr E*	12 59 0 „
6	II	Ec R	8 58 39 „
8	*I*	*Oc D*	12 52 0 „
9	I	Tr I	9 59 0 „
9	I	Sh I	11 0 0 „
9	IV	Tr I	11 33 0 „
9	*I*	*Tr E*	12 19 0 „
10	I	Oc D	7 19 0 „
10	III	Oc D	9 4 0 „
10	I	Ec R	10 38 33 „
10	*III*	*Oc R*	12 40 0 „
11	*I*	*Tr E*	6 46 0 „
11	I	Sh E	7 49 0 „
11	*II*	*Tr I*	12 26 0 „
13	*II*	*Oc D*	6 32 0 „
13	*II*	*Ec R*	11 35 11 „
14	*III*	*Sh E*	6 52 0 „
15	*II*	*Sh E*	6 47 0 „
16	*I*	*Tr I*	11 48 0 „
17	I	Oc D	9 8 0 „
18	*I*	*Tr I*	6 16 0 „
18	I	Sh I	7 24 0 „
18	I	Tr E	8 36 0 „
18	IV	Ec R	9 34 49 „
18	I	Sh E	9 44 0 „
19	I	Ec R	7 2 45 „
20	II	Oc D	8 58 0 „
21	*III*	*Tr E*	6 8 0 „
21	III	Sh I	7 15 0 „
21	*III*	*Sh E*	10 54 0 „
22	*II*	*Sh I*	6 28 0 „
22	II	Tr E	7 2 0 „
22	II	Sh E	9 24 0 „
24	*I*	*Oc D*	10 59 0 „
25	I	Tr I	8 7 0 „
25	I	Sh I	9 19 0 „
25	I	Tr E	10 27 0 „
25	*I*	*Sh E*	11 40 0 „
26	IV	Tr E	8 25 0 „
26	I	Ec R	8 58 7 „
27	*I*	*Sh E*	6 9 0 „
27	*II*	*Oc D*	11 26 0 „
28	*III*	*Tr I*	6 16 0 „
28	III	Tr E	9 52 0 „
28	*III*	*Sh I*	11 16 0 „
29	II	Tr I	6 34 0 „
29	II	Sh I	9 5 0 „
29	II	Tr E	9 30 0 „

Ec. Eclipse; Oc. Occultation; Tr. Transit of Satellite; Sh. Transit of Shadow; D. Disappearance; R. Reappearance; I. Ingress; E. Egress.

Saturn.

Saturn coming into opposition to the Sun at 4 p.m. on the 22nd, is a morning Star, as far as his Southing is concerned, during the first two-thirds of September, and an evening Star for the remainder of the month. He rises, however, about 7h. 30m. in the evening at the beginning, and between 5 and 6 at the end of it; and is now as well placed for the observer as he will be this year. His ring continues (almost imperceptibly) to close up.

Day of Month.	Right Ascension	Declination South.	Souths.
	h. m.		h. m.
1	0 8·0	1° 52′·8	1 27·7 a.m.
6	0 6·8	2 1·8	1 6·8 „
11	0 5·2	2 12·9	12 41·6 p.m.
16	0 3·8	2 22·3	12 20·5 „
21	0 2·4	2 31·8	11 59 5 „
26	0 0·9	2 41·1	11 38·4 „

It will be seen from the above Ephemeris that Saturn moves backwards during September through that very barren region in Pisces to the South of the First Point of Aries.

Uranus

May be considered to have left us for this year. But

Neptune

Will be coming fairly into view after the middle of the month, and towards the end of it will be above the horizon during the greater part of the working hours of the night.

Day of Month.	Right Ascension.	Declination North.	Souths.
	h. m.		h. m.
1	2 31·6	13° 1′·3	3 50·8 a.m.
6	2 31·4	13 0·0	3 31·0 „
11	2 31·2	12 58·5	3 11·1 „
16	2 30·8	12 56·6	2 51·1 „
21	2 30·5	12 54·6	2 31·1 „
26	2 30·1	12 52·5	2 11·1 „

Neptune will thus never move very far out of a blank region in Aries.

Shooting Stars

Are much more rare in September than in the previous month. Faint indications of Showers exist at the beginning of the month, and between the 18th and 25th. There is, moreover, a tolerably well-determined one on the 10th, which should be watched for.

Geenwich Mean Time of Southing of Fourteen of the Principal Fixed Stars, on the Night of September 1st, 1878.

Star.	Souths.
	h. m. s.
γ Draconis	7 10 33·81 p.m.
Vega	7 49 30·11 „
h^2 Sagittarii	8 45 51·03 „
Altair	9 1 20·78 „
α^2 Capricorni	9 27 44·10 „
α Cygni	9 53 38 14 „
α Cephei	10 31 55·68 „
ε Pegasi	10 54 24·23 „
α Aquarii	11 15 40·20 „
η Aquarii	11 45 9·56 „
Fornalhaut	12 6 55·78 „
Markab	12 14 40·42 „
γ Piscium	12 26 47·94 „
δ Sculptoris	12 58 26·87 „

The method of determining the Local Mean Time of Transit of either of the Stars in the above List will be found on page 60 of Vol. XXIII.; and that of finding the instant of its Meridian Passage at Greenwich on any other night in September on p. 393 of Vol. XXII.

SIREN FOG SIGNALS.

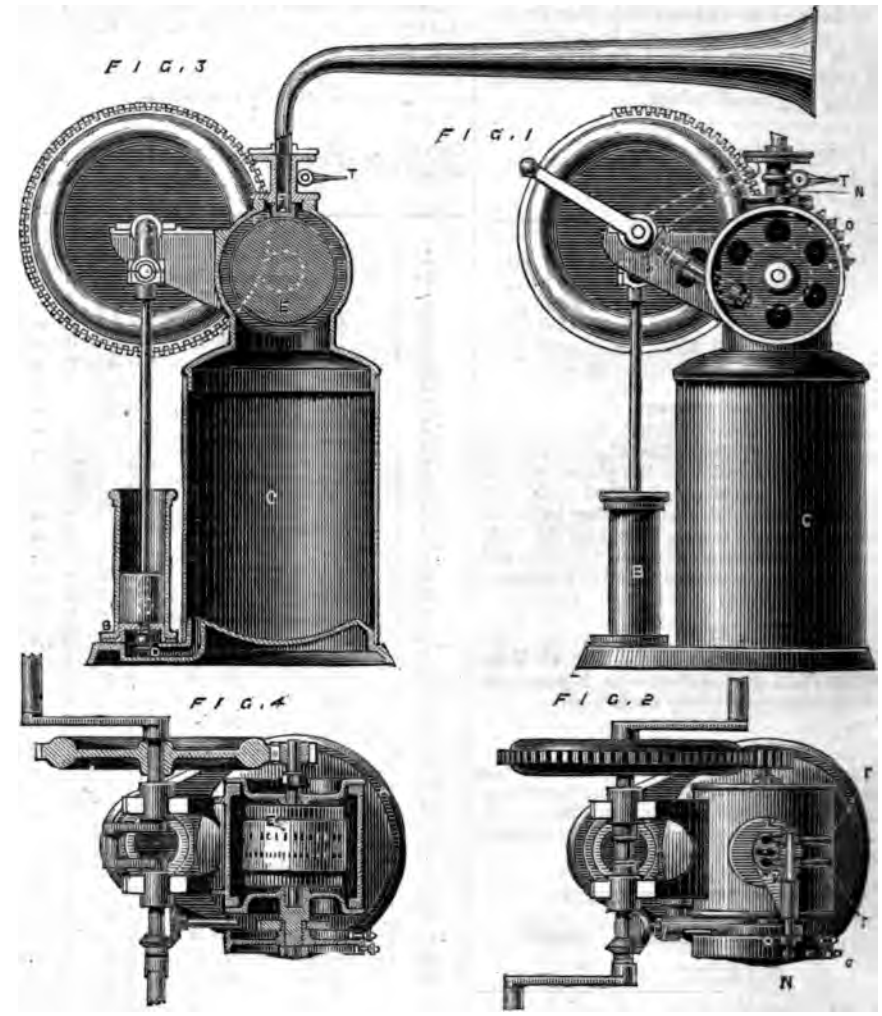
WITH Prof. Tyndall, Prof. Tait, and a number of smaller men turning their attention to fog signals, we may hope shortly to be in a position not only to provide vessels with the means of unmistakably indicating their presence and whereabouts, but also to warn the ships themselves of their proximity to a dangerous coast. At the meeting of the British Association, Mr. J. R. Wigham read a paper on the Irish Siren Fog Signal, invented and constructed by him. It is adapted either for steam or compressed air, and differs from those made in America and in England in being driven by a small turbine actuated by the current of steam or air by which the instrument is sounded, the rate of rotation being controlled and rendered uniform by a simple governor—a much less complex arrangement than the somewhat cumbrous mechanism which has heretofore been used. The Irish siren is applicable to steamships as well as to lighthouses. The first made by Mr. Wigham was similar to the American instrument, having two perforated discs, one revolving in front of the other, but with one important difference, that the holes in the revolving disc were constructed with bevelled edges, and it was thus caused to rotate by the direct action of the steam without the intervention of any machinery, precisely on the principle of the original siren invented by Cagniard de la Tour. The siren thus constructed is especially suitable for steamships, being so simple that the smallest boy in the ship can set it to work in a moment by merely turning on the steam. This arrangement, though satisfactory for vessels, is not so good for lighthouses where the sound is required to travel a greater distance. It was found in this case that the speed of the disc became so great as to produce a note so high as to be almost inaudible, and although the dying shriek of the siren, as it approached the point of inaudibility, was peculiarly weird and unmistakeable, and such as a few years ago would have been considered perfectly to have fulfilled the purpose of an effective fog-signal, yet it was found to be inferior in range and power to that of the prolonged uniform note which is to be obtained by the use of some kind of driving machinery by which a regular rate of rotation of the discs is maintained. Instead of discs, as in the American sirens, Mr. Wigham now uses two concentric cylinders, one fixed, the other revolving; but the chief peculiarity of the Irish siren is the means by which the cylinder is made to revolve, from the compactness and simplicity of which, and from the fact that it is not necessary that it should be assisted by a belt or otherwise with any motive power, it could be sounded at the water's edge, or on an outlying rock, or any position, no matter how distant from the station at which the steam boiler or compressed air receiver is situated.

We take this opportunity to illustrate one of the latest American developments of siren fog-signals, which has been patented in this country for its inventor, Mr. F. Brown, of New York. His invention consists (1st) in combining two or more sirens or siren valves with one trumpet or reverberator, in such manner that tones of different degrees of pitch may be given at certain fixed intervals. (2nd) In the combination of a siren or siren valve with a trumpet and throttle or cut-off valve, or mechanism whereby variable signals may be given at the pleasure of the operator. (3) In the combination of a siren valve with the air or gas chamber, and throttle or cut-off valve, in such manner that the siren valve is constantly working under or within the pressure of the air, or gas, or elastic medium.

The invention is so constructed as to be adapted for use on shipboard, and to be driven by hand-power, and is, therefore, made compact in form, and with all the parts combining together in a self-contained machine for using air as the elastic force.

Fig. 1 represents the apparatus in side elevation; Fig. 2 is a plan of the same as seen from above, with the trumpet removed; Fig. 3 is a vertical section of the apparatus as shown in Fig. 1; and Fig. 4 is a transverse section through the axis of the rotating valve.

The base of the apparatus carries the air-pump at B, with air-chamber or reservoir at C. The air-pump is connected with the air-reservoir at its lower end by a channel in the base, as at D, and motion is given to its piston by a crank on a shaft, which has on each end hand cranks for operating it; the shaft being mounted in brackets which project out from the top of the air-reservoir. The siren valve is shown at E, and is cylindrical in form, or similar to a broad-faced pulley. The axis is mounted in brasses or composition, which are inserted in bosses cast on the inner side of the valve chamber, and one end of the axis extends out through a stuffing box, and carries a pinion wheel to give motion to the valve. The exterior face of the valve revolves in close proximity to a seat, as at F, which extends down into the top of the air reservoir, and through the seat are made the openings that connect with the trumpet or its nozzle, as shown at F^1. The face of the seat or that next to the valve has its two openings in rectangular form, and there are openings corresponding in size through the rim of the valve, which communicates with the interior of the air-reservoir, so that as the valve rotates its openings meet those in the seat. But to vary the sounds or vibrations in the trumpet the spaces between the openings in the valve are varied, as, for example, the openings in one circumferential line are twice as far apart as those in the other; consequently the jet of air into the trumpet will be twice as frequent from the one as the other.



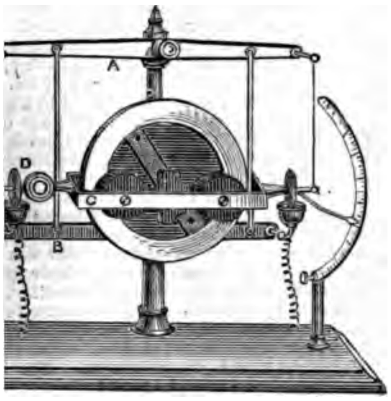
Motion is given to the siren valve from the large toothed fly-wheel on the crank shaft, and as the valve and its seat are placed in the upper part of the air reservoir, the air therein, when under pressure, is constantly exerting its force upon the valve and the seat to escape into the trumpet, but is prevented from doing so by the two valves at H, H^1, that are held down upon the back of the valve seat by springs. These valves resist the outward action of the air pressure whenever the holes in the siren valve correspond with those in the seat, the springs being made sufficiently strong to resist the outward pressure to the desired degree for producing the required force of sound waves; but the valves also serve as safety-valves to the reservoir whenever the air pressure becomes greater than the weight of the valves and the resistance of the springs, as it will then open the valves and escape into the trumpet and thereby give relief to the reservoir, and also cause an alarm sound in the trumpet, as it will be a combination of both outlets. But to give the proper sounds, the valves H, H^1, are raised by arms at K, K^1, mounted, one on a rock shaft and the other on a sleeve surrounding the shaft, both of which are mounted in a bearing in a bracket, fastened upon the exterior of the valve chamber.

It is evident that by rotating the shaft or the sleeve one or the other of the valves will be lifted, and as long as it is held open the air in the reservoir will escape in a series of puffs or jets proportioned to the speed of the siren valve and the spaces between its openings. To produce these jets at regular intervals a tappet arm, as at N, is attached upon the outer end of the rock shaft, and one is also upon the sleeve, and they extend out sufficiently far to come in contact with pins at O, screwed into the rim of a wheel revolved slowly by a worm and gear, driven from the crank shaft by the bevel gear. There are two rows of pins in the wheel, one for each tappet; consequently by arranging the pins alternate with each other, as shown on the wheel in Fig. 1, the outlet or throttle-valves will be operated alternately and regularly as each pin comes in contact with its tappet; the duration of the sound will be the same, but the pitch of the sound will be according to the openings in the siren valve. Long and short sounds may also be produced by setting the pins at O to a greater or less distance from the wheel, and a variation in the intervals may also be given by setting the pins of one row, so that two will act on one tappet to one of the other, and vice versâ. To give signals at the pleasure of the operator, or, for example, to produce sounds corresponding to those in the Morse system of telegraphing, or to any signal system of variable sounds, the shaft and sleeve are furnished with a key to each, T T, upon which the operator may press, and thereby open the throttle valves at plea-

and hold them open, as desired, to give ignal required. When these keys are he tappet wheel is removed, or its pins t out of contact with the tappet arms. rumpet may be attached to the valve- ›er by a disc as shown, so that it may be l around to the direction in which it is d the sound shall travel.

TRICAL INDICATOR TO SHOW E ROTATION OF THE EARTH.*

ıy article on this subject (see p. 518, No. 697) form of instrument is shown in which the s placed in a horizontal plane, and would in- an hourly motion of 15° at the poles, while at ıator it would not indicate at all. In the ›anying engraving an instrument is shown is suspended with the axis of the wheel sup- ; frame, C, at right angles to the plane of the r and parallel with the polar axis of the The frame, C, is suspended by silk threads tuds that project from the beam, A. Two ite mercury cups are supported by the beam, ›osition to make an electrical connection with cs on the axes of the frame, C. These cups ınected by a spirally coiled wire with the bind- ets that receive the battery wires. The A B, are connected by rods, so that when it ed to adjust the instrument the parts will in their proper relation. Upon one of the the frame, C, there is an index that moves ıt of the scale of degrees. Upon the other ere is a small mirror, D, for receiving a beam ıt and projecting it on a screen. By this ement a very long index is secured without nal weight or momentum. For this sugges- ım indebted to Professor A. M. Mayer, who gg. sted the suspension of the instrument by



:es. The instrument shown in the engraving when the axis of the frame, C, is adjusted ially, indicate 15° motion per hour in any ». The possible application of this instru- a a larger form to equatorial telescopes in the present clock trains suggests itself. The fficulty, if any, would be in providing tele- mountings of sufficient delicacy. The ment of the wheel, the commutator and ons is substantially the same in this instru- in the one previously described.

APPLICATION OF PHOTOGRAPHY THE PRODUCTION OF PRINTING RFACES AND PICTURES IN MENT.—V.†

By Thomas Bolas, Esq., F.C.S.

Collotypic Printing.

have already seen how extended is the use f bichromated gelatine in photo-mechanical ; processes, and we now have to study a in which the gelatine itself is used as a ; surface.

bare principles of collotypic printing are as :—A plate of glass or metal is coated with rm layer of bichromated gelatine, and this sed to light under a negative. Certain parts insoluble by the action of light, others soluble and capable of absorbing water. ate is damped, and a roller, charged with ık, is passed over it. Those parts which l the water refuse the ink; and a piece of ›eing laid on and pressure applied, the ink on the paper, forming a print. But more is is true, as we have an infinite number of grades between the two extremes of water-taking parts, and of ink-taking parts; those parts which had a slight exposure to light being capable of receiving both ink and water, the proportion in which each is received depending on the extent to which the part has been acted on by light. Here is a damp collotype plate; I hold it up to the light, and those who are near can see a very feeble image. I now pass the inking roller over it a few times, and the fatty ink adheres to those parts which have been exposed to light, the amount of ink being proportionate to the extent to which the light has acted; so that a picture is built up with all its gradations of light and shade. I hold up the inked plate before the light, and you see the image distinctly. I will now hand round the inked plate, together with a similar, but uninked plate. Here is one more plate, which I take from this dish of water; this I will ink, and take an impression from it on paper. Here they are, you see. If you hand them round, you can compare the plate with the proof printed from it.

The first step in preparing the collotypic plate is to take two pieces of plate-glass, such as I have here, to put some water and flour emery on one of them, then to grind them together until the rubbing surfaces are uniformly de-polished. It is not worth while for me to go on grinding these until they are finished, but here are some finished ones which you can examine. When the plates have been sufficiently ground, they must be well rinsed, and reared up against a shelf to dry. The next thing is to prepare a mixture of seven parts of albumen, three parts of commercial water-glass solution, and ten parts of water. This mixture being made, it is churned to a froth by one of these American egg-beaters. You see it only takes about two minutes to convert the whole into a froth. I now pour this froth on a paper filter, and as it breaks up it runs through. This solution is now ready to pour on the plates, and you see that it runs easily over. I now let it drain off at one corner, and allow the plate to dry in an inclined position. When dry, the plate is well rinsed in water, in order to remove all soluble matter, and is again reared up to dry. In this state the plate is covered with an extremely thin whitish film, which causes adhesion between the plate and the gelatine coating which is next applied. The sensitive gelatinous mixture is prepared by dissolving six parts of gelatine in 48 parts of water, and adding one part of ammonium bichromate, and 48 parts of alcohol. The mixture is then strained through fine muslin, and is ready for use.

Here is a metal hot plate, made double, and in the interspace water is kept boiling. Three levelling screws support one of the prepared glass plates, about an inch from the surface of the metal hot plate. The glass plate usually reaches a temperature of about 50°C. under these circumstances, and when this is the case, and the plate is quite level, all is ready for coating it with the sensitive gelatine. I now pour on the middle of the plate as much of the sensitive mixture as it will conveniently hold, and you see that it runs well over the plate, even up to the corners. I now lift up the plate quickly, drain off the excess of gelatinous mixture, give the plate a rocking motion, and put it back on the levelling screws in its old position. In about ten minutes it will be dry and ready for exposure in the printing frame, and this exposure is about equal to that which would be required to make a silver print from the same negative; but a plate which has been dried quickly requires a longer exposure than one which has been dried slowly.

Mr. Debus is now holding a dried plate against the lime light, and you merely see an even yellow tint, arising from the uniform film of bichromated gelatine. He will now hold up a similar plate which has been exposed under a negative, and you see a faint brownish image, showing all details and shades of the original. After having printed the plate under the negative, the next step is to soak the plate in cold water, in order to remove the free bichromate; and during this soaking the image becomes much fainter, as you will see when I hold this soaked plate before the lime light. During this soaking in water another change, and a remarkable one, takes place; all the exposed parts of the plate become puckered up into a multitude of little folds, which wind about in a very peculiar manner. These folds may be traced almost all over the picture, their depth being greatest on those parts which have been most exposed—at least up to a certain limit, beyond which increased exposure tends to destroy the folds. The pitch of these folds may vary from about fifty to three hundred to a linear inch, and this pitch varies according to the treatment of the plate, the kind of gelatine used, the condition of the bichromate, the length of time which the sensitive mixture is kept before use, the rapidity of drying, and other circumstances. This puckering, reticulation, or grain has much to do with the printing qualities of the plate, one with a coarse grain being easier to print from than one with a fine grain, but the results are, in general, not so good. When the plate has been soaked in water sufficiently long to remove the excess of bichromate and to develop the grain, it is taken out and allowed to dry spontaneously. The dry plate may then be kept without injury for several days, or weeks, or even months. It should be kept in a dry cool room, and, as a rule, ought not to be put away in a brightly lighted place.

We now pass on to the inking of the plate and its treatment in the press. Before use the plate should be soaked in water, in order to saturate the soluble portions of the gelatine with this fluid, and generally five or ten minutes is sufficient for this purpose. It is usual to employ the ordinary lithographic roller, and ordinary lithographic links, for collotypic printing, and when a lithographic roller is in really first-rate condition it answers admirably; but a new lithographic roller can only be got into a sufficiently good condition by daily exercise for about a month, and the least carelessness, the drying of ink on it, or a cessation of work for a few days, will degrade it from the state of a roller suitable for collotypic work to that of on ordinary roller suitable for lithography.

Here is a form of roller which I have devised, and have found to answer admirably, as it is always ready for use. It consists of an outer cylinder of red indiarubber, made smooth on the outside by means of fine glass paper; inside this is a thickness of about three-quarters of an inch of ordinary typographic roller composition (glue and treacle), and inside all a wooden core, provided with handles. To make this kind of roller, I put the indiarubber cylinder inside this brass mould, place the core in position, and pour in a little of this glue and treacle composition—just enough to seal the joint at the bottom—and when this has set I will fill the space with the glue and treacle mixture. When a roller of this kind is done with, the ink can be cleaned off by means of a rag moistened with a little oil of turpentine, care being taken not to use too much. The roller is then ready to be put away, and can be brought into use again at a moment's notice.

The labour of mixing stiff inks and colours, and of getting an even film on the inking slab, is considerable; but I have found that the following plan obviates all difficulty on this score. The ink is mixed up with oil of turpentine to the consistency of cream, and the colour may be modified by the addition of the artists' oil colours, which are sold in tubes. In this way a thorough mixing of the colours is ensured, and when it is intended to use a portion, a piece of muslin is tied over the mouth of the bottle containing the colour, the bottle is then inverted, and the muslin-covered neck is rubbed over the inking slab. The ink thus filtered out is spread evenly by means of an ordinary typographic ink roller, and is then allowed to remain a few minutes, in order that the turpentine may evaporate. Thus is obtained a layer of ink, free from lumps, well mixed, and evenly spread. The collotypic plate, being now taken from the water, is laid on the bed of the press, this having been previously covered with a sheet of white paper, and is gently wiped with a soft piece of muslin. The inking roller being charged with ink from the slab, is gently rolled backwards and forwards, as I am now rolling, it being borne in mind that a slow rolling with heavy pressure tends to put much ink on the plate, and quick rolling with light pressure tends to take off an excess of ink. It is advisable to be provided with two inks, one rather thinner than the other, as the half tones sometimes require a thin ink to bring them fairly out. To make this thin ink a little of the very fluid lithographic varnish (known as tint varnish, or S. H. varnish) is added to the mixture of turpentine and ink. The kind of press best adapted for collotypic printing is the roller lithographic press, like those commonly used in France and Italy; a Waterlow's autographic press is very well adapted for the work, but the scraper press does not answer so well. You see that the press I am using consists merely of two rollers, with the tympan and bed riding between them.

The plate having been inked, and the paper laid on, a moist sponge is passed over the back of it. I then put on a few thicknesses of blotting paper and a sheet of indiarubber an eighth of an inch thick, shut down the tympan, and pass through the press. Here, then, is the result.

Any kind of paper may be used for collotypic printing, but if it be desired to imitate silver prints, a thin and rather soft enamel paper must be used, and the prints must be varnished with a varnish prepared by dissolving two parts of white shellac and one part of mastic in a convenient quantity of methylated spirit. The strength of the solution will depend on the effect required, and it is scarcely necessary to say that the varnish must not be allowed to chill. Here is a print; I will varnish one-half of it, and when dry you can compare the two sides.

The process which I have demonstrated to you is practically that of Professor Husnik, as set forth in his invaluable work on the subject, and if I were to give you the leading features of the various collotypic processes I should occupy several hours in doing it. The characteristic feature of the Albertype process consists in covering the glass plate with a film composed of gelatine, albumen, and potassium bichromate, and exposing this to light through the plate of glass, so as to make that part in immediate contact with the glass insoluble, washing off the soluble portion in warm water, so as to leave a very thin film of insoluble gelatine, capable of serving a

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Geo. M. Hopkins, in the *Scientific American*.

ıg the Cantor Lectures delivered before the f Arts.

a bond between the glass and the actual printing film, which is now applied.

Mr. J. R. Sawyer, of the Autotype Company, has elaborated a process by which he has produced magnificent results, some of which you may see hanging up all round the room. You may see among these representatives of almost all classes of photographic work—ancient manuscripts, coins, architecture, landscapes, engineering works, and book illustrations. Directly opposite to me is an exceedingly fine collotypic print of Norwich Cathedral, and this is from one of Mr. Sawyer's own negatives. You will also notice a series of prints representing the great public engineering works of France, which are now being printed by the Autotype Company, under the direction of Mr. Sawyer. The production of this series, regularly and in large numbers, proves the thorough practicability of the collotypic process when in careful hands.

You see before you some admirable specimens of collotypic printing, by Messrs. Braun, of Dornach, Messrs. Strumper and Co., of Hamburg, and Messrs. Wright and Co., of London.

The next great step in collotypic printing is the application of steam machinery to the process; the difficulties of wiping the plate, inking, and taking off the paper by machinery are considerable, but these difficulties are being gradually overcome.

MODERN IDEAS OF CHEMICAL ACTION.

THE lecture delivered by Prof. Dewar on Monday in last week will be long remembered by those who had the good fortune to secure admittance to the building in which it was delivered. The many novel and delicate experiments exhibited were rendered doubly interesting by the extraordinary proportions to which they were magnified, and rendered visible by the whole audience. The subject of the lecture was "Dissociation, or Modern Ideas of Chemical Action," and the following is an abstract:

New chemistry and old were now so distinct, said Prof. Dewar, that it was for some years quite customary to refer them, as it were, to two different times, and this had been mainly brought about by the large advances which had recently been made in organic chemistry. His object was to deal with some of the large generalities that had been elaborated through a long process of time, and to show that the advantage of the long experiments which were apparently of little use at the time, was that in the cumulative result they were of much greater value than sudden and brilliant discoveries. For this purpose he must direct attention for a moment to chemistry at the beginning of the century. Black died in 1799, and they justly regarded him as the father of modern chemistry. He was so rigid a teacher that though he started the new chemistry with Lavoisier in his last days, he still strongly objected during 30 years of his professional career to regard any doctrine of chemistry as final at his time, and the consequence was distinctly stated that he never called his lectures lectures on chemistry, but lectures on the action of heat and matter. It had been a matter of very great difficulty to chemists to understand how at that period Black managed to lay so firm and secure a basis in such a difficult department of science. The great discovery of Black was the production or origin of fixed air, associated with the transformation of bodies where they were liquefied or became gaseous—the great doctrine of latent heat—that a body in passing from a solid into a liquid took in heat which was not measurable by the thermometer. At the beginning of the century it was distinctly regarded as proved that air was really a substance that differed from the fluid in some way or other, having stored into it a certain quantity of heat. In a few years they found Dalton commencing to say, and stating distinctly in 1805, that he had no doubt that the permanent gases were liquefiable bodies. He said at the time that the experiments of Black and others had so far proved the results that there would scarcely be entertained any doubt respecting the reducibility of elastic fluids of whatever kind into liquids, and that we ought not to despair of effecting it by the use of low temperatures and strong pressures exerted on unmixed gases. Now, in order to illustrate what Dalton really did, he (Dewar) would begin by proving that all liquids in a gaseous state had a certain amount of tension, and that the vapour exerted a certain pressure which was measurable. He had on the table three ordinary barometers, and into two of them he would introduce two fluids, leaving the third as a standard. Into the first he would introduce at the top a little alcohol, and into the little space at the top of the second some ether. They would then see that the alcohol floated about on the surface of the mercury, and that the mercury was [illegible] depressed, that depression being produced by the tension of the fluid. Different fluids had different [illegible] pressure. Ether had an enormous [illegible] and it would be observed that it forced the [illegible] down much lower than the alcohol [illegible] investigation as to the pressure of [illegible] could only be regarded as second to his great discovery of the atomic theory, for it directed the attention of investigators to the laws relating to the pressure of vapour and temperature. Now, in order to show better what he had been explaining he would magnify through a lens fixed air—carbonic acid, discovered by Black, and then subject it to pressure. As the pressure was put on, the manometer hand rose, and they would see the liquid carbonic acid appear as a clear liquid on the surface of the mercury. This carbonic acid was as permanent as water, provided it was at the required pressure, which was something more than 60 atmospheres. The pressure would fall as he reduced the temperature, and by compressing it again it would rise again temporarily. He would show them that this liquid could be made to boil. The appearance of this liquid carbonic acid was, as illustrated, entirely altered by altering the temperature. This was typical of all fluids, and indeed of all solids. He also showed how the fluid could be made to disappear by increasing the temperature, notwithstanding that he increased the pressure ever so much. Even if he subjected it to the pressure of 100 atmospheres the liquid would not appear. Arranging a current of vapour to gradually heat the glass, in a short time they would see the fluid gradually disappear although he kept increasing the pressure to keep up the volume. This had been most elaborately worked out by one of the greatest discoverers of the time—by Dr. Andrews, of Belfast—namely, what he called the "critical point"—and he was only sorry that Dr. Andrews was not present to see magnified, and on so large a scale, an experiment which he had often shown him on a smaller one. At 80° this fluid optically disappeared, and no amount of pressure would at that temperature bring it back. But by cooling it again they would get back the liquid, though there was then no liquid there, apparently. This was exactly parallel to what went on with a large number of gases. The effect of pressure in modifying chemical bodies dates from the beginning of the century, being observed very shortly after the time of Black. In fact, Black had a very favourite pupil in Hutton, the great geologist. At that time it was a source of great discussion amongst geologists and physicists how far water or fire played the greatest part in the actions that had taken place in the past. One school argued that water had done everything; the other that fire did everything. Hutton supported the doctrine that fire modified the character of the stratified rocks and he answered the objections raised to the stability of certain chemical bodies by proposing the theory that pressure under the ocean produced a modifying influence on chemical changes. His disciples were taught this, but never attempted any experimental verification, with the acception of Sir James Hall, who made a very interesting experiment about 1798, on the character of basalt when fused. He showed that if they fused basalt it could be reproduced, provided sufficient time was given for it to cool. After Hutton's death Sir James Hall made an elaborate series of experiments to prove that Hutton's theory was right. The substance he took was carbonate of lime. How was it that in an ordinary limekiln caustic lime was obtained and carbonate of lime did not exist? How was it that carbonate of lime was obtained at all if fire had acted, as was said, in geologic states? Hall tried to prove that stability depended upon pressure, and succeeded in producing chalks and actual marble by confining the marble or chalk in an enormous tube of great length, heating it to a high temperature, and preventing the escape of anything; so that chalk, or a species of marble, was formed by heating carbonate of lime. Fifty or a hundred atmospheres was sufficient to produce a chalk of very little weight, and therefore, large deposits of lime could be had without its being necessarily caustic. About 500 of such experiments had been greatly lost sight of. Little had been done, and a repetition of this experiment in a different form was one made within the last twelve or fifteen years. The principle was one which he would illustrate. The lecturer then gave an elaborate chemical illustration of the experiment referred to. The great development of the effect of pressure in modifying chemical bodies was due to Prof. Clair Deville of Paris, who, for the last twenty years had rigidly followed the philosophy of Black in examining the action of heat on chemical bodies or mixtures of bodies. In other words, he had compared a vapour most rigidly with the behaviour of a chemical body, and all the experiments of Deville were really related to a very ingenious experiment of Mr. Justice Groves who found that water, although a very stable fluid, was readily decomposed at a white heat by means of red-hot platinum. This struck Deville as an extraordinary experiment, because here they had highly heated steam giving such a temperature as to decompose water itself, and by experiment he found that all that water required for its decomposition was that they should have a continuous current of vapour driving away the amount decomposed. This was exactly parallel to the decomposition of chalk. The experiment was then made and showed that at a temprurure very much lower than the fusing point of platinum, water was decomposed into gases, and that this was so was shown by reproducing water from the gas by the aid of the electric spark. Another very interesting experiment was made, showing the results of boiling action set up among the crystals of carbonate of potash, as also another experiment with palladium with the same object. Every vapour has a certain curve that represents all its relations—namely, the increase or diminution of pressure to the temperature. If it was true that the behaviour of a chemical body was so strictly analagous to that of a vapour, then all the laws of dynamics could be applied to the stability of chemical bodies. This had modified entirely all previous ideas of metallurgic interactions, and it has enabled chemists to ascertain temperatures very much beyond the range of the best thermometers, to consider carefully the case of high temperatures as they occurred in the sun, and to explain a great many abnormal reactions that chemists had never before been able to explain. The temperature in dissociation was that temperature where a body could not exist—that is, that it was that temperature in the case of the body of water where no water could exist, where there was no possibility of producing water at that temperature; that was a temperature of something like between 3,000 and 4,000 degrees, instead of being 30 degrees. All the elaborate relations of temperature and pressure of vapour might be applied to the stability of chemical bodies; consequently, the range of their knowledge had been enormously extended. It might appear to many that the case of a solid body differed from that of a fluid, and it might be imagined there was no parallel between the gas given off from the carbonate of lime or potash and that of water. If he took a little solid carbonic acid it would be easy to show that it was a substance that at the temperature of the air was continually boiling. It was actually in a state of ebullition. He would use snow to make a block of ice, and no doubt he would succeed in getting a block of it. There would be a mass of fixed air in the form of ice, and he would be able to show that if the ice was put in a fluid that did not solidify, it would actually be in a condition of continual ebullition, although the temperature was considerably below that of the Arctic regions. The solid may boil just as much as the fluid. The lecturer then, by a beautiful and highly successful experiment, produced carbonic acid snow, and by increased pressure produced a block of ice. He explained that the density of the solid in the form of ice was about one and a half times that of water. When it was placed in liquid it readily sank, and was continually giving off gas, and this he proved by placing it in ether. Dr. Dewar exhibited another experiment, in order to prove that a body that was eminently unstable existed at the temperature of a red heat where that body would be ordinarily regarded as a body non-existent. For this purpose he placed a strip of palladium in a hydrogen flame. The palladium was observed to be vibrating, and that was due to the inequality of temperature forcing the hydrogen temporarily in and temporarily out, and proving the temporary existence of a body of great instability at high temperatures. The inference from this investigation was to show that the generalisations of the greatest importance were those that were the work of an enormous number of minds. In order to reach this analysis of chemical stability they had included the work of many years of the ablest experimenters. The results of a century of experiments were really to go back to the philosophy of Black—to study the action of heat on bodies and mixtures, and to examine the analogy of chemical bodies with those subjects with parallel relations—namely, vapours; and in that way they were enabled to apply all the great discoveries of investigators in thermo-dynamics to the stability of chemical compounds. They continually heard of discoveries by astronomers with reference to the condition of the solar atmosphere. Think for one moment what this investigation showed them with reference to the solar atmosphere. It told them the efficacy of sudden explosions on an atmosphere heated to an exceedingly high temperature. The result was hundreds of bodies were formed for the first time, and hundreds of bodies were decomposed, forming an enormous number of new ones out of the sphere of its enormous jet, simply from the variation in the pressure. No doubt they would have a proof of the application of these principles by the discovery shortly, that there were certain lines in the solar spectrum suddenly produced, and as suddenly disappearing, that were due, not to elementary bodies, but to the formation of temporary compounds. This subject was one of the greatest generality, and enabled them to feel that all the sudden and brilliant discoveries of which they had so many lately, were not to lay hold of them to the exclusion of considering the enormous value of the researches of the laborious investigator.

THE HABITS OF ANTS.

AT the recent meeting of the British Association, Sir J. Lubbock read a paper on the habits of ants, in the course of which he said he had been for some years watching the habits of ants and had kept under observation about 30 species. Though living in captivity they were in good health, and he had in

t a queen which had lived with him since
He could confirm the statements which had
de with respect to the architectural skill of
eir attention to their young—their remark-
ganisation—their possession of domestic
, and even the institution of slavery. He
watched several other insects, which lived
ciation with them, of which M. André
ed that there were 583 species. In some
association was accidental, in others it was
the nests afforded shelter to other insects,
e were also some uncomfortable companions
tached themselves to ants and could not be
f. The common house ant was to be found
es in association with other ants, but the
re exceptional, and he had never seen any
. A nearly allied species, however, the
a, was sometimes found in association with
enerally the fusca. In such cases the nest
to the sanguinea. The queen and the
ere of that species, and the fuscas were
ough free to come and go, as there was no
slave law, and they seemed to be quite re-
to their position. They assisted in the
d duties, and in foraging for provisions.
t the aphides in corn, and derived a con-
share of their sustenance from them. In
er, when they are of no use, they were still
ith great care, until the spring, when they
gain useful, an instance of prudence and
ght unexampled in the animal kingdom.
s one species which took no part whatever
uties of the household, and would even
the midst of plenty if the food were not
their mouths. He had confirmed Huber's
le experiments on this point, and had kept
ve and in health for months by allowing
lave for an hour a day to feed and clean
To test their intelligence he suspended some
out half an inch over the nest, which could
eached by a paper bridge 10ft. long. He
e a small heap of earth by which they could
They soon swarmed over the earth and
eat, but when he removed some of the
ever occurred to them to heap it up again,
ey tried to stretch up to the honey, and
t round by the bridge. He make a similar
nt by placing honey which could only be
y crossing a chasm over which he had laid
ge a bit of straw. He slightly moved the
nd they tried in vain to stretch over, but
ught of putting the straw back, which they
ly have done.

one knew that if an ant or bee found a store
others would soon collect about it; but
intelligence was implied if the ants and
accompanied their friends. The case was
if they could describe the locality and send
nds to it. They did not, however, appear
to communicate as much as that to their
If the nest of Formica fusca were dis-
nd one of them found a place of conceal-
e was anxious that her friends should come
e went up to one of them and took it by
ible. The second ant rolled herself up into
nd was carried over her shoulder to the
he second ant then went to a third, and the
as repeated. He put an ant which had
out food for some days to honey, and saw
feeding she was on her way to the nest
met some friends, whom she fed, and then
alone to the honey. On her way back
met some other friends, whom she fed,
of them went back with her to the honey.
urse, they, no doubt, brought others. He
they were able to distinguish between a
a small quantity. To test this, he put
e Lasius Niger species into a small store,
s into a large one, and having watched for
found that the ants with the small quantity
2 friends to share it, and the ants with
store brought 257. To try whether they
l their friends to a store, he put an ant
some honey, which he placed near her
e fed, returned to the nest, and came out
riends. He took her up, however, and put
he honey, and her friends then wandered
l then returned to the nest. It was hard
ether there were differences of character in
e same species, as they behaved differently
erent conditions; but there were great dif-
f character and habits between those of
species, putting aside the slave-making
hich he thought would find it impossible to
vith the self-dependent and freer species.
mmunities even showed curious analogies
ier stages of human progress. There were
g, the pastoral, and even the agricultural
e first lived chiefly by the chase, and
one. Their battles were single combats
described by the ancient poets. The
l a higher type of social life. They utilised
ecies of aphides like flocks and herds.
e immense, and acted in concert. He
ey would probably exterminate the first
t as the white man exterminated the
Of the agricultural class—the harvest
would not speak, as there were none in this country. When he first began to keep ants he isolated the nests by water, but it was necessary to change that often, and observing that the hairs on the stems of flowers preventing the ants from climbing them, he had since used ferns One of the most surprising points connected with ants was that while there was one nest they never appeared to quarrel, all others, even of the same species, being treated as strangers and enemies. There was no mistaking the treatment. If an ant (fusca) wanted to carry away a friend to a place of security she took her by the mandible, and her friend rolled herself into a ball, but an enemy is seized by the leg or an antenna. He confirmed the experiments of Huber as to their being able to recognise their friends, even after a long absence, or rather their acquaintances, for although he saw that they attacked and killed their enemies he could not find any trace of warm affection for their friends. He tested this by taking some out of a nest, and suspended them in a bottle covered with muslin. Those in the nest took no notice of them, but when strangers were put in they were indignant, and never stopped until they cut through the muslin and attacked them. He marked some ants in a nest with paint, and found that their friends removed it; but a stranger going into the nest was restless, and got out as quickly as possible. It would be interesting to know how they recognised their friends. It might be by smell —or some sign—or by actual recognition. In order to try whether they could recognise them when insensible he first used chloroform, but that practically killed them, and he then made them intoxicated. He did so by putting them into whiskey, not whiskey into them, for they were too sensible to take it even on week days. He tried an experiment with 25 friends and 30 strangers. The sober ants coming out of the nests, and finding the intoxicated ants lying helpless on their backs in ludicrous attitudes, proceeded to take them up and carry them off. Of the twenty five they brought 20 into the nest, where, probably, they soon slept off the effects. The other five they dropped into the moat of water which then surrounded the nest. Why they did so he could not tell. Perhaps they fell into the hands of stern teetotalers. As to the 30 strangers, 28 were thrown into the moat, and the other two were taken no notice of. He took some pupæ out of a nest, and on putting them back after some months, found that they were received as friends, while some, which were put into a different nest, were attacked. It was generally stated that all the eggs in a nest of ants or bees were laid by queens. That was not strictly so, for some were laid by workers, though the cases were exceptional. He had nests in which there were no queens, and yet there were eggs in them, but the eggs laid by workers always produced males. He had made some experiments to test the senses of ants, and found that they were capable of distinguishing between different colours, and avoided violet. Their sense of smell was also delicate, but he had seen no proof that they were capable of hearing, and he had proved by an experiment, which he described, that they were not capable of communicating with each other by sound.

BRITISH ASSOCIATION.

THE ADDRESS IN GEOGRAPHY.

THE address in Section E was delivered by the President, Sir C. S. Wyville Thomson, F.R.S., and as might have been expected dealt principally with physical geography and those researches carried on by the staff of the Challenger. After briefly reviewing the efforts made by different countries and individuals in the work of exploration, deep-sea sounding, and Arctic discovery, the President gave an account of the

General Oceanic Circulation.

All recent observations have (he said) shown us that the vast expanse of water which has its centre in the southern hemisphere, is the one great ocean of the world, of which the Atlantic with the Arctic Sea and the North Pacific are merely northward extending gulfs; and that any physical phenomena affecting obviously one portion of its area must be regarded as one of an interdependent system of phenomena affecting the ocean as a whole. Shallow as the stratum of water forming the ocean is, it is very definitely split up into two layers. At a depth varying in different parts of the world, but averaging perhaps 500 fathoms, we arrive at a layer of water at a temperature of 40° Fahr., and this may be regarded as a kind of neutral band separating the two layers. Above this band the temperature varies greatly over different areas, the isothermobathic lines sometimes tolerably equally distributed, and at other times crowding together towards the surface; while beneath it the temperature almost universally sinks very slowly and with increasing slowness to a minimum at the bottom. The causes of natural phenomena, such as the movements of great masses of water, or the existence over large areas of abnormal temperature conditions, are always more or less complex, but in almost all cases one cause appears to be so very much the most efficient that in taking a general view all others may be practically disregarded; and speaking in this sense it may be said that the trade-winds and their modifications and counter-currents are the cause of all movements in the stratum of the ocean above the neutral layer. This system of horizontal circulation, although so enormously important in its influences upon the distribution of climate, is sufficiently simple. One of the most singular results of later investigations is the establishment of the fact, that all the vast mass of water, often upwards of 2,000 fathoms in thickness, below the neutral band, is moving slowly to the northward; that in fact the depths of the Atlantic, the Pacific, and the Indian Oceans are occupied by tongues of the Antarctic Sea, preserving in the main its characteristic temperatures. The immediate explanation of this unexpected phenomenon seems simple. For some cause or other, as yet not fully understood, evaporation is greatly in excess of precipitation over the northern portion of the land hemisphere, while over the water hemisphere, and particularly over its southern portion, the reverse is the case; thus one part of the general circulation of the ocean is carried on through the atmosphere, the water being raised in vapour in the northern hemisphere, hurried by upper wind currents to the zone of low barometric pressure in the south, where it is precipitated in the form of snow or rain, and welling thence northwards in the deepest channels on account of the high specific gravity dependent on its low temperature, it supplies the place of the water which has been removed. The cold water wells northward, but it meets with some obstructions on its way, and these obstructions, while they prove the northward movement, if further proof was needed, bring out another law by which the distribution of ocean temperature is regulated. The deeper water sinks slowly to a minimum at the bottom, so that if we suppose the temperature at a depth of 2,000 fathoms to be 36° F., the temperature at a depth of 3,000 may be, say, 32°. Now, if in this case the slow current meet on its northward path a continuous barrier in the form of a submarine mountain ridge rising to within 2,000 fathoms of the sea surface, it is clear that all the water below a temperature of 36° will be arrested, and, however, deep the basin beyond the ridge may be, the water will maintain a minimum of 36° from a depth of 2,000 fathoms to the bottom. In many parts of the ocean we have most remarkable examples of the effect upon deep-sea temperature of such barriers intersecting cold indraughts, the most marked instance, perhaps, a singular chain of closed seas at different temperatures among the Islands of the Malay Archipelago; but we have also a striking instance nearer home. Evaporation is greatly in excess of precipitation over the area of the Mediterranean, and consequently, in order to keep up the supply of water to the Mediterranean, there is a constant inward current through the Straits of Gibraltar from the Atlantic; I need not at present refer to an occasional tidal counter-current. The minimum temperature of the Mediterranean is about 54° F., from a depth of 100 fathoms to the bottom. The temperature of 54° is reached in the Atlantic at the mouth of the Straits of Gibraltar at a depth of about 100 fathoms, so that in all probability future soundings will show that the free waterway through the Straits does not greatly exceed 100 fathoms in depth.

The Depth of the Sea, and the Nature of Modern Deposits.

It seems now to be thoroughly established by lines of trustworthy soundings which have been run in all directions, that the average depth of the ocean is a little over 2,000 fathoms, and that in all probability it nowhere exceeds 5,000 fathoms. Within 300 or 400 miles of the shore, whether in deep or in shallow water, formations are being laid down, whose materials are derived mainly from the disintegration of shore rocks, and which consequently depend for their structure and composition upon the nature and composition of the rocks which supply their materials. These deposits imbed the hard parts of the animals living on their area of deposition, and they correspond in every way with sedimentary formations with which we are familar of every age. In water of medium depths down to about 2,000 fathoms, we have in most seas a deposit of the now well-known globigerina-ooze, formed almost entirely of the shells of Foraminifera living on the sea surface, and which after death have sunk to the bottom. In depths beyond 2,500 or 3,000 fathoms no such accumulations are taking place. The shores of continents are usually too distant to supply land detritus, and although the chalk building Foraminifera are as abundant on the surface as they are elsewhere, not a shell reaches the bottom; the carbonate of lime is entirely dissolved by the carbonic acid contained in the water during the long descent of the shells from the surface. It therefore becomes a matter of very great interest to determine what processes are going on, and what kind of formations are being laid down in these abyssal regions, which must at present occupy an area of not less than ten millions of square miles. The tube of the sounding instrument comes up from such abysses filled with an extremely fine reddish clay, in great part amorphous, but containing, when examined under the microscope, a quantity of distinctly recognisable particles, organic and inorganic. The organic particles are chiefly siliceous, and for the most part the shells or spines of radiolarians which are living abundantly on the surface of the sea, and apparently in more or less abundance at all depths. The inorganic particles are minute flakes of disintegrated pumice, and small crystalline fragments of volcanic minerals; the amorphous residue is probably principally due to the decomposition of volcanic products, and partly to the ultimate inorganic residue of decomposed organisms. There is ample evidence that this abyssal deposit is taking place with extreme slowness. Over its whole area, and more particularly in the deep water of the Pacific, the dredge or trawl brings up in large numbers nodules very irregular in shape, consisting chiefly of peroxide of iron and peroxide of manganese, deposited in concentric layers in a matrix of clay, round a nucleus formed of a shark's tooth, or a piece of bone, or an otolith, or a piece of siliceous sponge, or more frequently a waterlogged fragment of partially decomposed pumice. These nodules are evidently formed in the clay, and the formation of the larger ones and the segregation of their material must have taken them a very long time. Many of the sharks' teeth to which I have alluded as forming the nuclei of the nodules, and which are frequently brought up uncoated with foreign matter, belong to species which we have every reason to believe to be extinct. Some teeth of the species of *Carcharodon* are of enormous size, four inches across the base, and are scarcely distinguishable from the huge teeth from the tertiary beds of Malta. It is evident that these semi-fossil teeth, from their being caught up in numbers by the loaded line of the trawl, are covered by only a very thin layer of clay. Another element in the red clay has caused great speculation and interest. If a magnet be drawn through a quantity of the fine clay well diffused in water, it will be found to have caught on its surface some minute magnetic spherules, some apparently of metallic iron in a passive state, and some of metallic nickle. From the appearance of these particles, and from the circumstances that such magnetic dust has been already detected in the sediment of snow-water, my colleague, Mr. Murray, has a very strong opinion that they are of cosmic origin—excessively minute meteorites. I think it is conceivable that the metallic spherules may be derived from the decomposition of the lighter products of submarine volcanoes. So far as we can judge, after a most careful comparative examination, the deposit which is at present being formed at extreme depths in the ocean, does not correspond either in structure or in chemical composition with any known geological formation; and, moreover, we are inclined to believe, from a consideration of their structure and of their imbedded organic remains, that none of the older formations were laid down at nearly so great depths—that, in fact, none of these have anything of an abyssal character. These late researches tend to show that during past geological changes abyssal beds have never been exposed, and it seems highly probable that until comparatively recent geological periods such beds have not been formed. It appears now to be a generally received opinion among geologists—an opinion which was first brought into prominence by Professor Dana—that the "massive" eruptions which originated the mountain chains which form the skeleton of our present continents, and the depressions occupied by our present seas, date from the secular cooling and contraction of the crust of the earth, from a period much more remote than the deposition of the earliest of the fossiliferous rocks; and that during the period chronicled by the successive sedimentary systems, with many minor oscillations by which limited areas have been alternately elevated and depressed, the broad result has been the growth by successive steps of the original mountain chains and the extension of the continents by their denudation, and the corresponding deepening of the original grooves. If this view be correct—and it certainly appears to me that the reasoning in its favour is very cogent—it it is quite possible that until comparatively recent times no part of the ocean was sufficiently deep for the formation of a characteristic abyssal deposit. The question of

An Open Polar Sea

Prof. Sir Wyville Thomson regards as virtually settled. There is neither an open polar sea nor continuous, but stretches of water or heavy packs of ice, as the wind listeth. Speaking of the possibility of reaching the Pole he says it seems possible that in a cold season, with the pack in the condition in which Markham found it in 1876, some progress might be made in this way, if it were conceivable that the end to be gained was worth the expenditure of so much labour and treasure.

The Antarctic Regions.

But little progress has been made during the last *quarter of a century in the actual* investigation of the conditions of that vast region which lies within the parallel of 70° S. Some additional knowledge has been acquired, and the light which recent inquiries have thrown upon the general plan of ocean circulation and the physical properties of ice, have given a new direction to what must partake for some time to come of the nature of speculation. From information derived from all sources up to the present time it may be gathered that the unpenetrated area of about 4,700,000 square miles surrounding the South Pole is by no means certainly a continuous "Antarctic Continent," but that it consists much more probably partly of comparatively low continental land, and partly of a congeries of continental (not oceanic) islands, bridged between and combined, and covered to the depth of about 1,400 feet, by a continuous ice-cap; with here and there somewhat elevated continental chains. Sir Wyville Thomson gave the reasons for this belief, but as they have already appeared in the "Voyage of the Challenger," and in papers read at different meetings, we need not here reproduce them, or his remarks on the deep-sea fauna. We think the address erred by being too long, and by seeming too much like an extract from a book, but it had at least the great merit of being audible.

THE ADDRESS IN ECONOMIC SCIENCE.

The address in section F was delivered by the President, T. K. Ingram, LL D., M R S.A., who in his opening remarks alluded to the critical position held by the section in the Association, not a few of the most distinguished members thinking that Political Economy and Statistics have no claim to citizenship in the commonwealth of Science. The President was equal to the occasion and delivered as we mentioned last week one of the best addresses of the meeting. We give the substance of his remarks:—That economic phenomena are capable of scientific treatment is a proposition which I do not intend to spend time in demonstrating. It is comprehended in the more general question of the possibility of a scientific Sociology, and any one who disputes it will have enough to do in combating the arguments by which Compte, and Mill, and Herbert Spencer have established that possibility. Nor do I intend to waste words in showing that if there be a science of society, no other branch of investigation can compete with it in importance or in dignity. It has the most momentous influence of all on human welfare. It presides, in fact, over the whole intellectual system—an office which some, mistaking the foundation for the crown of the edifice, have claimed for mathematics. It receives contributions from all other departments of research—whether in the ascertainment of results, to be used for its purposes, or in the elaboration of methods to be applied in its inquiries. It is the most difficult of all the sciences, because it is that in which the phenomena dealt with are most complex and dependent on the greatest variety of conditions, and in which, accordnigly, appearances are most deceitful, and error takes the most plausible forms. There is, in my judgment, no duty more incumbent in our day, than that of recognising the claims of Sociology, whilst at the same time enforcing on its cultivators the necessity of conforming to the genuine scientific type. Yet it is now sought to expel from this Association, which ought to represent the harmonious union of all positive research, the very limited and inadequate portion of the science of society which has ever found recognition in its scheme. I assume, that then, economic phenomena are proper subjects for scientific treatment. But, strangely enough, a professor of political economy has recently disputed the possibility, or at least the utility, of a scientific handling of economic questions. Professor Bonamy Price, of the University of Oxford, who has published a volume in which several of those questions are handled with much ability and freshness of treatment, not only repudiates a scientific character for his own inquiries but alleges the scientific method to be a mistake. According to him, ordinary people are right in believing that they can arrive at truth on these questions by the aid of their natural lights—that by virtue of their untrained sagacity they can take a shorter and far clearer path through their own observations, than through what he calls "the tangled jungle of scientific refinements." In plain terms, he is in favour of relegating the study of economic phenomena to the domain of empiricism—to what is called the common sense of practical men. A more fatal suggestion could not, in my judgment, be made. I am forced to say that Professor Price seems to me to labour under radical misconception as to the nature and conditions of science. Because the facts of the production and distribution of wealth have always gone on spontaneously amongst mankind, and definite modes of social action with respect to them have progressively established themselves, economic investigation, he argues, adding nothing to what men have with more or less sagacity and intelligence always practised, cannot be regarded as having the nature of a science. But it might be similarly shown that there is no science of human nature, for the intellectual processes, the feelings, and the practical tendencies of man have always been similar; they have not waited for science to develop themselves and pass into action; rather their long-continued spontaneous action was the necessary condition of the science that studies them. So, too, with respect to all human action on external nature—practice always must proceed theory; art, more or less intelligent, must precede science. Science is simply the ascertainment and co-ordination of laws. A law is the statement of a general fact; we explain a particular fact by showing that it is a case of a more general fact. Now, from the beginning to the end of his own book, Professor Price is endeavouring to ascertain such general facts, and to explain particular facts by means of them—in other words, he is busied upon science without knowing it. He rests much of the importance of economic studies, which he regards as essentially practical, on their efficacy for uprooting the evil weed of false theory; but theory of some sort will always be necessary. The decline in the credit and influence of political economy, of which I have spoken, appears to me to be in a large measure due to the vicious methods followed by its teachers. The distrust of its doctrines manifested by the working classes is no doubt in a great degree owning to the not altogether unfounded belief that it has tended to justify the absolutely existing social arrangements, and that its study is often recommended by the influential classes with the view of repressing popular aspirations after a better order of things. And it is doubtless true that some of the opposition which political economy encounters, is founded on the hostility of selfish interests marshalled against the principles of free trade, of which it is regarded as the representative. It is appropriate to this place to point to the growing coldness or distrust exhibited by the higher intellects towards political economy—a fact which lies on the surface of things, and shows itself everywhere in contemporary literature. The egotistic spirit in which it is steeped may explain the continued protest which Carlyle and Ruskin have, mainly as moral preachers, maintained against it—though that very spirit is closely connected with vicious method. But it is no longer necessary to consider scattered indications of the feeling of eminent individualities on this matter, for of late years the growing dissatisfaction has risen to the dimensions of a European revolt, whose organs have appeared not in the ranks of general literature, but within the sphere of economic investigation itself. It is a characteristic result of the narrowness and spirit of routine which have too much prevailed in the dominant English school of economists, that they are either unacquainted with, or have chosen to ignere, this remarkable movement. The largest and most combined manifestation of the revolt has been in Germany, all whose ablest economic writers are in opposition to the methods and doctrine of the school of Ricardo. The question as to the relation of economic studies to the general body of human knowledge is really the most radical and vital that can be raised respecting them, and on it more than on any other depends, in my opinion, the future of these studies. It is sometimes sought to get rid of this question in a very summary manner, and to represent those who raise it either as weakly sentimental persons who shrink from studying the conditions of wealth apart, because there are better and higher things than wealth; or as persons of confused intellect, who wish to mix together things which are essentially different in their nature. On the former of these imputations it is unnecessary to dwell. I am far from undervaluing sentiment in its proper sphere; but I take up no sentimental ground on the present question. In denying the propriety of isolating economic investigation, I appeal to considerations derived from the philosophy of science. When we pass from the study of the inorganic world to that of the organic, which presupposes and succeeds to the former, we come upon the new idea of a living whole, with definite structures appropriated to special actions, but all influencing one another, and co-operating to one result—the healthy life of the organism. Here, then, it is plain that we cannot isolate the study of one organ from that of the rest, or of the whole. We cannot break up the study of the human body into a number of different sciences, dealing respectively with the different organs and functions, and, instead of a human anatomy and physiology, construct a cardiology, a hepatology, an enterology. It is not of course meant that special studies of special organs and functions may not be undertaken—that they may not be temporarily and provisionally separated from each other; but the fact insisted on is, that it is essential to keep in view their relations and interactions, and that therefore they must be treated as forming part of the subject matter of one and the same science. And what is thus true of theory is also true of practice—the physician who had studied only one organ and its functions would be very untrustworthy even in the therapeutics of that organ. The most characteristic fact about what is well called the social system is the consensus of its different functions; and the treatment of these functions as independent is sure to land us in theoretic and practical error. There is one great science of sociology; its several chapters study the several phases of social existence. One of these phases that of the material well-being of society, its lustrial constitution, and development. The study these phenomena is one chapter of sociology—a apter which must be kept in close relation with rest. In nothing is the eminent superiority of lam Smith more clearly seen than in his tendency comprehend and combine in his investigations all different aspects of social phenomena. Before term "social science" had been spoken or itten, it could not be expected that he should have ceived adequately the nature and conditions of at branch of inquiry—much less founded it on finitive bases—a task which was to be achieved re than fifty years later by the genius of Comte. t he proceeded as far in this direction as it was ssible to do under the intellectual conditions of his ne. In striking contrast with the spirit of the ster is the affectation, habitual in his followers, ignoring all considerations except the strictly nomic, though in doing so they often pass over encies which have important effects on material ll-being. Thus, when Senior is led to make some servations of the utmost importance and interest, the very doubtful advantage to a labouring family the employment of the mother and the children in n-domestic work, he thinks it necessary to apolo- e for having introduced such remarks, as not rhaps, strictly within the province of political nomy. And when he finds himself similarly luced to observe on the evils of severe and inces- nt labour, and the benefits of a certain degree of sure—subjects so momentous to working men, and sely connected with their material as well as ral condition—he pauses and corrects himself, mitting that he should not only be justified in itting, but perhaps was bound to omit, all con- lerations which have no influence on wealth. This the very pedantry of purism; and the purism is t merely exaggerated—it is really altogether out of ace. Mill, though, as I believe, he did not occupy m ground in relation to the constitution of social ience, is free from any such narrowness as:— For practical purposes," he says, "political onomy is inseparably intertwined with many other anches of social philosophy. Except on matters mere detail, there are perhaps no practical estions, even among those which approach nearest the character of purely economical questions, hich admit of being decided on economical premises one." This is true, but it is only part of the uth. For purposes of theory as well as of practice e several branches of social inquiry are inseparably tertwined; and this larger proposition Mill in other place has stated with all the desirable ful- ss of enunciation, declaring that "we can never derstand in theory or command in practice the ndition of a society in any one respect, without king into consideration its condition in all other spects."

Professor Fawcett, in his recent timely and useful eatise on free-trade and protection, finds that he nnot restrict himself in the study of that question, the economic point of view. "As complaints," says, "are constantly made by protectionists that eir opponents persistently ignore all the results of otection which are not economic, I will be careful consider those results." And he goes on to aintain the proposition, in which I entirely concur, at protection may produce social and political nsequences, even far more mischievous than the onomic loss it causes to a country. I believe that e most effective weapons against this and other onomic errors will often be found in reasons not sed on material interests, but derived from a con- deration of the higher ends of society, and the eal of the collective life of the race. And when we ave to deal with the larger economic subjects, now apidly increasing in urgency, which are more im- ediately in contact with moral conceptions, these estions of the ultimate ends of the social union nnot be left out of sight. This was seen by Mill, ho was open to all noble ideas, and saw that the actical life of mankind cannot be governed by aterial egoism. In discussing the claims of com- unism, he says:—"Assuming all the success which claimed for this state of society by its partisans, it mains to be considered how much would be really ined for mankind, and whether the form that ould be given to life, and the character which would impressed on human nature, can satisfy any but very low estimate of the capabilities of the species." ere, you observe, is raised the entire question of e ends of social life; and economic progress is bordinated, as it ought to be, to the intellectual d moral development of humanity. It is o often forgotten that he is before all things man and a member of society—that he is usually e head of a household, and that the conditions of s life should be such as to admit of his maintaining e due relations with his family—that he his also a tizen, and requires for the intelligent appreciation the social and political system to which he belongs certain amount of leisure and opportunity for ental culture. Even where a higher education is w sought for him, it is often conceived as exclu- vely designed to adapt him for the effective exercise his functions as a producer, and so is reduced to chnical instruction; whereas moral and social ideas are for him, as for all of us, by far the most important, because most directly related to conduct. Labour again is viewed as a commodity for sale, like any other commodity; though it is plain that, even if it could be properly so called at all, yet in some particulars, as in the difficulty of local transfer (a family having to be considered), and in the frequent impossibility of waiting for a market, it is quite exceptional amongst commodities.

We have not space to do full justice to the address, but quote some of Prof. Ingram's concluding passages: Let me now recapitulate the philosophical conclusions which I have been endeavouring to enforce. They are the following:—(1) That the study of the economic phenomena of society ought to be systematically combined with that of the other aspects of social existence; (2) That the excessive tendency to abstraction and to unreal simplifications should be checked; (3) That the *à priori* deductive method should be changed for the historical; and (4) That economic laws and the practical prescriptions founded on those laws should be conceived ane expressed in a less absolute form. These are, in my opinion, the great reforms which are required both in the conduct of economic research, and in the exposition of its conclusions. I am far from thinking that the results arrived at by the hitherto dominant economic school aught to be thrown away as valueless. They have shed important partial lights on human affairs, and afforded salutary partial guidance in public action. Viewed as provisional and preparatory, the current political economy deserves an approbation and an acceptance to which I think it is not entitled if regarded as a final systematisation of the industrial laws of society. I do not expect that the views I have put forward as to the necessity of a reform of economic studies will be immediately adopted either in this section or elsewhere. They may, I am aware, whilst probably in some quarters meeting with at least partial sympathy, in others encounter determined hostility. And it is possible that I may be accused of presumption in venturing to criticise methods used in practice, and justified in principle, by many distinguished men. I should scarcely have undertaken such an office, however profoundly convinced of the urgency of a reform, had I not been supported by what seemed to me the unanswered arguments of an illustrious thinker, and by the knowledge that the growing movement of philosophic Europe is in the direction he recommended as the right one. No one can feel more strongly than myself the inadequacy of my treatment of the subject. But my object has not been so much to produce conviction as to awaken attention.

THE ADDRESS IN MECHANICAL SCIENCE.

The address in section G was delivered by Mr. E. Easton, C.E., the President, who took for his subjects the "conservancy of rivers and streams." About one-half of the address was taken up with a history of the subject, but from the other half we quote the following:—So much has been written on the engineering details of this subject, by men far better qualified than I am to deal with them, that I shall confine myself to the simple statement of the principles which have been recognised by the chief authorities as essential, and to a few suggestions, which my own experience leads me to think may be of some value.

That the freer the admission of the tidal water the better adapted is the river for all purposes, whether of navigation, drainage, or fisheries.

That its sectional area and inclination should be made to suit the required carrying power of the river throughout its entire length, both for the ordinary flow of the water, and for floods.

That the downward flow of the upland water should be equalised as much as possible throughout the entire year; and

That all abnormal contaminations should be removed from the streams.

In carrying out these principles, it is perhaps superfluous to say that modifications must be introduced to suit the particular phenomena of each river. In some watershed areas it would be easy to construct reservoirs which would to a great extent equalise the flow and reduce floods. In others it might be better to control the floods by means of embankments. In others, to have weirs, and sluices, delivering into side channels, parallel to the main stream, with the same object. Sometimes reservoirs or receptacles must be made for catching the débris brought down by the streams. In fact, every river must be treated as a separate entity. It is therefore necessary that a systematic collection of data relating to rainfall, the geological character of the gathering ground, and the volume of each separate stream, should be made for each watershed area; and this should be carried on for a sufficient length of time to enable a fairly correct estimate to be formed of the behaviour of the river both in time of flood and in time of drought. The establishment of self-acting tide-registering gauges at several points of every outfall should be insisted on. By these means the whole of the phenomena of a watershed area could be ascertained and recorded, and safe and trustworthy knowledge could be obtained, which would contribute towards the determination, not only of the works which ought to be executed, but of the incidence of the taxation by which the necessary fund should be raised. For instance it is obvious that where the geological character of a watershed is variable, one portion of it consisting of a permeable stratum, such as chalk or red sandstone, and another portion of an impervious stratum, such as the tertiary clays or the shales of the millstone grit, the same works would not be adapted to each section of the river, nor would it be fair to charge all the expense according to the same scale of contribution. The former—that is, the permeable stratum—is not only, from its absorbent nature, not the cause of floods, but is, by reason of that characteristic, absolutely constituted by nature one of the very works which must be devised by art to mitigate the effects of rainfall on the latter or impervious stratum.

Bearing this in mind I have often thought that nature might be usefully imitated in this operation by passing the surplus rainfall into the permeable strata of the earth by means of wells, or shafts, sunk through the impermeable strata overlying them. This has been done in isolated cases for the drainage of lands, but not for the deliberate purpose of preventing floods and equalising the flow of rivers.

I also wish to remark that artificial compensating reservoirs may be much more frequently made use of than is generally supposed to be possible, when it is considered that, so long as the dams are constructed in situations where there is no danger of their giving way, it is by no means necessary that they should be water-tight, and that, therefore, they can be constructed at a very much smaller outlay. In fact, the purpose would be answered by a series of open weirs, which would collect the water in times of flood, and discharge it gradually down the stream. The example of our French neighbours in the more general use they make of movable weirs—*barrages*—of various constructions could, I am satisfied, be followed by us with very great advantage in many cases.

Water Power.

The question of water power is one which I think deserves more consideration than it has lately received. It has been the fashion to consider that small water mills are of little or no value, and in the present state of most rivers and streams this is to a very great extent true, but only because the supply of water to work them is so variable and uncertain. Sufficient attention has never yet been given to the subject of the amount of compensation water which should be given for the use of riparian proprietors when the watershed areas are dealt with for purposes of water supply. There is a kind of empirical rule acknowledged by most of the eminent water engineers, that one-third of the average flow of three consecutive dry years is a fair equivalent for the abstraction of the water falling on a gathering ground. I am strongly of opinion that, looking to imperial interests, advantage should be taken of every opportunity of dealing with a gathering ground to provide for a much larger proportion of its available water being sent down the streams, so that the natural water power of the country may be properly developed. The extra cost of the necessary works must, as a matter of course, be borne rateably by the interests benefited. It is certain that with the progress of invention many more ways of utilising this power will be discovered. At present, through the medium of compressed air, of hydraulic pressure, and of electro-motors, the great disadvantage of its being only available at the spot where the water runs is overcome, and the power can be transmitted to any distance, and used wherever it may be most conveniently applied.

I do not wish it to be understood that in suggesting the collection of additional data relating to the phenomena of rivers, I am advocating delay in dealing with the existing state of things until the facts have all been ascertained. On the contrary, I believe that the first step ought to be the establishment of a distinct water department, which should at once address itself to the remedying of the evils which are found to be most pressing.

When it is considered that many lives are annually sacrificed, either directly by the action of floods, or by the indirect but no less fatal influence of imperfect drainage—when it is remembered that a heavy flood, such as that of last year, or that of the summer of 1875, entailed a monetary loss of several millions sterling in the three kingdoms—that during every year a quantity of water flows to waste, representing an available motive power worth certainly not less than some hundreds of thousands of pounds—that there is a constant annual expenditure of enormous amount for removing débris from navigable channels, the accumulation of which could be mainly, if not entirely prevented—that the supply of food to our rapidly growing population, dependent, as it is at present, upon sources outside the country, would be enormously increased by an adequate protection of the fisheries—that the same supply would be further greatly increased by the extra production of the land when increased facilities for drainage are afforded—that, above all, the problem of our national water supply requires for its solution investigations of the widest possible nature, I believe it will be allowed that the question as a whole, of the management of rivers is of sufficient importance to make it worthy of being dealt with by new laws to be framed in its exclusive behalf.

ABSTRACTS OF PAPERS, &c.

Babbage's Analytical Engine.

The report of the committee, after describing the principle of the machine, states that it has not been possible to form any exact conclusion as to the cost. Nevertheless, there are some data in existence which appear to fix a lower limit to the cost. Mr. Babbage, in his published papers, talks of having 1,000 columns of wheels, each containing 50 distinct wheels. This apparently refers to his "store." Besides the many thousand moulded pewter wheels for these, and the axes on which they are mounted, there is the "mill," also consisting of a series of columns of wheels and of a vast machinery of cams, clutches, and cranks for their control and connection, so as to bring them within the directing power of the Jacquard systems of variable cards and operation cards. Without attempting any exact estimate, the committee say that it would surprise them very much if it were found possible to obtain tenders for less than £10,000, while it would cost a considerable sum to put the design into a fit state for obtaining tenders. On the other hand, the cost might reach three or four times the amount above suggested. It is understood that towards the close of his life Mr. Babbage had contemplated carrying out the manufacture of the engine on a smaller scale, confining himself to 25 figures instead of 50, and to 200 columns instead of a thousand or more. This would, of course, reduce the expense of the metal work proportionately, but not materially. The conclusion at which the committee arrived was that they could not advise the British Association to take any steps to procure the construction of Mr. Babbage's analytical engine.

Underground Water.

The report of the Underground Water Committee was read by Mr. De Rance. The value of the maps of the Government Geological Survey as a basis for investigation in questions of water supply was commented on, and the area occupied by permeable formations capable of yielding water in wells sunk in suitable situations was stated to be no less than 26,687 square miles, which, receiving a rainfall averaging 30in. a year, would yield up to wells not less than 240,000 gallons per day for each square mile of surface, or a total quantity far in excess of that required by the population of England and Wales. The great value of these supplies for the towns and districts of the midland counties was insisted on, for their purity, and from the absence of the strong Parliamentary opposition which is encountered in all large gravitation schemes, whether the water be proposed to be taken from natural lakes, as the Thirlmere scheme for Manchester, or from artificial reservoirs, as the proposal to take the sources of the Severn for Liverpool. The well-boring at Bootle, near Liverpool, 26in. diameter, just completed for the Liverpool Corporation by Messrs. Mather and Platt, was described as of great interest, the boring having reached a depth of 1,000ft. without reaching the base of the new red sandstone. The committee express a hope that this boring will be continued, as it will settle several questions not merely of local interest, but of national importance, as to the water-bearing capabilities of the lower beds of the new red sandstone at great depths, the character of the coal-measures which undoubtedly underlie Liverpool, and the depth to them. Among a large number of other wells and borings alluded to was one at Burford, near Oxford, where the coal-measures, with a coal-seam, were found present under the oolitic and triassic strata.

The Pedetic Action of Soap.

Professor W. Stanley Jevons read a paper on this subject, in which he said, Since the publication of my paper on Pedesis, or the so-called Brownian movement of microscopic particles, it has been suggested to me that soap would form a good critical substance for experiment in relation to this phenomenon. Having tried the experiment, I find that with a solution of common soap the pedetic motion becomes considerably more marked than before. I have observed this result not only with china clay and some other silicates, but also with such comparatively inert substances as the red oxide of iron, chalk, and even the heavy powder of barium carbonate. The last-named substance, one of those which we should least expect to dance about of its own accord, gave a beautiful exhibition of the movement when mixed with a solution of about 1 per cent. of soap, and viewed with a magnifying power of 500 or 1,000 diameters. The correctness of this result was also tested by observing the suspending power of solutions of soap-solution compared with water. If a little china clay be diffused through common water the greater part of the clay will soon be seen to collect together in small flocks and fall to the bottom, in two or three hours the water being almost clear. However, if about 1 per cent. of soap be dissolved in the water, the behaviour of the clay is quite different. The larger particles subside, but the smaller ones remain diffused through the liquid for a long time, giving it a milky appearance, quite different from the flocky and grainy appearance of the common water. If one per cent. of sodium carbonate be dissolved in common water, and china clay be mixed therewith, the subsidence of the clay is still more rapid, owing, as I have explained, to the electric increase in the conductivity of the fluid, and the consequence decrease of pedesis. But I now find that if soap be added at the same time, pedesis is not destroyed but considerably increased, and the clay remains a long time in suspension—two or three days at least. These facts give a complete explanation of the detergent power of soap. It has long seemed to me unaccountable that for cleansing purposes the comparatively neutral soap should be better than the alkaline carbonate by itself; we are told that the alkali is but feebly combined with the stearic or other fatty acids. But why combine it at all if we need only the alkaline power of the base? The fact is that the detergent action of soap is due to pedesis, by which minute particles are loosened and diffused through the water so as to be readily carried off. Pure rain or distilled water has a high cleansing power, because it produces pedesis in a high degree. The hardness of impure water arises from the vast decrease of pedesis due to the salts in solution. Hence the inferior cleansing power of such water. If alkaline salts be added, dissolved in water, it becomes capable of acting upon oleaginous matter, but the pedetic power is lessened, not increased. But if soap be added also, we have the advantage both of the alkali dissolving power and of the pedetic cleansing power. At the same time we have a clear explanation why silicate of soda is now largely used in making soap; for I have shown, in the paper referred to, that silicated soda is one of the few universal substances which increase the pedetic and suspensive of water.

Instrument for Determining the Presence of Fire-Damp in Mines.

Prof. G. Forbes read a paper describing an instrument for detecting fire-damp. The instrument consists of a resonator of variable dimensions, and a tuning fork of definite pitch. The resonator is a metal tube 1in. in diameter, and 15in. long, in which a piston slides so as to regulate the length of the tube. This tube is fixed in a block of wood, to which is attached a tuning fork, whose points are just above the open end of the tube. The tuning fork is sounded in any convenient way, and the piston is moved out and in till the proper length is found, which is indicated by the resonator intensifying the sound of the tuning fork. With practice the length can be determined with tolerable accuracy. But the length depends upon the density of the gas, a light gas requiring a longer resonator, and by reading off on a scale the position of the piston a person can judge of its density. In this manner 1 or 2 per cent. of fire-damp, mixed with common air, can be detected. Barometric pressure produces no difference on the instrument. The temperature correction is made by reading off a thermometer of the proper dimensions, instead of reading off a fixed mark on the piston. The only error possible is by the presence of dense carbonic acid gas. But carbonic acid gas tends to destroy the explosive character of fire-damp, and it appears that if the presence of carbonic acid prevented the instrument from indicating fire-damp, it would certainly be sufficient to prevent the explosive character of the fire-damp.

The Chairman (Father S. J. Perry) said that if the authorities in mines would pay attention to the indications of barometers and thermometers, he believed there would be fully 75 or 80 per cent. of the lives saved; but it seemed impossible to get them to do that. The instrument which Professor Forbes had described would be exceedingly useful for persons going through the mines, enabling them to find out what was going on, and therefore to take immediate precautions.

Prof. S. P. Thompson said the liberation of gas took place, not so much when the barometer was low, as when a sudden fall occurred. Long continuance of low pressure did not necessarily produce an explosion. He did not see how Professor Forbes' instrument would help miners very much if they neglected the barometer, for the gas which caused the dangerous explosions would not at once mix with the air; there would be currents, and unless it was known in what particular part of the mine to apply the instrument it would be useless in the hands of people who were so careless with the appliances they already had.

A Clock with a Detached Train.

Prof. G. Forbes said: In the course of some experiments still progressing I have used a clock to give electric signals every second. It has a train of only one wheel working in a pinion. It is driven by a weight which falls through 5 feet in an hour. This clock only goes one hour, but serves the purpose for which it was made. I wished lately, however, to make it go for a longer time, so I drove it by a weight hung by a pulley on an endless chain in the usual way, and I attached a common 5s. Swiss alarm clock to the chain to wind it up continuously. This answers so well that I would suggest a similar construction as not only the cheapest but also the best form of a clock with escapement. It consists of a pendulum and escapement with no train whatever, with an endless chain or thread passing over a pulley on the axles of the 'scape-wheel, and over the minute-wheel of a secondary clock hanging between them in a festoon which supports the weight by a pulley. The secondary clock gives the hours and minutes, and the clock without train shows the seconds. We thus have a clock without the errors introduced by a train. It is a gravity escapement without the locking friction.

Edmonds' Phonoscope.

This little instrument, the phonoscope, is for producing figures of light from vibrations of sound, and was described by Mr. Ladd. It consists essentially of three parts—an induction coil, an interrupter, and a rotary vacuum tube. The action of the instrument is as follows:—Sounds from the voice or other sources produce vibrations on the diaphragm of the interrupter, which, being in the primary circuit of the induction coil, induce at each interruption a current in the secondary coil, similar to the action of a contact-breaker or rheotome; therefore each vibration is made visible as a flash in the vacuum tube. The tube revolving all the time at a constant speed, the flashes produce a symmetrical figure like the spokes of a wheel, as in the Gassiot Star. The number of spokes or radii is according to the number of vibrations in the interrupter during a revolution of the tube, and on the number of vibrations being varied to any extent according to the sounds produced the figures in the revolving tube will be varied accordingly. The same sounds always produce the same figures, providing the revolution is constant. In cases of rhythmical interruption being produced in a given sound, as in a trill, most beautiful effects are noticeable, owing to the omission of certain radii in regular positions in the figure.

Binaural Audition.

Professor Silvanus P. Thompson read a paper on "Binaural Audition," in which he narrated the results of a long series of experiments on hearing with the two ears. The author has discovered that we possess a perception of the interference of sound, as the following experiment shows:—If two tuning forks in unison be put slightly out of tune, so as to show "beats," and their tones be led separately to the two ears with pipes of indiarubber, the beats are still to be heard through the two sets of actual vibrations, and never have the opportunity of uniting. Since the discovery of this phenomenon many persons who had experimented with the telephone, including Prof. Graham Bell and Sir William Thomson, had observed the same thing. Another phenomenon observed first by means of tuning forks and indiarubber tubes, and afterwards by means of telephones and the microphone, was that when two sounds reached the two ears in opposite phases, so that the drum-skin of one ear was moved forwards when that of the other ear was moved backwards, the sound was no longer heard in the ears, but apparently localised at the back of the head. Prof. Thompson's principal experiments during the year had been directed to this singular localisation of the sound. He had carefully investigated the effect of varying the pitch, the intensity, and the quality of the sounds so led to the ears, and had found them to be independent of pitch. With incomplete differences of phase the efforts were of a somewhat mixed character. It was also demonstrated that this discovery afforded a method of analysing compound sounds by bringing them to the two ears by two tubes of unequal length; for when the difference in their lengths amounted to half the length of the wave of any one component, that component was singled out and localised at the back of the head. So, in binaural audition, a difference could be perceived between two compound tones which differed only in the phase, but not in the pitch or the intensity of their components; contradicting the assertions of Helmholtz and Sedley Taylor.

The Antiquity of Man.

Mr. Tiddeman read the sixth report on the exploration of the Victoria Cave, situated about 20 miles north of Leeds. The committee had to make an important announcement—viz., that Prof. Busk had changed his opinion in regard to the Victoria Cave bone, which he had formerly stated to be human. Professor Busk was now of opinion that the bone was ursine, and not human. This bone presents the strongest possible resemblance to a rather abnormal recent human fibula in the College of Surgeons, and was also considered not unlike the fibula in the famous Mentone skeleton. It was therefore considered to be an undeniable proof of the co-existence of man with the extinct mammals in Yorkshire. This was not the only bone found in the Victoria Cave which was supposed to have a bearing on the antiquity of man, and his existence in Britain before the last great cold period had passed away. Many bones were found in the cave cracked and split, as was the custom with savages to split them for the extraction of marrow. It is not easy to explain away the evidently artificial marks upon the other small bones found in the cave.

Prof. Boyd Dawkins wished to enter his emphatic *caveat* against the antiquity of man being grounded on anything yet found in the Victoria Cave. He had studied all its phenomena, and he could not allow the report of the committee to pass without expressing his dissent from the main points contained in it. As to the general question of the antiquity of man it was one which was being still fought out in Europe and America, and in support of the supposed enormous antiquity of man a very great amount of very untrustworthy evidence was being in many cases put forward. The evidence of the antiquity of man was at one time based on the discovery of this fibula which was found while he was in charge of the cave. It was of such an uncertain character that he had not dared to have anything to say to it, but Prof. Busk undertook to say that it was a human fibula. It was on the authority of Prof. Busk that it had been set down in his (Prof. Dawkins') book, "Cave Hunting," as a human fibula. On the contrary, he (Professor Dawkins) disclaimed all responsibity for the human character assigned to the fibula, and from the examination of certain ursine bones in France, in Italy, and in the Museum at Cambridge, he saw at once that this fibula on which the vast antiquity of the human race was supposed to depend was not of a human but of an ursine character. The next point relied on was that of the cuts on bones. These cuts were certainly made by some metallic-edged tools—he could not say whether steel, or bronze, or iron. But the bones on which these cuts were found did not, in his opinion, belong to any extinct animals or rare animals, but might very well belong to an ordinary bit of leg of mutton or of goat. So much for the cuts on the bones. A very important point had been raised by Mr. Tiddeman as to the antiquity of sheep or goats in Europe, and on this matter there was a vast amount of evidence. In the first place, none of the caves in the country which had been scientifically explored (leaving the Victorian Cave out of consideration) had presented a single example of the presence of the remains of sheep or goats in association with the remains of extinct animals. The same thing might be said of the caves of France, of Switzerland, and of Italy, and in no caves of Germany was there, as far as he knew, the slightest evidence to associate sheep or goats with any of the extinct animals. The general drift of all the evidence was to show that sheep and goats were not living at the same time with the now extinct animals. Supposing that man was living in association with the extinct animals, what was the age of the extinct animals? On that point doctors differed. Whether or not they belonged to the post-glacial period was an open question, and so even if it was assumed that man was living at the period sf the extinct animals, there was no evidence that dated back to the pre-glacial or inter-glacial periods. Small scraps of bone, as big as one's finger, with alleged artificial cuttings, which could otherwise be explained, did not constitute sufficient evidence on which they would be justified in stretching back the antiquity of man to far distant unknown eras.

Capacity of Crania.

Prof. W. H. Flower read a paper on the above subject. Of all the measurements by which to determine the difference between the human skulls of people of one race and of a foreign race, perhaps the most important was that which gave the cubic capacity of the great cavity of the skull which contained the brain. Many ways of ascertaining it had been tried. Some persons laid great stress on the weight of the brain, but for his part he thought that on the whole if the capacity of the skull could be got it would be more valuable. The weight of the brain differed very much according to the age or physical conditions of the person when he died, and there were certain diseases which went to increase the specific gravity. But when the actual capacity of skull was found they had the actual capacity of the brain at the time of health. The weight of the brain could not be ascertained in cases where the races had become extinct, such as the Tasmanians, many of the Polynesians, the ancient Britons, and the ancient Irish, and others, specimens of whose skulls they possessed, and by which they could ascertain the capacity of the brain. He might be asked if he attributed any great and direct importance to the weight and age of the brain as an indication of intelligence. Well, he thought it was one of the very many points that had to be considered in this question; but he thought there were a great many other things to be remembered in this view of the question. For instance, many people had large brains and did not know how to use them, and some who knew how to use them did not try to do it. They would see that many of the races that were naturally considered the higher races, and had taken the lead in the civilisation of the world, had undoubtedly larger cranial capacities than the peoples who were at the bottom of the ladder of civilisation. Of course he would never accept the mere fact of a man's head being large as an indication of superior intelligence, but it was one point to be considered. The measurement of the skull was not only an important but it was also a difficult work—more difficult in fact than a great many people supposed. A large number of measurements published were only of an approximate value owing to the numerous fallacies and difficulties experienced in arriving at a satisfactory method of measurement. Nothing apparently could be easier than to take a skull and stop the cavities, and pour some fluid into it, and then pour it out and measure it; but they could not do this with the skull, as the bone was very porous, and full of minute invisible holes, through which the fluid soaked as it would through a sponge. The materials that had to be used in testing the capacity of the skull must be something solid. Various things, such as shot, grain, &c., had been used. One good method was that of Mr. Busk. He filled the skull with mustard seed well shaken, and pressed into it with the thumb, and then poured into a long wooden box with glass sides in it, in which it was well shaken and pressed down. The figures on the glass indicated the spaces filled. This he thought was the most satisfactory way as yet invented, and they could hardly hope for better. To get the average of any race they must get a large number of skulls, and he must say their collection was very insufficient at present. According to a comparison between the skulls of 63 men of various races and skulls of 24 women, the size of the woman's skull to the man's was as 854 to 1,000. The largest normal skull he had ever measured was as much as 2,075 cubic centimetres. The smallest head he had measured was 960 cubic centimetres, and that belonged to one of those peculiar people in the centre of Ceylon who were now nearly extinct. The largest average capacity of any human head he had measured was that of a race of long flat-headed people on the west coast of Africa. The Laplanders and Esquimaux, who were a very small people, had very large skulls. The latter gave an average measurement of 1,546. He then came to the English skull, which was nearly the same size—1,542; but they belonged to the lower grades of English skulls. The inhabitants of the Canary Islands give a capacity of 1,498; the Japanese, 1,486; the Chinese, 1,424; the modern Italian, 1,475; the ancient Egyptian, 1,464; the true Polynesians, 1,454; negroes of various kinds, 1,377; the Kaffirs, 1,348; Hindoos, 1,306. They then came to the Australian aborigines, who were amongst the smallest, only giving an average of 1,283. They have two races still below the Australians—namely, the Andamanese, who were a very diminutive people, with a capacity of 1,220; and the Veddahs, of Ceylon, who had an average skull.

Left-Handedness.

Dr. H. Muirhead read a paper "On Left-Handedness." He had been drawn to pay some attention to left-handedness in reference to its hereditariness in families. The human family were in general right-handed. No instance had been brought forward of a left-handed tribe or race. The oldest pictorial illustrations that they knew of did not differ in this respect from the story of to-day. Why was man right-handed? It had been said that man was best able to balance himself on his right leg and foot, and if that were so he would naturally be better able to use his right arm in offence or defence. If this were so it would account for the left-hand side of the brain becoming more influential. There were, of course, some exceptions to the rule of right-handedness. A theory had been put forward to the effect that the choice of hands depends upon the relatively preponderating weight of upper or lower part of the body, but he thought it depended on which half of the brain took the lead. Left-handedness once begun in a family was likely to run in it. It was very common in the tribe of Benjamin. It was a curious fact that left-handed people had the left foot ⅛th to ⅓rd of an inch longer than the right.

An Equatorial Mounting for a Three-foot Reflector.

Lord Rosse gave a short explanation of the peculiarities of an equatorial mounting recently erected at Parsonstown, showing the points in which it differed from the ordinary type of mounting. The optical arrangements were exactly the same as in ordinary cases. The old mounting at Parsonstown, being made of wood, fell into decay, and he resolved to replace it by metal, and mount the instrument equatorially. The leading peculiarities of the mounting were, that the points of reversal were situated at the east and west, instead of at the north and south. The bearings on which the instrument turned in right ascension were smaller than in the ordinary mountings. The motions in declination and in right ascension were effected by means of screws, so that on a windy night the instrument could not run away with the observer. The tube was square. The clock was connected by means of a stretched strap of brass, and the gallery was quite unique. The counterpoise was less than usual. The only reflector of a similar size mounted equatorially was that constructed by Mr. Grubb, for the Melbourne Government, but its drawback was that, just as the observer had moved it to the very best position for observation—namely, the south—it had to be reversed and every connection altered. The gallery was also worked by means of screws, so that there was no danger of the observer coming down quicker than he wished. The tube was square in section. The cage was independent of the mounting, moving on a circular rail, and with a second motion like that of a derrick crane. The mounting was only suitable for a reflecting telescope. It was designed in a great measure by Mr. Bindon Stoney.—Mr. Bindon Stoney said: The weight of the speculum, with the tube and the box, in this case was little short of two tons, and the object to be sought was to move this large mass so that it should be free from vibration. This had been very successfully accomplished. The tube had been made square, because it was rather stiffer than a circular tube with the same amount of material, and the manufacture was simpler.—Lord Rosse, in reply to a question, said the fork was made of wrought iron. There were no friction rollers He had never observed the least vibration in the strongest wind.

On Simplification of Graphic Formulœ.

Dr. Oliver J. Lodge. D.Sc., read an interesting paper on this subject. In a graphic formula of a compound the elements were ordinarily represented by its chemical symbol (a capital letter), and the connection between the atoms was represented by straight lines joining the letters. Graphic formulæ were of most use in organic chemistry, where the principal compounds consisted only of the elements C, H, O, N, whose atomicities were 4, 1, 2, and 3 or 5 respectively. In any formulæ, therefore, four bonds always radiated from the letter C; N was the meeting place of three or five bonds, according to circumstances; two bonds met at each O, and a single bond terminated at every H. Supposing that the letters were omitted, and the bonds joined up together, the position of the atoms would still be apparent as the meeting-place of a definite number of bonds, and therefore the letters were unnecessary. The simplification he proposed was the omission of the symbols used to denote the atoms, and the joining of the bonds in such a way as clearly to define the atomicities, and therefore the natures of the several atoms. Formulæ so drawn became reduced to a sort of geometrical diagram, and conversely any geometrical curve represented some real or imaginary chemical compound.

On the Detection by Means of the Microphone of Sounds Accompanying the Diffusion of Gases Through a Thin Septum.

Mr. W. Chandler-Roberts, F.R.S., read a paper in which he stated that the passage of gas by diffusion was undoubtedly due to molecular motion, and he pointed to the great importance of the study of any fact which appeared to bear on molecular movement. Without committing himself to the view that sounds rendered evident by the microphone when hydrogen was diffused through a septum were wholly due to molecular movement, he stated the several points which appeared to favour the view.—Prof. Emerson Reynolds stated that, as a matter of fact, when Mr. Roberts was good enough to allow him to make observations on the previous day, he heard a distinct rushing of sound while the apparatus was covered with hydrogen. On the removal of the jar of hydrogen he heard the distinct rush again. That might of course, be due to the inrush of air; but, while agreeing that the subject was of very great interest, and being in a position to assert that a sound was produced, he would be very sorry to offer any opinion as to the possible cause.—Mr. Braham asked whether the sound was heard after covering the apparatus with hydrogen, or whether the sound was only heard at the moment of covering and removing the hydrogen?—Mr. T. Wills suggested that, as the whole apparatus, microphone included, was, during the experiment, surrounded with the jar of hydrogen gas, the diffusion might be taking place in the material of the microphone itself. The microphone is made of gas coke, and the pores of this coke are, no doubt, full of air. On being introduced into an atmosphere of hydrogen an interchange of air from hydrogen will take place, and it is possible that it is this action which is heard in the telephone.— Mr. Roberts, in replying, said that, with regard to the question raised by Mr. Braham, he should mention that the sound was continuous after a certain time, but it ceased in this case in five seconds, when the balance was established between the gas and air. He considered Mr. Wills' suggestion a valuable one.

Historical National Names.

Mr. A. L. Lewis read a paper on the "Evils arising from the Use of Historical National Names and Scientific Terms." The propositions endeavoured to be established were:—(1) That there were at the first population of Europe certain primitive races, of which three are particularly described; (2) that these races are so mixed at the present day that representatives of them appear not only in most European nations, but in the same families, and among children of the same parents; (3) that notwithstanding this mixture and the effects which it must permanently have, racial character displays an astonishing permanence; (4) that this mixture, being so slow in its effects, and yet, having become so general, has probably been at work, and for a very great length of time—so great that the peoples to whom the earliest history of Europe introduces us, were probably nearly as much mixed as those of the present day; (5) that it is desirable to discontinue the use of the political names of those people as ethnic names, and to employ others based on the physical characteristics of the individuals; (6) that while physical characteristics are the only basis for a true division into races, yet in any practical application of this division, we must consider the influence upon individuals of different races of a community of language, whose history or tradition must not be lost sight of, although these things do not prove community of race, but only the contact at some time or other of the races to whom they are now common.

Prof. Huxley said the subject of the paper was one of importance, not merely on ethnological or scientific grounds, but because it was unfortunately the source of a great many practical fallacies, which have had, and in fact have still a very large political influence. He doubted very much whether there was any deliberate system of misnomer which was working more mischief in this world than the preposterous talk about the national qualities of the Celt and the Saxon. He believed that if there was a proposition in ethnology which was capable of historical proof it was that, so far as physical characteristics were concerned, the ancient Gauls—as was the opinion of the Roman and Greek historians—were persons of precisely the same physical peculiarities as the ancient Teutons known to the same historians. So far as physical characteristics went, he did not believe that there was a shred of evidence to show that the persons who spoke Celtic dialects at the time they made their appearance in Western Europe were in any physical respect different from those who spoke the older Teutonic dialect, and not only that there was no difference, but there was a most extraordinary resemblance, inasmuch as those stock, when they came into contact with the civilised world were described in the same terms—as sturdy, fair-haired people with fair skins, and what I think without any exaggeration may be described as a remarkable shortness of temper. He could not—no person who was a professional zoologist could—fail to entertain the most exalted ideas of influence of race, and he had no doubt there was great influence, but what he did very much doubt was whether they had the smallest means of knowing what was the amount of influence exerted on the people of this country by the different ethnological elements which compose it. Let any one who listened to the talk about natural characteristics, and what was said about particular institutions being impossible for some of the people of these islands and possible for others—let him carry his mind back for the last twenty years and think what was at that time said about the German people. We did not hear anything of the Teutonic dreamers since the battle of Sedan. He did not believe, taking any one section of the British empire—whether Scotch or English or Irish—that race has any appreciable influence upon their social and political condition in the present day—that was to say, his impression was that if the south-eastern parts of the British empire, the county of Kent, for instance, had been subject to just the same sort of conditions for 400 or 500 years, as, he would say, Connemara and Galway, he should expect the results to be as nearly as possible the same; and it was a curious fact of ethnological study that those parts of Ireland which are supposed to exhibit in the most marked manner these characteristics, sometimes complimentary and sometimes uncomplimentary, were those in which it could be proved to demonstration that the Norman and English elements were most predominant.

The Microphone.

Mr. W. J. Millar, C.E., read a paper detailing some experiments on the microphone, and ventured to make the tolerably obvious announcement that the experiment opened out a very interesting field of inquiry. He has found that sounds can be obtained without a magnet, the receiver being simply a piece of tin around which a few yards of covered copper wire is wound; the various microphone phenomena can be exhibited with this simple receiver; the sounds, however, are very much reduced in loudness. In giving an account of Prof. Hughes's experiments we mentioned that the difficulty appeared to be to point out what substances and in what manner the effect could not be produced, as long as any likely method of operating was adopted. Prof. Bell's telephone is the best yet devised, but it is known that even that is capable of being considerably modified, even to the extent of dispensing with the magnet altogether. The sounds, however, are not then so loud.

Platinum Pictures.

Mr. W. Willis, jun., read a paper on "A New Process of Photo-Chemical Printing in Metallic Platinum." It is a fact well known to chemists that metallic platinum in all its states, massive and molecular, is totally unchanged or unaltered by atmospheric influences. It is also well known that platinum in a finely-divided state has an intensely black colour. Now, if a picture be produced on paper or other suitable substance, in which the dark portions and shades are formed by this black finely-divided metal, it is evident, so far as this metallic pigment itself is concerned, that the picture is perfectly permanent and unalterable. The object of this process is to produce pictures in which this result is obtained. The chemical reaction upon which the platinotype process is based is one discovered by the writer some years ago. He found that a hot solution of ferrous oxalate in potassic oxalate instantly reduced platinum to the metallic state from its chlorides and other salts. The remarkably simple form the process now takes may be briefly indicated as follows:—Paper is coated with a mixture of aqueous solutions of ferric oxalate and potassic chloro-platinite, then dried, and exposed to light under a negative. After it has had a sufficient exposure it is floated on a hot aqueous solution containing potassic oxalate and a salt of platinum. This solution instantly develops the picture, which is then washed in one or two solutions to remove the chemical salts adhering to the paper. When dried the print is finished. This printing process derives considerable interest from the fact that it is the first in which platinum in the metallic state has been made use of as a pigment, and that it is the first photo-chemical process giving permanent results of any practical value, in which the particles of pigment forming the picture are imbedded in and entangled amongst the fibres of the paper on which they are printed, and do not depend for their adhesion on the *use of any sizing material.*

SCIENTIFIC NEWS.

THE new comet discovered by Mr. Lewis Swift, of Rochester, New York, has not been seen in Europe, and further information from America explains the reason. First, there was an error in the telegraphic announcement, the time of the discovery being incorrectly given; and, secondly, the motion in declination, which was extremely rapid, was reported as slow. On the morning of July 8 the comet had a large northern declination, but it soon went so far south of the equator that it was below the horizon of any part of Europe. Observations of the comet, a small and faint body, were made by Prof. Peters, at Clinton, commencing soon after its discovery.

Amongst the visits paid by the members of the British Association whilst in Dublin, perhaps the most interesting to a certain section of the members was the inspection of the works of Mr. Grubb. That distinguished optician, it will be remembered, constructed the great Melbourne reflector, and many specimens of his handiwork are scattered about the British Isles. His fame obtained for him the important task of constructing the largest refractor that has ever been attempted, and the fitting up of the new observatory at Vienna with the requisite domes and machinery. The telescope will have a clear aperture of 27in., and will be placed inside a steel dome 45ft. in diameter, and weighing about 13 tons. So nicely balanced are all the movements that this immense roof can be moved round easily, and adjusted to a nicety by one hand. It is worthy of note that Mr. Grubb's factory is a purely national one, all the work turned out there being accomplished by Irishmen.

The total attendance at the meeting of the British Association was 2,577, and the receipts amounted to £2,605.

We have frequently had occasion to praise the wise expenditure sanctioned by the American State Government for geological surveys and other important scientific work, which is duly recorded and published at cost price. The manner in which the reports of our geological surveyors are issued in this country drew forth some severe comments at the British Association. If it is worth while printing the memoirs at all, they should be sold at a low price, and placed at the disposal of the public. Mr. Tiddeman, as a member of the survey, said it was disagreeable to the surveyors to think that their labour was almost entirely thrown away on account of the high prices put upon the publications, which moreover were issued in a style that would disgrace a fifth-rate publishing firm.

Mr. Darwin has been elected an hon. member of the Bavarian Royal Academy of Sciences.

The most successful experiments made with balloons for the purposes of warfare are those which Capt. Templar has been carrying on at Woolwich. The failure of many other inventors had induced the authorities to look with misgiving on all schemes of the kind, but a very fair measure of success has attended the latest trials. According to the *Times*, Capt. Templar uses a "new description of gas," but the fact is, he employs hydrogen made by passing steam through a red hot tube containing fragments of iron. Two balloons are employed, one capable of containing 25,000 cubic feet, and the other a small one of only 10,000 cubic feet capacity—the smallest that has ever been used to float a man for any time with coal gas. In his larger balloon Capt. Templar, who has studied the effects of the wind, has already succeeded several times in descending very near the desired spot; but at present the experiments are confined to testing the behaviour of hydrogen and the impermeability of the envelope, as well as the feasibility of working small captive balloons in camp.

At a meeting of Sheffield manufacturers, held last week, twenty workmen were selected to go to Paris as artisan reporters.

The Giffard captive balloon in Paris is an immense success. It has made as many as seventeen ascents in one day, and in fifteen days the sum of £6,000 was received for admission to the inclosure and for tickets to ascend. One franc is charged for permission to witness the operations, and 20 francs for an ascent.

An Act received the Royal assent on the last day of the session which will enable the trustees of the British Museum to remove portions of their collections. The collections in zoology, geology, and palæontology, mineralogy and botany, or portions of them, may be moved to the Natural History Museum at South Kensington. Do the trustees mean to hand over those marvellous specimens of the art of stuffing which are the wonder and delight of the children on Bank Holidays?

Col. Yolland has made a report to the Board of Trade in which he points out that a fatal accident would probably have been prevented if the continuous footboards had been extended beyond the buffer castings, so as to leave a no larger opening than 2ft. Fifty persons are annually killed by falling between the platform and the train.

At the meeting of the London and North-Western Railway Company last week the chairman stated that during the half-year there had not been a single fatal accident amongst passengers.

The report of Mr. Farrer, of the Standards Department, mentions the Birmingham Wire-gauge as an arbitrary measure, the accuracy of which there is no means of securing. The Standards Department cannot recommend that such a measure should be legalised as an Imperial secondary standard. The uncertainty attaching to the designation of a plate or a wire with a No. and B.W.G. is well known, and we believe if the manufacturers would appoint a committee to determine the dimensions of any gauge, the Standards Department would assist them to make it legal.

The Summerlee, an iron screw collier, had her main deck blown off by an explosion of gases while passing down Channel last week. The master was killed.

Prof. Mendelejeff is coming to Western Europe for a twelvemonth to study aëronautics—a subject on which he is preparing a large work.

The employment of wood in the manufacture of paper is not conducive to the longevity of that substance. Prof. Reuleaux, called attention to the subject in a lecture delivered at Leipsic, pointing out that, as the paper used in the German public offices is mainly composed of wood, we may expect the destruction, from natural causes, of many important official records. He limits their duration to about 15 years.

For the Liebig memorial at Munich 120,000 marks have been subscribed, sufficient for a bronze statue and for a handsome pedestal.

We are requested to state that Sir Joseph Whitworth, having expressed a desire that some important alterations should be made in the conditions of his scholarships, the detailed rules for carrying out his wishes are now under consideration. They will be published as soon as possible, but in order to prevent disappointment this notice is given. No important changes will be made in the conditions of the competitive examination in May, 1879. But the conditions of the tenure and of the amount of the scholarships may be somewhat modified.

Mr. Herbert Spencer, who was in rather feeble health for some time, has now considerably recovered, and is arranging materials for an autobiography.

The Committee on Heavy Siege Guns are preparing a report in which they have come to the conclusion that no more heavy muzzle-loading guns should be constructed. The ground they take is that an enemy firing shrapnel shells at a detachment working a land battery would effectually prevent guns of this class being loaded.

Magnetic Iron.—Donati Tomasi passes a vapour current, under a pressure of five or six atmospheres, through a copper tube of two or three millimetres diameter. The tube is rolled spirally around a small iron cylinder, which becomes so strongly magnetic that a steel needle placed at some centimetres distance is powerfully attracted. The magnetism continues as long as the vapour current is maintained.

LETTERS TO THE EDITOR

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[We do not hold ourselves responsible for the opinions of our correspondents. The Editor respectfully requests that all communications should be drawn up as briefly as possible.]

All communications should be addressed to the Editor of the English Mechanic, 31, *Tavistock-street, Covent-garden, W.C.*

All Cheques and Post-office Orders to be made Payable to J. Passmore Edwards.

⁂ *In order to facilitate reference, Correspondents, when speaking of any Letter previously inserted, will oblige by mentioning the number of the Letter, as well as the page on which it appears.*

"I would have everyone write what he knows, and as much as he knows, but no more; and that not in this only, but in all other subjects: For such a person may have some particular knowledge and experience of the nature of such a person or such a fountain, that as to other things, knows no more than what everybody does, and yet, to keep a clutter with this little pittance of his, will undertake to write the whole body of physicks: a vice from whence great inconveniences derive their original." —*Montaigne's Essays.*

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TIME AT THE ANTIPODES—"DON'T REFER ME TO BACK NUMBERS"—THE COMMON HOUSE FLY—THE SOCIETY'S THREAD—THE BRITISH ASSOCIATION AND THE ENDOWMENT OF RESEARCH—ASCENDING LIGHTNING — OBJECT-GLASS OF TELESCOPE — APPARENT DIVERGENCE OF THE SUN'S RAYS—PANCRATIC EYEPIECE-SPIDER LINES—PHOTOGRAPHIC.

[14757.]—"W. W. H." (query 33761, p. 586) will find the question which he there raises discussed round and round, and in fact utterly thrashed out in Vols. V., XIII., XXIII., and XXIV. of the English Mechanic.

And replying thus suggests to me to add how heartily I endorse, and how thoroughly I agree with, the remarks made under the head of "Don't refer me to back numbers," in your "Answers to Correspondents," on p. 588. That the same questions should be asked over and over again seems to me to be unfair to everybody. The task of answering them would appear to have devolved, to a considerable extent, upon a relatively small number of your readers; and I think that they have a right to protest against being called upon, time upon time, to repeat what they have written (very often quite recently) before. Speaking as one of them, I think I may say, without much egotism, that I seldom spare myself trouble in replying to any legitimate question put for the first time, and having reference to a subject with which I am familiar. This being so though, I neither can nor will waste my time in the repetition of the ipsissima verba of answers to which any one can find immediate reference by the expenditure of three pence; and I cannot doubt that the greater part of my brother correspondents feel in this matter as I do myself.

"Musca Domestica" (query 33796, p. 587) may read with advantage "The Earthworm and the Common House fly," by Samuelson and Hicks; Van Voorst, London, 1858. He will find in it most explicit details with reference to all those points on which he is desirous of obtaining information, given in a popular and intelligible form, and well illustrated.

I shall trust to Mr. Lancaster to reply to query 33804 (p. 587), as I am unable to answer it off-hand, and his technical knowledge is necessarily very superior to my own in connection with such subjects as that to which "Orderic Vital's" question refers. Having said which though, I would further add that I personally object to telescope eyepieces which screw altogether, and infinitely prefer those which slide in a piece of tubing. To be fumbling about on a dark winter's night, trying to make the screw of an eyepiece "bite," in attempting to attach it to the instrument, involves a very needless waste both of time and temper. All my own eyepieces are fitted into tubes, and I can change the whole battery one after another in a comparatively few seconds. The advantage of this in the observation of any evanescent phenomenon is enormous.

Since reading your excellent résumé of the more purely scientific portion of the address of the President of the British Association (p. 569 et seq.) I have received a copy of the address itself in extenso, and am struck with the contrast presented between the utterances of Dr. Andrews in 1876 on the subject of the Endowment of Scientific Research, and those of Mr. Spottiswoode this year in Dublin. "On the general question," he says, "it is not difficult to offer strong arguments in favour of permanent National Scientific Institutions; nor is it difficult to picture to the mind an ideal future when Science and Art shall walk hand in hand together, led by a willing Minister into the green pastures of the Endowment of Research." There is, I must confess, something of the mendicant and cadging whine of the South Kensington and Royal Society Ring in this portion of the address, which is pre-eminently distasteful. And by the bye, in connection with endowment, Mr. Spottiswoode enlarges on the benefits which have resulted to Science from the grants of various sums made by the British Association in furtherance of different investigations. I cannot, however, find that Sunspottery is one of the subjects which the B. A. has subsidised. It is the British Taxpayer and not the Association, for example, who is paying for the Sapper sent out to India to take Solar Photographs for the use and glorification of a person at home. Does not this tell a little tale? "A," said Sydney Smith, in his exemplification of English Charity, "never sees B in distress but he straightway feels that C ought to relieve him." Innumerable and inconceivable benefits to Science and to the Nation generally (we are told) must result from protracted gaping at the Fraunhofer lines; but, somehow such benefits are too remote to justify the British Associaton in making a grant in furtherance of their realisation; so that pattern Milch Cow, the Consolidated Fund, is to be pulled at to support one or more of the most impudent and pushing of the Endowment ring in dignified (?) idleness. Verily a "Minister" who is to be taken in by such transparent humbug as this must surpass indefinitely in "greenness" the "pastures" into which he is to lead Science and Art!

I am so far convinced by the arguments employed by "J. T. M.," in letter 14738 (p. 601), as to be willing to concede that my vivid impression of seeing a flash of lightning strike upwards *may* have had its origin in an optical illusion. I cannot, however, on that account subscribe to his idea that lightning never does strike from the earth to the superincumbent clouds, because I think it exceedingly probable—in fact almost certain—that it must not unfrequently do so, whether we can see it or not.

And, in connection with the letter to which I am referring, and in expressing my appreciation of its concluding paragraph, I may perhaps be permitted to say that I must be very oddly constituted if I did not derive pleasure in contributing my own mite of information to columns from which I have derived so very much myself. I always look forward to Friday as the one day of the week on which I am certain of learning something.

I think that "Wallaby" (query 33861, p. 611) is certainly wrong about the object-glass of his telescope consisting "of two double convex lenses lying loosely on each other." Is he quite sure that one is not concave on (at least) one of its surfaces? The double convex lens will be found to fit—or very nearly fit—into the concavity of the second one; and alternate faces of it should be tried to ascertain which approximates most closely in curvature to such concavity. In placing the compound lens thus formed in its cell the double convex component must be the anterior one (*i.e.*, that next the object viewed). It is, though, difficult or impossible to say what is the matter with "Wallaby's" instrument without seeing it.

Whatever difficulty "L" (query 33863, p. 612) may have in conceiving that the apparent divergence of the Sun's rays is an effect of perspective, the fact remains that it is so; just as much in fact as the apparent approximation of the trees at the end of a long avenue, or of the rails on a railway, which extends to any considerable distance in a straight line.

Would it be too much trouble for "Light" (query 33873, p. 612) to turn to letter 14651 (p. 521) for an answer to his question?

In answer to query 33875 (p. 612) they are really spider lines which are employed in micrometers and transit eyepieces. I have myself got them from spiders which inhabit out-buildings, my mode of proceeding being simply to get my spider to run along a rectangular wire frame. This I shook sharply, when the spider would at once lower himself by a thread, and by winding him up I got this thread evenly stretched across my frame. I am not sufficiently well acquainted with the arachnidæ to definitely name either of the species of spiders which have furnished me with lines; but almost any web-making one—not too small—appears to do very well.

I have myself surmounted the difficulty which besets 'Hastreu" (query 33879, p. 612) by roughening the edges of my plates on a grindstone.

A Fellow of the Royal Astronomical Society.

THE LAWS AND PRINCIPLES OF ACOUSTICS IN REFERENCE TO THE TELEPHONE, &c.—LIGHT, HEAT, AND SOUND.

[14758.]—In following up the subject of my letter of 24th ult. (14659, p. 524), I find it necessary at the outset to correct and clear away some speculative errors of modern theory which would otherwise be very misleading; and, if any of your correspondents have a prejudice in favour of these errors, I hope they will candidly prepare to part with them at once, and bear in mind that the links of physical truth are so closely and consecutively connected that it is impossible to gain any substantial advantage to science by the *per saltum* mode of procedure on which such theories have been propounded.

The "fact" has of late years been announced, and has begun to be accepted, "that light is nothing more than an excessively fine kind of sound, the effects of which are perceived by the eye instead of the ear." Nothing, however, can be more absolutely inaccurate than such a proposition, and it is only necessary to refer to the well-known fact, mentioned in my previous communication, that light will pass through the vacuum of an air pump, without obstruction, while sound will not, to eliminate this error from the record of scientific axiomata. At the same time it must be observed that there is this remarkable connecting and analogous feature of light and sound, that the appreciable tones of music and the appreciable tints of the spectrum are the same in point of number, and admit of the same arrangement in octaves. This singular scientific coincidence—for I fear I must deny it to be anything more—is, strangely enough, rather strengthened than weakened by the further correction of a very old error of theory, which has become almost established by long scientific usor—*i.e.*, the theory that the colours of the spectrum are an analysis of light. To dispel this error by demonstrating that the colours of the spectrum are not elementary components of white light, but only different degrees of intensity in the manifestation of light, rather increases than diminishes the analogy between light and sound; for it has long been thoroughly known that the tones of music are only different degrees of intensity in the manifestation of sound.

In 1870 I announced, as I had for more than twenty years previously suspected, that colours were only different degrees of intensity in the manifestation of light—a suspicion strengthened and proved to my own mind by a wider series of scientific phenomena than it is now necessary to refer to, but suppressed till then from want of a demonstration equally convincing to others. The fact, however, admits of instant verification to all your correspondents by means of a very simple experiment, which, unfortunately, Sir Isaac Newton never knew. Had he used a slit as Wollaston was the first to do, instead of a round hole in his dark shutter, for his experiments with the spectrum, and passed his prism along from one end to the other of the slit—a demonstration which is within easy reach of any of your readers—he would have found that every portion of the slit of light became blue, yellow, red, &c., according to the part of the prism through which it passed, and never would have been led into the error of supposing that there were absolute and unchangeable blue, yellow, and red rays, forming different component parts of white light, or that the spectrum itself was an analysis of light. Indeed, Newton himself never appears to have been completely satisfied with his own theory, for he was never able to confirm it by synthesis, as he found that no recombination of the colours of the spectrum would reproduce the white light. But the reason of this is obvious—yellow is a weaker light than white light, and you cannot raise yellow to a higher intensity by adding to it still weaker lights than itself, which red and blue undoubtedly are. The weaker lights can only dilute it further, though they may have the effect of neutralising distinctive tinting.

We have thus, then, the fact that light and sound are in a remarkable degree analogous—the appreciable tints of colour and the appreciable tones of music being the same in number, and admitting of the same arrangement in pitch, or in octaves, for the artist speaks as correctly and intelligibly of high and low tone as the musician, the analogy being further confirmed by the reciprocating and double demonstration, that optical colour and musical pitch, and variations of tone in either, are only different degrees of intensity in the manifestation of both. We are further quite prepared to find, when microphonic acoustics have been sufficiently perfected, that colours are accompanied by sound, and difference of colour by difference of sound where the manifestation of colour takes place in vibratory media; for there can be no doubt now that light as well as sound proceeds by vibration in such media. But here this singularly close analogy between light and sound absolutely terminates, and their alleged identity utterly fails. Sound is only an impact of vibration, and is limited in its action to vibratory media in continuous connection. Light proceeds by vibration in vibratory media, but it is not a mere impact of vibration, and is not limited in its action to vibratory media, whether in continuous connection or otherwise. What then, distinctively, is light?

As accurate discovery in the direction pointed to by this question is of the deepest scientific interest and importance. Let us proceed, in pursuing it, with the most critical care; and, in the first place, let us state still more minutely the distinction between light and sound. Sound, then, is a mere vibratory action of vibratory media. But light is not an action of vibratory media, though it acts by vibration upon and within such media. Sound causes only mechanical action in vibratory media, but light (and heat) will cause chemical as well as mechanical action in such media—a fact which very widely increases the distinction between light and sound. Is, then, light anything more than an action? Is it an element? Science has long hesitated over the question as to whether light, heat, and electricity be not one and the same—strongly inclined to the affirmative, yet hesitating with a commendable prudence, not always so well displayed in even more important directions, and strongly averse to carrying the conclusion *per saltum*. That light and heat are most intimately connected with electricity is beyond all doubt; for the action of electricity can produce both light and heat, and reciprocally light and heat can both produce the action of electricity. They are, therefore, all three unquestionably connected in this respect, and capable of stimulating and acting on each other. But let us see whether we cannot establish some remarkable distinctions between them. If light and heat be elementary they have this peculiarity, that they are elements which are never in a state of quiescence. They are never found or known to science but in a state of action, and their action, whether in vibratory media, in vacuo, or in free space, is uniformly an action of radiation. They are, neither of them, ever found in a state of equilibrium. But science has long been accustomed, and with strictly scientific accuracy, to speak of electricity as in quiescence, non-excitement, equilibrio, and inaction, as well as to talk, with equal and distinctive accuracy, of electric excitement and electrical action, and also of actions of electricity which are not actions of radiation—as actions of circulation, transmission, induction, &c., direct and indirect. It is thus manifest that the conditions and characteristics of electricity are much more varied and numerous than those of light and heat. Hence there is no possibility of demonstrating that light, heat, and electricity are identical. But may not the greater include the less? To this end let us inquire whether light and heat be elements, or anything more than mere actions. Now it is contrary to all scientific experience and analogy to conceive of any elementary matter in continual action, as light and heat always are. It is contrary to all known physical facts and laws that any element, in continual or temporary action, can pass through other elements, or elementary media, without disturbing the condition and quiescence of those other elements more than light and heat do by their radiation. And it is still more contrary to all known fact and law that the same element should be capable of passing through itself at all angles, crossing and re-crossing each other, and reflecting, as light and heat do, without interrupting and impeding itself. No known gas or liquid, elementary or compound, will do so. But light and heat will do all this, and their only known analogue in the whole range of physics is sound (vibration) which, as we already know, is not an element but only an action. A strong presumption is thus established that light and heat are not elements, but only actions of some kind, and this is further supported by the fact that light and heat have other peculiarities analogous to sound which are characteristic of mere actions. Thus sound, light, and heat all act by radiation in the first instance, and are all capable of being converged and transmitted in special directions as well as radiated—with this distinction still maintained, that light and heat may be so converged and transmitted in vacuo, and without vibration, as well as in vibratory media. But that light and heat are nothing more than mere actions is further proved by the fact that no elementary matter can be expanded and diffused from any given centre of development without disturbing all other elementary matter immediately around and in contact with that centre. Thus explosive powders, deflagrated metals, evolved gases, &c., will all disturb and displace the media by which they are surrounded, by their radial action.

Thus we are shut up to the conclusion that light and heat are non-elementary, and merely special actions. At the same time they have this characteristic, that they are, as astronomy has established, actions of something not dependent on vibration or vibratory media, and are capable of traversing all space, crossing, re-crossing, and reflecting in all directions, without friction or self-interruption. And as they are actions of something which must be co-extensively diffused, what can that something be but the all-pervading fluid—electricity—with which, as already shown, they are so intimately connected, that all three are capable of stimulating and acting upon each other even in vacuo where nothing else is known to exist.

Let us now consider the distinctive characteristics of light and heat, and see whether we cannot still farther strengthen some of the previous conclusions. In addition to the immediate distinction that heat is not, any more than sound, an optical perception, and that light is not, like heat, perceptible to the sense of touch, there is this further peculiarity that light is more powerfully and rapidly dispersive than heat. This is well exemplified by reverting to the phenomena of the spectrum, which, as already shown, is not an analysis of light, but only different degrees of intensity in its manifestation. Here, it will be observed that the red or heating rays are the ***least dispersed***, and that when passed through the other parts of the prism, through which the yellow and blue refractions take place, they cease to be heating rays in consequence of the increased and more rapid dispersion they thus obtain. Heat is thus shown to be a subordinate action of light, and it is found also in opaque media, where its dispersion is still further interrupted, to be more latent as light and more manifest as heat. Light is consequently a more rapid, energetic, and diffusive action of electricity than heat, and heat may, in this as in many other well-known instances, be identified with obstruction and friction; for while we are apt, as a first impression, to suppose that the least refracted portion of the light passing through a prism is the least interrupted, the reverse is actually the state of the case; for the prism is in reality a facilitator of dispersion, and where most refractive most dispersive. It is thus less dispersive in the red than in the yellow and blue portions of its refraction, and hence the explanation why the colours of the spectrum are only different degrees of intensity in the manifestation of light.

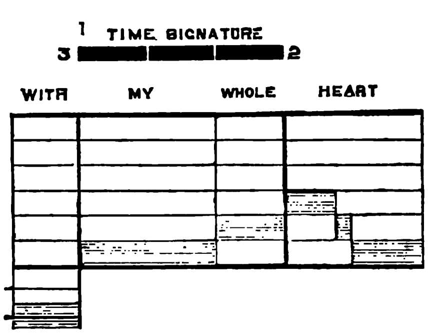
The distinctive conclusion then is, that sound is a mere vibratory action of vibratory media, but that light and heat are special actions of electricity.

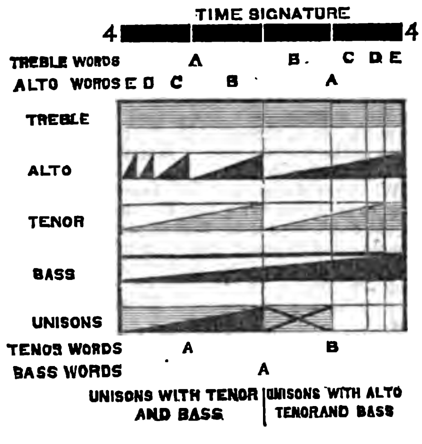
J. Alexander Smith.

98, Gower-street, W.C.

NEW MUSICAL NOTATIONS.

[14759.]—I have sent two illustrations for C. Lark (see letter 14703, p. 554), respecting time in the new musical notation. The first illustration is two bars of "Glasgow," an old common metre tune





in triple time, $\frac{3}{2}$, on the key of G. The first note is a minim to the word "with," and then the bar line; the second is a semibreve to the word "my," and then a small line; and the third is a minim to the word "whole," and then a bar line; the fourth note is a slur to the word "heart," of the value of a semibreve. This slur is made up of three notes, all of different sizes; the first is a dotted crotchet, the second is a quaver, the third is a minim. The individual notes of slurs in the new notation have no small lines, the whole space is left empty, and each note is measured off to its proper length—as correct as the engraver can make them, without any small lines. It is the rule in the new notation that the treble or air has the honour or privilege of having all the small lines to itself, and when the other three parts do not coincide with the treble they must shift for themselves the way they best can, and this "best can" is shown in the second illustration, where the most of the notes are of a triangular shape. The second illustration is comprised in as little space as possible to save expense in engraving—tune, tone, and harmony not being essential in the present illustration.

In the new notation the bars are all of one length in the same tune from beginning to end. Before the drawing is made the bars are counted, so many bars to the line, and so many lines in the page or sheet, so that the page or pages shall contain the tune without altering the bars in the smallest degree, as is the case in the old notation. The rests are measured off to the same scale as the notes. The second illustration shows how four singers can sing different words, different tones, and different times, and yet be all quite distinct to the eye. and all of one colour; and certainly any person with half an eye will sing a longer time to a long note than he will do a short one without knowing whether the note is a quaver, or crotchet, or minim.

C. Lark asks if I have had any practice in teaching. I have seen sol-fa singers of both sexes come into my house, and after singing for about one minute from the new notation they would say, the one to the other, "it is far easier to sing from this than from the sol-fa." C. Lark talks about children finding no fault with the want of an "up and down." How can children know better? They just do as they are taught, and do not introduce inventions.

Let C. Lark make out two sheets of music of a large size, one with the "up and down," and another in the sol-fa, and exhibit them to children who never saw a music-sheet, and who do know the tune, and he will soon see which of them the children will like best. If C. Lark will make himself as familiar with the new musical notation as with the sol-fa and the old, he will be more competent to criticise the notation invented by **Wark.**

TABLES FOR MULTIPLICATION — MAGIC MULTIPLICATION — THE PARABOLA AS A MULTIPLICATION TABLE.

[14760.]—I was surprised to see in *Nature* of 26th July a review of Mr. Sawyer's book, explaining his tables for multiplication, from which it appeared that the reviewer considered them worthy of favourable comparison with logarithms as an aid to calculation; but I certainly did not expect to find "Oberhof" devoting two columns of your practical periodical to an exhaustive explanation of their use. I admit that the invention appears plausible at first sight, and in fact I spoiled ten pages of paper in preparing them for the tables before I quite understood the not very lucid explanation given in *Nature*. I also admit that, for persons exceptionally slow in calculation, the tables may be of great value, provided they have much calculation to do; but for persons of ordinary mathematical capacity, whether they have much or little calculation to do, I very much doubt the tables possessing much advantage—in the first case, because constant practice in multiplication will soon enable any one to jot down the lines and arrive at a product almost as quickly as he can write them down; and, in the second case, because those who do little calculation will scarcely carry the tables about with them in preference to trusting to their own mental power to do a calculation when an occasion arises. Of course I do not suppose that the inventor has any idea of superseding the multiplication table in education, but then what does his system amount to? It is, in fact, nothing more than an ingenious arrangement for saving the user the mental strain of remembering what in any case he must learn in childhood, and what he can never allow himself to forget. It is true that the trouble of using the tables would be much less in proportion for large numbers than for small ones, and that for such large numbers, therefore, there might be some advantage as compared with ordinary multiplication. So far, however, it appears to me very much a case of six of one and half a dozen of the other, but when Mr. Sawyer's system is compared, as regards multiplication, with the system of "magic multiplication" referred to in Vol. XXII., pp. 202, 307, and 335, by "Aletheus" and others, I am confident that there would be found no superiority in the former plan. "Aletheus" treated the matter more as a puzzle worth finding out than as of practical importance, but I have used his system constantly since and have found it of the greatest possible value. I recommend it to all who have not yet tried it, and as present readers may not all have access to that volume, I will in as few words as possible, explain the principle. Taking the product of any two numbers we see that the first figure (to the right) of the product is the product of the first figures of each of the factors; that the second figure of the product is made up of the products of the second figure in each factor by the first figure in the other, plus what may be carried over from the first figure of the final product; that the third figure in the product is made up of the products of the third figure in each factor by the first in the other, plus the product of the second figures in the two factors, and plus what may be carried from the second figure in the final product; and so on, imagining zeroes to the left of the factors until nothing but zeros are found in the product. In this system the trouble of putting down the usual steps of the multiplication, and even the necessity of putting the numbers to be multiplied down on paper at all, is quite dispensed with, for each figure of the product required is calculated mentally in regular order, beginning at the right before the next to the left is begun. The method requires the user to be expert in adding together mentally two numbers of at least 3 figures each, but this difficulty is no real disadvantage, as it is an excellent mental exercise, ɔt over, and then applicabl· to many other .s. I have occasionally a so mu't·p'ied three :· together at the same time, by this method, is, of course, far preferable to do it in two ive sums. I have tried to reverse the method ision but this does not app ar practicable. .y one succeeded in doing this?

king of tables for facilitating mu'tiplication, ment'on that some tim: ago I was trying to e a table such that the straight line joining vo points representi g number· on a plain should cut off from a given ·traight line in ne plane a por.ion pr·po tionat· to th· pro- f the two n m ers; the pro'l m being: the straight line representing products, to e relative position· of the point· repres nt ctors Aft r sundry t ials I s·cceed·d in i·g th· points in the way required, and on g a line through all these po'nt· I fo nd had drawn a pa.abola, o which the given t line wa: the a.i·. Thi· is evidently :ty of that curve, a d I might no doubt ved mys·if the trouble, had I not been .t of conic section·. If any one wish to points on the curve fulfil'ing th· problem, iest way is as follows:—Take any point B, axis of a parabola who e vertex is A, and A B into, say, 100 equal parts; through the B draw a straight li e at right angl·s to the itting the curve on both sides in C and D; :e point C, draw nine straight lines, cutting .sions 10, 20, 30, &c., to 90, on the ax's, and the curve in the required points, which · 1, 2, 3, &c.; do the same from the point D; e points on the curve, C A D, are so situated .e straight line joining any two of them on e sides of the axis, cuts the ax's in a point g their product. Theoretically this property erve for multiplying together, at one opera- ro numbers of any magnitude whatever; but ally eith·r the divisions would become micro- or the parabola gigantic. Still, it seems to t some use might be made of this property in .ing machines, and I should be glad to know ever been tried. Will some one also give of that this is a property of the parabolic is I do not find it in the books I have?

H. G. Moberly.

SURVEYING.

1.]—The method of ascertaining the acreage plan given by Guilden Mordon (let. 14727), ved to have been originally proposed by the :. Hutton, see pages 132 and 133 of "A e on Engineering Field-work," date 1840, by ster Bruff, C.E. But Mr. Bruff does not to hold it in much estimation. He after- says: "A much more feasible method was iently practised, by which the areas of large ave been computed with extreme accuracy. an consisted in affixing, by thin mucilage, a ly-prepared tracing of the map to be com- n thin rolled lead, cutting the tracing, and iently the attached lead, to pieces, weighing s before, and comparing the weights with ed results; or otherwise, by preparing a y of pieces of lead, each representing an surface; also other pieces representing roods ches, and a sufficiency of these being put into posite scale so as to counterbalance that area was required, the content would be ated by such quantity. We believe that this s been tried at the Tithe-office, and that in any instances the results so obtained were igly accurate as compared with the ordinary lious process of scaling. But incorrect were often obtained, probably from the diffi- obtaining lead of equal thickness and den- iich have induced the authorities together to the process." But although either of the methods may serve for the plan of one or two f land, they will not do for plans of parishes, or railways, which are generally required er purposes than merely ascertaining quan- Certainly in these cases very carefully pre- opi·s might be made to be cut up, and the s of each field, after having been ascertained cut-up copy, might be transferred to the plan, or to a book referring thereto, in the ianner; but I doubt whether, after all this and cutting up, the contents would be so ely obtained as they would be by using what d a computing scale, or some similar con- ·. with the original plan. However, if Morden really wishes to ascertain the con- a piece of land with greater accuracy than he by any of the above methods, he had better se of the actual measurements of the land, f properly taken, and he makes no mistake- s figures afterwards, will give him the y exactly. There need not be the error of a readth. But, if Guilden Morden lays down to a scale of "2 chains to the inch," how show that "an inch might well represent :" It appears to me that a square half-inch this, and that if he allows 16 poles to a neb, which he evidently means, although he does not say so, he will get, not the acreage, but only one-fourth of the acreage of his field. Perhaps he will be good enough to look at this again, and say which of us is wrong.

8½in. O.G.

A BABY JUMPER.

[14762.]—Having seen in the Mechanic several queries concerning the assistance of crippled children and the encouragement of weakly children to use their limbs, I give a description of a piece of apparatus which will be found most useful for the latter purpose, and perhaps to some extent for the former. The article is not by any means my own invention, nor is it new, as it was offered for sale more than 30 years ago, but from some reason or other its use seems to have almost died away. Perhaps one reason was its rather high price, and another (from one part of the machine being not properly constructed) its readiness to break and get out of order. In the following directions both these objections have been done away with, and any one with a little trouble may construct one in a few hours. First get a number of lengths of indiarubber 18in. long, and a little thicker than a pipe stem. The number of course will vary with the weight of the child and the quality of the rubber. I find that eight lengths will bear a child 14lb. weight easily; so an approximation may be readily got at. When the use of the rubbers is explained it will be seen that it is advisable to have rather too many than too few, so that no excessive strain may be thrown on them. Next obtain two pieces of wood, sound and free from knots, about 20in. long 1in. wide, ¾in. thick, a strong strap, about 2ft. long, and some broad strong tape.

To the ends of each length of rubber tie firmly a piece of strong cord, leaving a loop at each end. Next take all the lengths, and, laying them side by side, bind all the loops at one end well with string, so as to make a stout ring which may be easily slipped over a hook. Then cut a piece 7in. long from the buckle end of your strap, gather all the loops at the other end of your rubbers, slip the strap through them and stitch it up with shoemaker's "wax end," leaving the buckle projecting (Fig. 1 represents this part entire).

FIG. 1

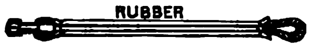
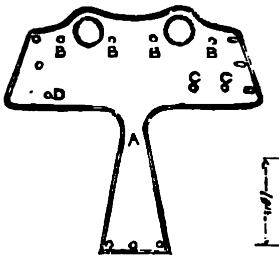


FIG. 3



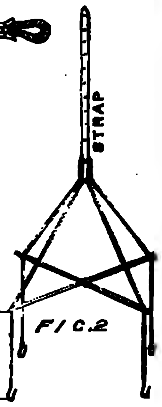


FIG. 2

Next take the two sticks and crossing them at right angles, tie them firmly in that position. Fasten a piece of tape to each end of the sticks, letting the ends drop down and then bringing the other ends together, tie them in a knot, and then, making a loop as before, slip the other piece of strap through and stitch. Tie the loose ends into loops, and the second part is finished (see Fig. 2). Our English mechanic must now call in the services of his good lady, and with her assistance construct, of some strong material such as good "union," the little jacket shown in Fig. 3. It should be double everywhere to prevent it tearing, and should fit "easy," but not be too large. The buttons, B, B, B, B, will be firmer if a little strong material is put behind them, and should be about an inch diameter. The appearance of the jacket will be greatly improved by binding it with bright-coloured braid. The arm-holes should be very large, so that no strain is thrown under the child's arms, and the part marked A must not be so wide as to chafe the child's thighs. One side of the jacket is cut on the slant so as to give room at the bottom of the waist for the buttons, C C. To use the machine, first suspend Fig. 1 from the ceiling by the loop, next buckle the strap of Fig. 2 to Fig. 1. Then place the jacket on the child, bringing the long swallow tail between the legs to the front and buttoning it on to C C and D, the latter of course being used to button the bottom of the jacket already. The child is next suspended on to the part shown at Fig. 2 by slipping the loops over the buttons B, B, B, B. By shortening or lengthening the strap the strain on the rubbers must be regulated so that the child's toes can just rest on the floor, and all is complete. Every jump of the child will take it from the floor and so encourage it to use its limbs. The advantage of the jumper is, that there is no prejudicial pressure anywhere, as the child actually sits on the part A, and both legs and arms are quite free to move as they please.

Our own child has been in one for over two hours at a stretch several times, and even fallen asleep in it. The jumper may be used (as we have used it), to give a baby lots of exercise, and yet not encourage it to walk before it is old enough to do so without detriment. If properly regulated it will be found that even when descending from a jump the child will not strike the floor with a force of many ounces.

With this little affair many of the wives of our English mechanics may go about their household duties uninterruptedly, and their babies, free from all danger, will get the benefit of lots of exercise. Our little one used one for hours when only five months old. The jumpers, when brought out first, were fixed with broad indiarubber straps in place of the round, an eyelet hole at each end; but when used a few times the eyelet tore the strap, and the machine became useless.

Should any part of the apparatus not be understood, I will gladly explain further, hoping to hear of its being a help to many of the better halves of "ours."

Wm. S. Travis.

THE LAND QUESTION.

[14763.]—Mr. Mayer (letter 14652, p. 522) asks for figures to show the extra cost of houses. I cannot go back for 30 years, but 23 years ago I built the house in which I now reside, and at that time masons' wages were 4s. per day, and their hours from 6 a.m. to 6 p.m., and on Saturdays 6 a.m. to 4 p.m., one hour and a-half allowed for meals. It so happens that I am at present building a small addition to my house, and I now pay 5s. 6d. per day, and the hours are half-past 6 a.m. to 5 p.m., and Saturdays half-past 6 a.m. to 12 noon—an increase in wages of 35 per cent., and decrease in hours of 17 per cent. = in that one item to 52 per cent.—and joiners are much on a par with the masons. I paid for bricks at that time 20s. per 1,000, and now the price is 30s. I cannot say whence this difference arises. Coals are dearer, and no doubt wages also help to enhance the price.

If we take an ordinary four-roomed house, such as a mechanic may be supposed to occupy, the area may be taken at, say, 54 sq. yards (6 × 9), and give same area for the yard = 108 sq. yards. Now, I paid 2s. 6d. per sq. yard for the ground; this would represent £13 10s., and I should, I suppose, now pay 5s. per sq. yard, which would be £27. Will any one say that the difference is a very serious increase in the cost of house rent, seeing that the interest on the difference would only represent at 5 per cent. per annum 13s. 6d.? No—no! The land laws may be capable of improvement, but if mechanics have higher wages and shorter hours they must make up their minds to pay higher rents, seeing that the house cannot be built without mechanics, and therefore must necessarily cost more.

H. G.

[14764.]—I quite agree with "Sigma's" letter (14699) appearing in "ours" of the 16th August. The monopoly of land has been more or less a curse to all European countries, and some restriction ought to be put upon the acquiring of land to be used as a mere estate—a chattel to show the wealth of the owner. There is no doubt that this aggrandisement on the part of the wealthy has raised the price of land throughout the whole of the United Kingdom, which is scarcely to be wondered at, for every one who has ever thought upon the subject must be aware that where there is competition amongst buyers the sellers will raise their prices as high as they possibly can. When the farmer and the nobleman go into the auction-room can there be any doubt, if the latter really wants the land, that he will get it? The very fact that he can buy land to the extent of 10,000 acres, while the farmer would not buy more than 1,000, will give him an advantage over the other without paying any more per acre.

Some of the views of your correspondent, "W. H. B.," are really amusing. He says, "and as land is only one form of wealth, he (S. Mayer) ought, in common justice, to likewise limit the acquisition of wealth in all its other forms." If "W. H. B." had said, "only one form of wealth" that was hurtful to the interest of the people and of this country, I could understand him, but I do not know what to make of the bare assertion above quoted.

If a nobleman buys furniture, pictures, or works of art, he supports workmen or painters, as the case may be, and consequently benefits trade by his purchases. But it is not so when he buys land. He then not only shuts other people out of the market, but keeps thousands of acres in an uncultivated state, which otherwise might be producing grain, &c., of every description for home consumption. Then he, "W. H. B.," objects to the stamps imposed on the instruments used for conveying land.

I presume that "W. H. B." is aware that no Government can exist without a revenue, and that, therefore, it must tax various things for the maintenance of that revenue; and is it not much more reasonable that a government should tax articles which are paid for by the wealthy classes than to tax wool, which would eventually fall on all classes, and most heavily on the poor? "W. H. B." seems to be rather too much in a hurry for the good effects that free trade is to bring about. He does not seem to have thoroughly made up his mind about free trade, and says that it has not brought about all the good that its most sanguine supporters said it would, and he gets rather like Pliable in the Slough of Despond, seeing that the way is not quite so good as he thought it—turns back precipitately. People, as a rule, believe in a law before they adopt it, and if the Americans or the French believe in free trade only to the extent that "W. H. B." does, can we wonder at their not adopting it? "W. H. B." seems to suggest in the few last lines of his letter that, as other nations do not adopt our precedent in free trade, it must therefore necessarily be bad—*i.e.*, that nations always do what's right, and like kings can never do wrong. I shall not discuss the merits of free trade any farther now, but I do advise "W. H. B." to read the history of his own country for the last 60 years, and Adam Smith's "Wealth of Nations," and when he has done this I think he will own that free trade is but free competition, which is only just to the consumer, and that if we cannot find markets in foreign countries for our goods to go without, rather than make artificial ones by retaliation in export and import duties.

Common Sense.

[14765.]—Barclay, the lexicographer, interprets the word "monopoly," the "sole privilege of making or selling anything." If that is a correct definition, "Pioneer" has been singularly unfortunate in choosing a title for an imaginary grievance—a grievance that literally has no foundation in fact. Let us see what facilities the Legislature has put within reach of the small capitalist seeking an investment in land. The words "working class" are omitted intentionally, because the appellation as applied exclusively to men brought up to a craft or trade is simply a misnomer—too well known to need refuting. In addition to the advantages offered by land and building societies to those who desire "a stake in the country," no reason exists why the principle of co-operation may not be applied. It may not be generally known that any number of persons may purchase land, build houses thereon, borrow money on mortgage, and do other acts, such as a man might reasonably do on his own account for himself alone, and avoid altogether the clauses of the "Companies Act" in reference to registration—the sole condition required being that the purchase shall be one for mutual advantage only, and not for the purpose of trade. S. Mayer may say, "very good so far as it goes, but I want to have power to take a piece of land out of any man's estate, whether he likes it or not. Lord Noeshu lives hard by. I want a piece out of his park, and close by the lodge at the western entrance. I can breed stock as well as he can, and by way of experiment I intend to begin at 'pigs.'"

"Pioneer" may be consoled with the assurance that the quantity of land brought to market in the hands of agents for disposal is largely in excess of public and private requirements, and when he goes for his holiday trip he may be somewhat surprised to find the words, "This eligible land to be sold for building," staring him in the face in almost every direction. In addition to the cost of labour and material necessary to produce a house in London must be added the exorbitant charges made by some architects to small builders for drawing plans, putting plan of ground on agreement, also on lease and counterpart, signing certificates for a "draw," and final certificate for mortgage. To these heavy charges must be added the fees to district surveyor, and charges occasioned by the action of vestries, water and gas companies. Artisans working in London ought to be able by co-operation and the aid of a liberal railway company to live beyond the boundaries of the Metropolitan Board, and so avoid a heavy rental incidental to a home in town.

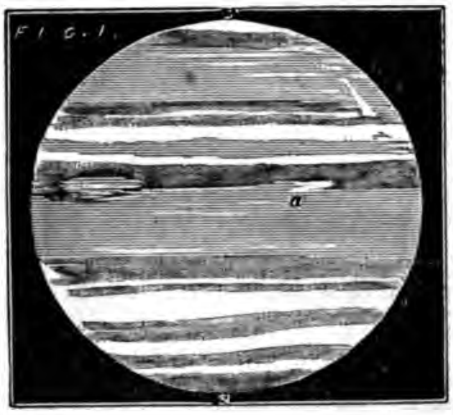
Penance Point.

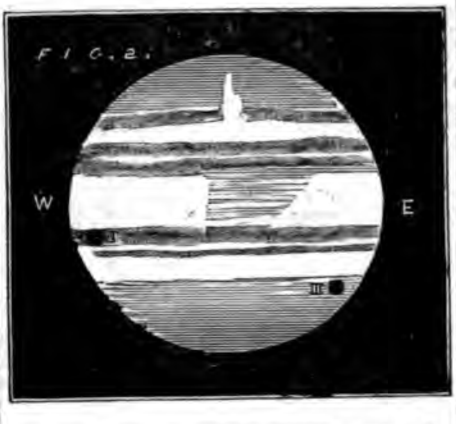
JUPITER.

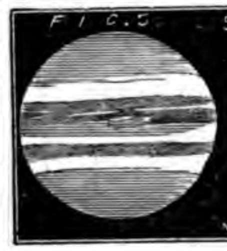
[14766.]—Upon p. 575 "F. R. A. S." gives us a picture of Jupiter, as seen with his 4⅓in. Dallmeyer, 1878, August 8, 11h. 40m. Perhaps a short illustrated history of this spot may interest him and others of your readers. I saw it first upon 1877, July 30d. 9h. 30m., as at *a*, in Fig. 1, reduced from my tinted sketch. After this I saw it upon several occasions without noticing any particular change in it until 1877, August 30d. 8h., when I saw it as in Fig. 2, and noticed the shaded band across the torrid zone. This figure is particularly interesting from the shadows of I. and III. both being shown upon it. I saw it next on 1877, Sept. 4d. 8h. 45m., as in Fig. 3, when its shape had perceptibly altered, which it had done still more so on 11d. 7h. 45m., *when it appeared* as in Fig. 4. I did not see it again until 1878, July 27d. 13h., when it had the appearance presented in Fig. 5. All these figures are reduced from my figures made whilst at the telescope, a 9¼in. With, different apertures being employed at different times. Having described what I have seen of the spot depicted by "F. R. A. S." I will say a few words about the Jovian colours.

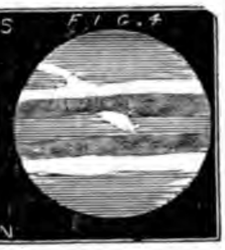
Last year, when the atmosphere was at all favourable, I invariably found the equatorial zone of a blackish grey, tinted now and again—particularly in the neighbourhood of the above spot—with a tinge of ochre—the N. equatorial belt a reddish fiery copper, edged on its northern side by a strip still more fiery. The S. equatorial belt had the same tint, but was much less fiery. The N. polar cap was of a beautiful blue, and the S. of a pale orange brown. This year several modifications have taken place, which I will describe. The torrid zone is perhaps a very little yellower, and the N. equatorial belt retains its colour about the same as last year, save that the vivid N. border has faded. The S. equatorial belt has experienced the greatest change, being of a dark bluish-slate colour. The polar caps both show the same tints as last season, but with less intensity. But there is one more great change in the colours—there is a patch S.E. of the bright spot, in the S. temperate zone, which has assumed the same tint as the N. equatorial belt, though with less intensity. I did not notice the great rift in the S. equatorial belt this year, but saw another bright spot close under the S. equatorial belt, which came round the limb after the figure was drawn.

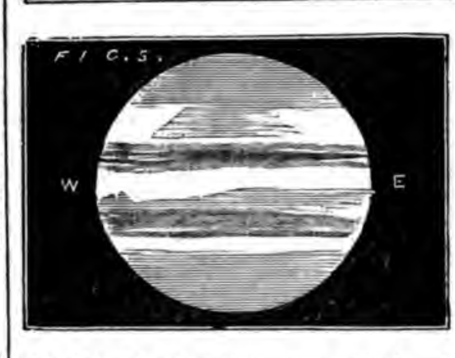
Frank C. Dennett.











ON THE PROPAGATION OF MOTION IN WAVES AND TIDES.

[14767.]—At the present time, when the scientific mind is awakened to the importance of those less evident forms of motion in matter which we designate variously as vibrations, undulations, heat, light, sound, &c., it may prove of interest to some of your readers to learn the results of a series of experiments, carefully instituted by A. Tylor, Esq., as to the mode in which undulations are propagated in water, and the bearing of these results on the accepted theory of tidal waves, &c. Some of these experiments have been detailed in the September number of the *Mittheilungen der K. K. Geographische Gesellschaft*, of Vienna, for 1877; and others have been laid before the London Institution by Mr. Tylor himself; but the facts are not so generally known, as their importance merits.

By means of a specially constructed apparatus, consisting of a circuit of 24ft. of 10in. glass pipe, laid horizontally, and provided with a box, in which waves could be generated by a head of water of about one foot, Mr. Tylor found that a wave traversed the whole circuit under ordinary atmospheric pressure in 4·475 seconds, but that its velocity was so far diminished as to require 4·925 seconds to make its second circuit, which is equivalent to a loss of 9 per cent. of its velocity. A wave caused by the same head of water in the generating box, but moving in a partial vacuum (18in.) took 4·76 seconds to complete its first circuit, and showed no calculable loss of velocity in making its second circuit. Mr. Tylor concludes, from these results, "that the velocity of a wave is dependent on the quantity of air which it has to move, and that a wave can only propagate itself until it has displaced its own weight of air," leaving out of account the loss of power due to friction and other obstructions. Upon this basis the following formula is constructed, which gives the limit of possible propagation of any given wave:—

The specific gravity of air being one 1, let us call that of water (which is 773) A. Let f_{I} be the force which a wave loses in its first undulation, while f_{II} be that lost in the second, and so on. Let x be the weight of the wave, then $f_{\text{I}} = \frac{x}{a}$, $f_{\text{II}} = \frac{x\ f}{a}$ $f_{\text{III}} = \frac{x - (f_{\text{I}} + f_{\text{II}})}{a}$ + and

$$f\,n = \frac{x - (f_{\text{I}} + f_{\text{II}} + \ldots .\ f\,n - 1)}{a}.$$

Suppose that after n undulations the waves should come to rest—*i.e.*, $\Sigma f\,.\,n = x$, the sum of the series will be

$$\Sigma f\,.\,n\,. = \frac{x}{a}\,\frac{\left(1 - \frac{1}{a}\right)\,n - 1}{1 - \frac{1}{a} - 1} = x.$$

We see from this that only when $n = x$ will the wave come to absolute rest; but by setting certain values for n, we find that after 520 undulations the wave loses half its force—or, tabulated—

After	520 undulations	50 per cent.	
,,	1800 ,,	90	,,
,,	2330 ,,	95	,,
,,	3600 ,,	99	,,

It appears, therefore, that quite apart from molecular friction, wind, or other obstructions, a wave will lose over 99 per cent. of its force when it has made 4,000 undulations.

Consequently it is, to say the least, improbable that a wave can travel (as suggested by Professor Stokes, "Cambridge Phil. Trans.," Vol. IX. p 61) 574 English miles, and then break on a distant shore. If we examine Professor Stokes' suggestion, that a wave 40 fathoms, or 240ft. long, which, according to his formula, would travel 574 miles, only diminishing its height by a little more than $\frac{1}{300}$ part, and apply to it Mr. Tylor's formula, as obtained by experiment—viz.:—

$$\Sigma f\,n = x \left\{1 - \left(\frac{a - 1}{a}\,n\right)\right\}$$

n will be equal to 12,628, or the least number of undulations a wave 240ft. long, must make to travel 574 miles. Then, say for simplicity

$$x = 1 \quad \Sigma f\,n = 1 - \frac{1}{12{,}573{,}500}$$

or very nearly 1. That is to say the losses caused by the displacement (lifting) of the air would be practically equal to the original force (x) of the wave, and the wave after the 574 miles' travel would be only $\frac{1}{12{,}573{,}500}$ of its original size. Supposing the wave to have had a height of 30ft. originally (the length remaining the same), the height would be diminished to $\frac{1}{34926}$ of an inch. The area originally being 3600 square feet longitudinally, would be reduced $\frac{1}{3492}$ part of a square foot, corresponding to a wave $\frac{10}{208}$ of a foot long by $\frac{10}{1664}$ of a foot deep; it is evident that such a wave could not break *visibly* on a beach.

According to Mr. Tylor's formula, the limit of such a wave of 240ft. long, by 30ft. deep, would be reached, at a distance of 208 miles, and this without taking into account any friction, but only reckoning the work done in displacing the air. At this point the wave would be reduced to 1in. in height.

In further corroboration of this view it was found that "on projecting a jet of water successively into two graduated glass tubes, one filled with air, and the other exhausted, the jet rose higher in the exhausted tube because the water had no air to displace. Again, on turning on water in a bath, a high wave is generated at first. When the water has removed the air round about the orifice, and substituted a stream of water in its stead, the wave diminishes to half its original height, although the force of the water is unchanged: here the resultant wave is diminished, because *heavy* water has to be moved instead of *light* air; and this effect goes on increasing, until at last no perceptible wave is to be seen, where at the outset a wave 2in. in height was produced.

Experiments were also made with reference to waves or impulses propagated through water in a closed vessel, so arranged as not to allow actual movement of translation in the fluid. By means of a chronograph specially constructed, capable of measuring continuous operations, lasting 1-500th of a second, Mr. Tylor found, as the mean of two experiments, that an impulse of 10lb. was propagated at a speed of 39·7 miles per minute, through a ½in. composition pipe, 97ft. long, and completely filled with water. Comparing this result with the partly analogous case of an earthquake shock conveyed by the sea, Mr. Tylor refers to Dr. Fred. von Hockstetter's report on the earthquake at Arica, near Lima, August 1868, in which it is mentioned that the shock was recorded on the tide gauge at Newcastle, near Sydney, in Australia, as vibrations in the water, and not as an actual wave. The distance traversed being 7,380 miles, and the time required by the shock to traverse this distance, being 22h. 28m., gives a velocity of 5 miles per minute. In the earthquake of May 9, 1877, at Huanitos, on the coast of Peru, ships trembled through vibrations in the water, while similar vibrations are reported by Mr. H. W. Russell to have been recorded on the Newcastle tide gauge (Sydney) on the 11th of the said month. Observations, show that the shock caused by the Lisbon earthquake in 1755 travelled at the rate of 6 miles a minute from the West Indies.

In Mr. Tylor's opinion the action of the tide on any coast is rather the consequence of a series of impulses or vibrations than the result of material waves. He instances that a ship at ebb tide near London is ten feet below the level of the ocean, while at flood tide, the same ship would be 10ft. above the level of the sea. The level of the sea in the meantime has not changed, although its whole mass has an alternate and opposite horizontal vibration twice in the twenty four hours. The impulse starting the tide on the Atlantic coasts must travel at the rate of at least 6 miles per minute; for it is seen that the greatest range of the times of high and low water in the Irish Sea (186 miles long) is only 30 minutes. This has been ascertained by Capt. Beechey (see "Phil. Trans." for the year 1848, p. 105), by anchoring boats at short distances around the whole coast, and observing that the tide turned simultaneously at all points. This turn of the tide, which is independent of high and low water, can only be caused by positive and negative impulses or vibrations from the Atlantic ocean itself.

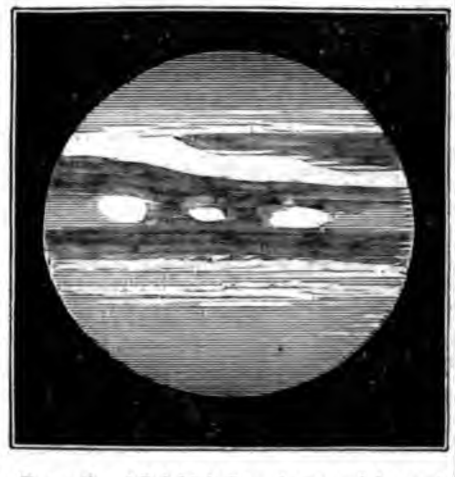
Hence Mr. Tylor concludes that the term, "tide," is a better one than "tidal wave," as no wave in the true sense of the word exists, which could satisfy the theory held by many scientific men, that a tidal wave travels round the earth at a speed of 1,000 miles per hour, always in the same direction. On the contrary, the semi-diurnal movement of the tidal water is nearly equal and opposite. It would therefore appear that the accepted formula for wave motion, as applied to tidal movements by Mr. Scott Russell and others, is probably not correct, as we do not find from observation that a wave generated in water 25,000ft. deep travels any faster than one generated in 1,000ft. La Grange, in 1790 explained that there is a limit to wave motion as regards depth of water; in fact, we have no grounds for supposing that waves, causing a rising and falling in the water, have been generated in the depths of the sea (except by earthquakes), so as to cause displacement of the water to any greater extent in deep water than on the coast.

Touching upon the causes of the diurnal variation of the tide, Mr. Tylor considers them due to the change of position relatively to the moon which each place goes through in 12 hours. That is, a place on the equator, 200,000 miles distant from the moon, may be 208,000 miles distant twelve hours afterwards; the earth having, during this time, made a semi-revolution, the place will be 8,000 miles in a direct line further from the moon, and he states "that the cause of diurnal variation is due to the changes, both of the angular incidence of the moon's attraction, and the changes of the moon's absolute force of attraction, due to differences of distance at which that attraction acts as well as the direction in which it acts, and the declination of the moon alone cannot be the sole direct or even principal cause of diurnal variation of the tide, though it has a very appreciable effect thereon."

Selimo Bottone.

JUPITER—THETA DELPHINI.

[14768.]—Enclosed is a rough sketch of the planet, as seen last night with my 5in. "Wray" and power 180, time 10 p.m. The white spot to which "F.R.A.S." calls attention (p. 575) will be, I presume, the large one to the left. If so, it has increased notably in size, and is now quite elliptical. Two others were seen, but smaller and less distinct. In fact, the equatorial belt seems to be breaking up into this "beaded" appearance. Unfortunately my 11in. "Calver," reflector cannot be depressed below 18° S. declination, or I should have obtained a sketch with a larger aperture.

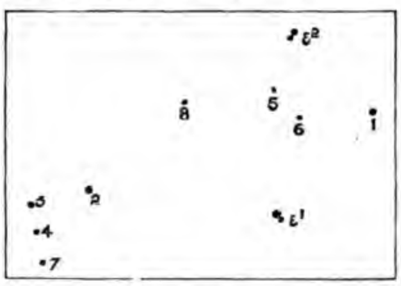


Respecting θ Delphini, I made a careful examination of that locality this last two nights, with the following results:—Theta, I estimated a small 6 mag., being inferior to 1 Del., but superior to 10 of the same constellation. Eta appears to be slightly variable, being now equal to ι Delphini, of the 5½ mag. About a year ago Eta was very little brighter than Theta, and decidedly inferior to Iota. In Wollaston's Catalogue, published 1789, Theta and Eta are both rated 6 mag., from Bradley's and Maskelyne's observations.

Leicester, Aug. 19. **W. S. Franks.**

SATURN, ε LYRÆ, RING NEBULA, &c.

[14769.]—Upon 1878, July 27d. 15h. (till sunrise) I gave a lot of attention to Saturn, with about 8in. of aperture and a power of rather over 200, obtained with a Huyghenian eyepiece and a Barlow lens, under very good definition. The portion of the ring projected upon the sky seemed very much paler than the planet, but I could not trace it where it crossed the disc, so that the apparent darkening must have been an illusion, though a very singular one. I missed the orange colour of the ring so noticeable last season. One thing struck me specially: it was the shadow of the ring, that seemed to present at its southern edge a double outline. On the same evening, at 14h., I made the figure of ε Lyræ and its neighbourhood, given below. The sky was unfavourable part of the time, from some passing clouds, but the definition was good, and enabled me to employ the full 9¼in., with 215 power. The stars are numbered according to their brightness.



The ring nebula in Lyra was examined at 11h. 30m. with 8in. and 132 power. The ring was very bright and filled with haze, and the northern part of the ring (border) much the broadest.

F. C. Dennett.

NOTES ON OUR SATELLITE.

[14770.]—Klein's New Crater.—I have the following observation:—"1878, July 20d. 13h. 10m., terminator along E walls of Aristoteles, Eudoxus, Menelaus, and Maurolycus; 115 power on 2·25in. Very good definition. Traces seen, with some difficulty, of some crateriform object N.W. of Hyginus, in about the place indicated by Klein. No trace of the still newer oval object E. of it, but the crater on the southern arm of the mountains in the black patch N seen very easily and distinctly."

Mare Crisium.—The evening terminator upon 1878, Aug. 15d. 10h. 45m., lay along the ridge on the Mare Crisium, immediately W. of Picard. There is a large ring in this ridge, S.W. of Picard, depicted by Schröter, 1789, Oct. 6 (see last vol., p. 624), but too largely, and by me, differently, but wrongly placed (see p. 38 of this vol.). I saw this ring on Aug. 15, but clouds covered the moon before I was enabled to make any estimations as to the position of the formation. If any who observed and drew this formation upon the night mentioned could manage to send a copy and description, I should be greatly obliged, and I think some others of "ours" would be benefited thereby. **F. C. Dennett.**

RAINBOWS.

[14771.]—What am I to believe in answer to my original question upon this subject? About a year ago I wrote to ask whether the end of a rainbow, apparently resting in the distance upon a pool of water, would be reflected in the water, and coincident with the bow above, in the eyes of an observer?

I had heard it stated in his sermon by a clever reverend gentleman that science proved there would be no reflection, and to have this statement corroborated or disproved by some of your able correspondents was the object of my letter.

For nearly a year the discussion—truly a very interesting one—has been going on, and there are almost as many writers on the one as on the other side of the question.

While it is difficult to disbelieve those who aver they have seen the reflection, and that seems a principal argument on their side, still many clever letters tend to prove the reverse; so that, until some more able writer sets the question at rest by a clear solution of the difficulty, I must still sign myself an

Enquirer.

[14772.]—Mr. John Thompson (letter 14723) is right in pointing out an inaccuracy in my letter (14657). I should have said that a boatman at F would see a bow whose summit is C; all other points of the bow seen at F would be formed by rays entirely distinct from those reaching A, who would therefore see another bow (inverted).

Supposing the rain-drops to be falling over a large area, it will be seen that a bow may possess considerable depth so as to form, so to speak, a hollow cone—that is, in my diagram on p. 523, the rays forming the summit of bow, B, may extend, and do, more or less, all along the line, A B G.

I think it matters little in what relative vertical plane the summits are placed, provided that the angles, S B A and S C F = 42°, and that the angles formed by the line, C F and F A, with the surface of the water are equal. **J. W. D[illegible]**

THE IDENTIFICATION OF VARIOUS ORGANIC COMPOUNDS FROM ALCOHOL TO HIPPURIC ACID.

[14773.]—Alcohol (C_2H_5HO) is a colourless liquid, having a burning taste and a characteristic odour. It is inflammable and volatile. It has a specific gravity of ·81 at 0° C. It is neither acid nor alkaline.

When alcohol is heated with strong H_2SO_4 and plumbic acetate, the odour of acetic ether is evolved. If mixed with bichromate of potassium, and a little HCl added, and then heated, the red colour will become green. It inflames readily, and burns with a pale flame, when not too dilute. On evaporation it leaves no residue. At a temperature of 110° C. it becomes glutinous. When burned it does not give much light, but much heat, and is converted into OH_2 and CO_2. When passed through red-hot tubes it is decomposed—the products varying according to the temperature. When heated with H_2SO_4 it may give olefiant gas, ether, or alcohol, according to the proportions in which they are mixed and the temperature. It boils at 78·5° C.

It dissolves many of the vegetable acids, most of the deliquescent salts, many gases, the hydrocarbons, the essential oils, the vegetable alkaloids, the resins, potassium, sodium, and their hydrates and sulphides, ammonia, bromine, iodine, carbonic anhydride, nitrous oxide, cyanogen, phosporetted hydrogen, small quantities of sulphur and phosphorus, soaps, sugar, fats, and fixed oils. It is miscible with water in all proportions. By a gentle heat it can be expelled, leaving the substances held in solution in a pure state.

Chlorine converts alcohol into HCl, the aldehyde, chloral hydrate, and ethylic chloride. When oxidised it is converted first into aldehyde, and then into acetic acid. It forms ethylates with sodium or potassium.

Chloroform is produced when it is distilled with chloride of lime. When treated with nitric acid, nitrous ether, and oxalic, glycolic, and glyoxalic acids are produced.

Aniline $\prec (C_6H_5)NH_2 \succ$ is a brownish or yellowish, almost colourless, oily liquid, having an odour like ammonia and a hot acrid aromatic taste. It is poisonous. It has a specific gravity of 1·028. It has a high refractive power, and does not conduct electricity. If any, it has a slightly alkaline reaction.

It boils at 182° C., and does not freeze at −20° C. On evaporation it leaves no residue.

It is soluble to a considerable extent in water, in which it sinks. It is very soluble in alcohol, ether, and wood spirits.

Solid mercuric chloride when heated with it gives a dark purple mass. An intense purple colour is produced by adding a solution of calcic chlorohypochlorite to a little aniline shaken with water. It stains deal of a yellow colour. It combines with cyanogen, and forms compounds with bromine and chlorine. From aniline various colours are produced, as stated at p. 192, May 3.

Benzoic acid (C_6H_5COHO) forms crystals baving a light feathery snow-white glittering appearance, having the odour of incense, and producing a hot sensation when some of the crystals are placed on the tongue, and an acid taste. Its molecular weight is 122, and one litre of the vapour weighs 61 criths. It fuses readily, and sublimes without residue. It melts at 121°C., and boils at 240°C. Its vapour burns with a smoky flame when heated on platinum foil. It sublimes when heated in a tube, forming acicular crystals, evolving an irritating vapour, and leaving no residue. It dissolves freely in water on adding a little KHO. Water dissolves it slightly, and alcohol and ether freely. The benzoates of the tetrad metals are the only ones not soluble in water. When ferric chloride is added to the acid or neutral solution of benzoic acid, or a benzoate, it produces a pale yellow or brown precipitate of ferric benzoate. When HCl is added to an ammonia solution, it is precipitated in feathery flakes. Calcic chloride gives no precipitate in solution, being soluble.

Plumbic acetate gives a white precipitate of plumbic benzoate in solutions of sodic or potassic benzoate. When heated with strong H_2SO_4, the acid does not blacken or evolve SO_2. Nitric acid has no action, but other dilute acids precipitate the acid from solutions of the benzoates in water.

Benzine (C_6H_6) is a colourless liquid having the odour of gas, but rather more agreeable. Its molecular weight is 78, and one litre of the vapour weighs 39 criths. The specific gravity of the vapour is 2·8 nearly, and that of the liquid is ·85, at a temperature of 15°C. It floats on water. It is neither acid nor alkaline. At the freezing temperature it solidifies into fern-like transparent crystals. It fuses at 5°C., and boils at 81°, evolving an inflammable vapour that burns with a bright smoky flame. The vapour is decomposed when passed through red hot tubes, carbon being deposited. On evaporation it leaves no residue. It is easily soluble in ether, alcohol, acetone, wood spirit, and oil of turpentine, but is insoluble in water. Benzol dissolves fats, oils, camphor, wax, guttapercha, and caoutchouc, and when hot it dissolves iodine, sulphur, and phosphorus. It is dissolved to a red liquid when added by drops to strong nitric acid, and when this solution is poured into a large quantity of water, nitro-benzol is separated as a heavy oil. When benzol is acted on by Br_2, monobrom-benzol (C_6H_5Br) is formed, and by further action two, three, four, or five atoms of hydrogen are displaced. Chlorine has a similar action. Sulphuric acid forms with it sulphobenzolic and disulpho-benzolic acids.

Bruoine ($C_{23}H_{26}N_2O_4+4OH_2$) appears as a white crystalline powder having a bitter taste, but it crystallises in the monoclinic system as oblique rhombic prisms that are transparent.

When heated it fuses easily, giving off its water of crystallisation. When it is distilled with potassic chromate and H_2SO_4, a liquid passes over that, is inflammable, and that burns with a blue flame. When the red solution, with strong HNO_3, is heated, it turns yellow.

Alcohol and boiling water, dissolve it, but not ether. It is more soluble in water than strychnine.

Strong H_2SO_4 gives a red colour when applied to the powder. Ammonia added to the HCl solution gives an oily precipitate that burns into crystals. A solution of iodine in potassic iodide gives, with the aqueous solution, a brown precipitate.

Butyric acid (C_3H_7COHO) is a colourless, thin oily liquid, having the odour of rancid butter. It has a hot, biting acid taste, and on the skin it produces a peculiar gnawing action. It has a specific gravity of ·98.

On evaporation it leaves no residue. It boils at *161° C., and is not solidified at − 20°.*

It is easily soluble in alcohol, ether, water, or sulphuric acid.

Calcic chloride or HCl, when added to its aqueous solution, causes the acid to form an oil on the surface. Butyric ether, smelling like pine apple, is formed when the acid is shaken with alcohol and H_2SO_4. Nitric acid forms with it nitrobutyric acid, and chlorine in the sunlight forms dichlorobutyric and tetrachlorobutyric acids. It forms salts with barium, calcium, copper, lead, silver, soda, &c.

Caffeine ($C_8H_{10}N_4O_2+OH_2$) forms fine white silky lustrous crystals having a bitter taste, and has no odour.

It fuses, when heated in a test tube, and sublimes without decomposition, on the cool part of the tube in needles. It fuses at 234° C.

It is largely dissolved by ether and boiling water, but sparingly in alcohol and cold water.

When a crystal of chlorate of potash is added to a strong HCl solution a red residue is left on evaporation, which, when dissolved in AmHO, gives a fine purple liquid that is bleached by KHO. When KHO is added until the solution is slightly alkaline, there is no precipitate when stirred and set aside. For other reactions for identification, see p. 192, May 3, last.

Carbolic acid (C_6H_5HO) forms long, moist colourless needles, having the odour of coal tar or wood smoke, like creosote, and has a hot taste. It quickly arrests all putrefactive and fermentative changes, and is very extensively used as a disinfectant. The liquid acid is brown, and has the smell of tar. Its specific gravity is 1·065. It is neither acid nor alkaline.

On evaporation it leaves no residue. It melts about 35°, and boils at 187° C.

It is dissolved easily by strong acetic acid, potassic hydrate, alcohol, and ether, but is sparingly soluble in water. When Fe_2Cl_6 is dropped into a solution in water it gives a dark purple colour, and it gives a red solution when dropped into strong nitric acid, and this solution, when boiled and cooled, gives crystals of picric acid. For further reactions see p. 15, March 15 last.

Caseine ($C_{168}H_{264}N_{42}O_{52}S$) is white and opaque when moist, but, when dry, translucent, horny, and crystalline.

When heated it carbonises and emits an offensive odour. Strong HNO_3 colours it orange, and dissolves it when heated. Strong HCl dissolves it when heated, giving a violet solution.

It is insoluble in boiling water, alcohol, and ether, but dissolves moderately in hot alcohol, and easily in saline solution—sal-ammoniac. And coagulated caseine is easily dissolved by solutions of alkalies and alkaline carbonates.

Acetic acid gives a flocculent precipitate with a solution, and in excess redissolves it. KHO dissolves it when heated. Millon's reagent imparts a rosy colour to the solution. When placed in water it slowly swells, becoming white and opaque.

When caseine is in solution it is coagulated at once by acids. Corrosive sublimate and cupric sulphate give precipitates with cold solutions of caseine. Rennet causes caseine to coagulate.

Hugh Clements.

(To be continued.)

INCREASE OF POPULATION.

[14774.]—I thought at first that B. Riley (let. 14752) treated the time quantity as a simple multiplier, instead of the power of the ratio. I find, on checking the actual calculations, that he is quite correct, and that it is only in the printing that it is given as a multiplier. His figures are correct, so that the difference between his result and mine is due to his assumption that 100,000,000 represents the population 2,850 years ago; whereas I accept as my data 2 for my first term, 1,500,000,000 for my last, and the number of terms, 5,882, according to our chronology, and I obtain a ratio greater than that of France, and less than that of England. Will B. Riley now kindly check my calculations as I have checked his? I see he is competent for this task.

J. Steel.

CONTINUOUS BRAKES UPON PILOT ENGINES.

[14775.]—When an engine and train are fitted with a continuous brake, if a pilot engine is required it is not necessary that it should be fitted with the same brake. All pilot engines, however, ought to have the same system of brake as the trains, as, in case of a train engine failing, the pilot at the next pilot station has to take the train forward, and great inconvenience is caused, and the brake rendered useless, if the pilot engine is not fitted with any or a different brake.

Also I am of opinion that every engine fitted with a continuous brake should have the hose coupling at the leading end as well as at the back of the tender. This would enable the whole of the brake power to be placed under the control of both drivers. As it now is, the pilot driver has the responsibility, while the second driver has the control of the brake power. And I know, from my own experience, that the steam of the pilot engine frequently blows down upon the second engine, and thus prevents the second driver from seeing anything for many seconds together.

Another reason why the brake power should work from the pilot engine is, that often when the continuous brake is applied from the second engine, if great care is not taken the pilot engine will break loose.

August 22nd. **C. E. S.**

L. & N. W. ENGINES—"LARGE BLOOMERS."

[14776.]—In accordance with my letter last week, I enclose the list of the above engines—36 in number—and built at about the following dates.—847 to 855, October to December, 1851; 887 to 896, winter of 1852; 987 to 1008, spring of 1861. Following are the principal dimensions: inside cylinders, single engines, driving wheels, 7ft., cylinders, 16 × 22, 195 tubes, 1152 h. surface. The above engines have stood as long a test as any engines on any railway, having run express trains from 1852 up to the present time—27 years' hard running.

847	Odin	992	Stork
848	Hecate	993	Burmah
849	Æolus	994	Ariel
850	Columbine	995	Briareus
851	Apollo	996	Raglan
852	Basilisk	997	Baronet
854	Dalemain	998	Una
855	Sandon	999	Medusa
887	Knowsley	1000	Umpire
888	Hydra	1	Leviathan
889	Camilla	2	Theseus
891	Duke	3	Tamerlane
892	Polyphemus	4	Lucifer
893	Harpy	5	Achilles
894	Trentham	8	Rowland Hill
895	Torch	853	was Vulture*
896	Dædalus	856	,, Ingestre*
989	Archimedes	890	,, Helvellyn*
990	Alaric	1006	,, Proserpine*
991	Japan	1007	,, President*

* These are now scrapped.

I promised to give some idea of the L. & N.W.R. links. The following was the "Wolverhampton" working for May and June of this year of the above class:—

M.	T.	W.	T.	F.	S.
a.m. 11·45	—	a.m. 7·5	a.m. 7·5	a.m. 11·45	—
a.m. 7·5	a.m. 8·55	a.m. 11·45	—	a.m. 7·5	a.m. 8·55
a.m. 8 55	a.m. 11·45	—	a m. 8·55	a.m. 8·55	a.m. 11·45
—	a.m. 7·5	a.m. 8·55	a.m. 11·45	—	a.m. 7·5

The engines running the above trains were—996, 1000, 1002, and 999. The diagrams are as follows:

Wolverhampton	Rugby	London
a.m. 7.5	a.m. 8.22	
	a.m. 9.40	
a.m. 11.15		
p.m. 1.30	p.m. 2.55	
p m. 7.5	4.55	
a.m. 8.55	a.m. 10.20	
	a.m. 10.45	p.m. 12.50
		p.m. 3.0
	p.m. 5.10	
p.m. 7.20	p.m. 5.53	
a m. 11.45		p.m. 2.50
		p.m. 6.0
p.m. 10.0		

Next week I will send the 7ft. 6in. engines and some of their working. Some one asked about an engine named "Panthus" or "Panther." The nearest I know to that name are "Pegasus," "Pandora," and "Panopea;" the former is a 7ft., the two later are 7ft. 6in. In the list of Bloomers, I omitted the three following—viz., 1198, Delamere; 1199, Caithness; 1200, Maberley These are not the same build as the Bloomers, but resemble them in many respects; 1198 was in the Exhibition of 1862; they have 7ft. wheels, inside cylinders. Lately most of the new coupled engines (Webb's) stationed at Crewe have been in for repairs, and the Bloomers 991, 992, 994, 998, 1001, have been working in their place on the London expresses. I saw 998 on the 10 a.m. down a few days back with 15 on, running in fine style.

Egeria.

THE MIDLAND 8 P.M. SCOTCH EXPRESS.

[14777.]—"L. L.," page 585, asks me to explain some particulars in the running of the Midland 8 o'clock Perth express: but before doing so, I must point out that there are several errors in the distances given by him which of course makes his calculations of the speed incorrect. Also one station, Apperley Bridge, is entirely omitted.

I have before mentioned that the Midland day expresses run over the old line viâ Staveley. The night expresses, including the 8 p.m., run viâ Sheffield, thus increasing the distance to Masborough Junction and all stations north thereof by 1 mile 75 chains.

In the following table I give the distances viâ both routes, as they will no doubt be useful for future reference:—

Distance from London.				—		—	Time at stations
Via Staveley		Via Sheffield					
miles	chains	miles	chains			p.m.	min
—	—	—	—	St. Pancras......	dep.	8·0	
49	65	49	65	Bedford	arr. dep.	9·5 9·8	3
99	9	99	9	Leicester.........	arr. dep.	10 13 10·18	5
119	67	119	67	Trent	arr. dep.	10·46 10·49	3
—		158	31	Sheffield	arr. dep.	11·40 11·46	6
185	6	187	1	Normanton ...	arr. dep.	12·23 12·33	10
202	49	204	44	Apperley Bdge.	arr. dep.	12·57 1·0	3
220	77	222	72	Skipton	arr. dep.	1·28 1·35	7
307	60	309	55	Carlisle	arr. dep.	3·30 3·37	7
405	76	407	71	Edinburgh	arr.	5·57	

Running time, 9 hours 13 minutes. Time standing at stations, 44 minutes.

This train arrives at Perth at 8·40 a.m., and the corresponding up train leaves Perth at 7 35 p.m., Edinburgh at 10·30 p.m., and arrives at St. Pancras at 8·30 a.m. These trains run during the months of July, August, and September. The 8 p.m. train is not nearly such a heavy one as the 9·15 express, as there is no Glasgow portion attached to it. In accordance with the judgment given upon the 17th of July, 1877, by the Royal Commission, the Caledonian Company are to send forward by one train each way per diem over their Scottish Central and Scottish North-Eastern Railways, one Pullman sleeping car and a brake van for Perth, one composite carriage for Aberdeen, and a composite carriage for the Highland line, being carriages which the North British Railway Company run in connection with a service between London and Edinburgh viâ their Waverley line to Carlisle and the Midland Railway. The North British are to pay as a minimum the mileage proportion of eight fares for the Pullman car to the Caledonian Railway.

The average load may be taken as equal to 11½ or 12 ordinary carriages between London and Edinburgh; but upon several occasions lately it has been equal to 16, 17, and in one case 21. This train, like all the Scotch expresses, is fitted throughout with the Westinghouse automatic brake. Ten minutes is allowed at Normanton for refreshments, and if it were required the journey could be performed in much less time, by running via Staveley, making less stoppages, and taking time off both the running and station times.

August 21st. C. E. S.

Suez Canal Currents.—At a recent meeting of the French Academy of Sciences M. de Lesseps gave an account of Suez Canal currents, furnished by M. Lemasson, the company's engineer, the result of observations taken since 1871 at Port Said, Suez, and other stations. Notwithstanding Lake Timsah and the Bitter Lakes, which form two great regulators, the north and south branches of the canal are not unaffected by each other. From May to October the winds cause a rise of level at Port Said and a fall at Suez. This difference of level, which reaches about 15·5in., leads to a current from the Mediterranean to the Red Sea—a current which, though interrupted by the tides, drives a considerable volume of water from north to south. In winter, on the contrary, the high winds give the Red Sea a level higher by about 12in. than the Mediterranean, causing a current from south to north. About 14,126 million cubic feet, or about 400,000,000 tons of water, yearly pass from one sea to the other. This, coupled with the tides, tends to neutralise the effects of evaporation from the surface of the lakes and to dissolve the basis of salt in the Bitter Lakes. That basis was 32·8ft. in thickness, but is gradually dissolving, especially in the course of vessels. The velocity of these local currents varies between Port Said and Lake Timsah from 0·5ft. and 1·3ft. per second; while in the broader part, between Suez and the Bitter Lakes, it is from ft. to 3·6ft. per second.

REPLIES TO QUERIES.

◆

**** In their answers, Correspondents are respectfully requested to mention, in each instance, the title and number of the query asked.*

[33029.]—**Electrotyping in 15 and 18 Carat Gold.**—Has "R. N. C." examined the backs of the articles which he thinks are electrotyped? This would be a better guide than merely examining the face of the work. He is doubtless aware that several dies might be used, and the parts afterwards soldered together. Gold is not acted on by acid in exactly the same manner as silver and copper. Gold requires a large excess of acid to complete its solution, and this excess must be removed before the cyanide can be added. Dissolve the alloy in nitro-muriatic acid, pour it off from the chloride of silver, which will be found at the bottom of the vessel, wash this chloride with a little distilled or rain water, and add the washing to the gold solution, which also contains the copper. Evaporate this solution in a porcelain dish. Towards the end of the process the heat should be reduced, as too high a temperature will decompose the chloride. It can now be dissolved in cyanide of potassium, and should make a colourless solution. Before seeing "R. N. C.'s" second communication I had sent a few notes on gilding, which perhaps may interest him. For electrotyping I should imagine a stronger solution should be used than for gilding. I should commence with the usual gilding solution (about the same strength, I mean) and very moderate battery power, and when the mould was well covered transfer to a stronger solution and a more active battery.—Os.

[33390.]—**Decolouring Shellac.**—This is done by dissolving the lac with a sufficient quantity of some alkali (preferably soda) and water to reduce it to a pulp. Chloride of lime in solution is then added a little at a time, extending over a few days, till the lac is bleached. It is then precipitated with a weak solution of sulphuric acid, washed in warm water, and wrung out while warm. A little knack is required, and I should advise you to buy what you want. Can any one tell me if it is possible to get a clear solution of bleached lac in spirit?—Dandie Dinmont.

[33462.]—**Harmony.**—I have only seen one edition of Stainer's "Harmony"—viz., that issued by Novello. It is not founded on the tempered scale, and, as I said in my last answer, is undoubtedly an admirable book for beginners.—C. J. Leaper.

[33478.]—**Electrical Indicator.**—What you want is not an electrical indicator but a patent sounder. This at least is what is described in the number to which you refer—691, page 375—and also fully described in either No. 688 or 689. If you make one of these patent sounders correctly it will give perfect satisfaction, and you can have nothing equal to it for the purpose. If the apparatus is properly proportioned, neither change of temperature nor pressure of the atmosphere will interfere with its accurate indication. There is no electricity about it—it is a simple pneumatic apparatus, very simple yet very clever.—Tyneside.

[33483.]—**London Pavements.**—"Pioneer" might get some details from the City engineer, Mr. Haywood, or from the numerous reviews of his reports in the *Building News*, but a few figures already known may be of use. The first cost of asphalte varies from 12s. to 18s. per square yard, according to quality, the thickness of the layer, and the cost of foundation. The total cost of laying and maintenance for 17 years of the Val de Travers in Cheapside is 40s. 6d. per yard. That in Moorgate-street costs only 27s. 3d. for the same time. The first cost of wood varies from 12s. 6d. to 18s. per square yard, and the cost of maintenance varies from 1s. to 1s. 6d. per year. The annual cost of the three kinds of pavement is approximately 1s. 7d. for granite, 2s. for asphalte, and 2s. 4d. for wood, but until a little longer time has elapsed the figures for asphalte and wood are extremely doubtful. Asphalte foot pavements are decidedly approved by pedestrians and the owners of, or dwellers in basements. They cost 6s. per square yard, whereas York flags cost 9s. per square yard. Wood makes the best road.—Pedestrian.

[33487.]—**Polishing Organ Pipes.**—Polish with crocus and—elbow grease.—J. K.

[33491.]—**Glove Cleaning.**—Try curd soap and milk.—Deputy.

[33491.]—**Spirit used by Glove Cleaners.**—I beg leave to repeat my statement that "benzine collas and such like preparations" are common petroleum spirit. I never said that benzol was the same as petroleum, because I know better. It is true that benzol has been called benzine, and perhaps may be still by some. It is sometimes called benzoline, but he who wanted benzol, and asked for either benzine or benzoline, would stand a poor chance of getting it. Let "Roy" try. "For cleaning gloves," says "Roy," "it matters not which is used." But it matters a good deal to "Delta" if one costs 1s. a gallon and the other 7s.—Dandie Dinmont.

[33498.]—**Harmonium Tremolo.**—A description of one is given on page 329, Vol. XXI. I found it answered very well.—Novice.

[33504.]—**Honey Dew.**—In South Australia most of the forest trees have a yellowish blossom, which, during the day, give out a very sweet perfume, and ascends above, but during the night and early morning (when the atmosphere becomes lighter) a dew falls, which is called honey dew, attached to some trees more than others. As soon as the morning light begins to appear an immense number of bees are seen collecting the honey, but half an hour after sunrise all the dew has ascended above.—J. Steele.

[33506.]—**Mineralogy—Wavellite.**—In reply to "F. W. S." I beg to say that 40 years ago or so I found wavellites in a quarry about 7 or 8 miles east of Barnstaple. I had one specimen, the best I ever saw, in which the wavellites were ¾in. in diameter. The following occurs in Brand's "Dictionary of Science," &c., edition 1853:—"Wavellite, a mineral named after Dr. Wavel, of Barnstaple, in which neighbourhood it was first found. It is a hydrated phosphate of alumina; it has also been called hydrargillite." My specimens were of a light topaz yellow, but opaque. The following extract from the "Encycl. Brit.," Vol. VII., p. 638, edition 7th, art. "Davy," may assist "F. W. S." In 1805 he (Davy) read two papers to the Royal Society: the first was "An Account of Some Analytic Experiments on the Wavellite." Sir Humphry Davy was of west country origin, and so it appears are wavellites.—J. L. H. S.

[33510.]—**Snoring Horse.**—Has not "E. B. F.'s" horse turned "roarer?" There are plenty of them about, and there is no cure.—Not a Vet.

[33527.]—**Gold-Fish Tank.**—Slate bottom, mahogany posts and rails, glass let into groove in slate with putty to which white lead has been added. Cover all putty seams with two coats of oil gold size.—Nemo.

[33563.]—**Rash.**—Without doubt this is a case of eczema, and as such can be certainly cured if the sufferer will only turn vegetarian. I give this advice from experience, and am also able to state that none of the enjoyments of this life will be lessened if he makes the change, for, as a rule, all stomachic complaints, such as constipation, indigestion, &c., can be cured by a pure and well-selected vegetable diet. If querist will write and give particulars to Mr. Bailey Walker (the secretary of the Vegetarian Society), Massie-street, Cheedle, Manchester, he will receive full information respecting diet, &c., free of charge.—Arthur L. Cooper.

[33567.]—**Ancient Literature.**—Obtain G. Smith's "Assyrian Researches," containing photos and translations thereof, published by Sampson Low and Co., London, price 18s.—Deputy.

[33569.]—**Bath Bricks.**—These bricks are made at Bridgewater, Somersetshire, from the mud of the river Parret. The name of Bath bricks is taken from the name of the first maker, a Mr. Bath.—Furnace Feeder, Manchester.

[33570.]—**Leamington Kitchen Range.**—I, unfortunately, am not among "the few mistresses who have common sense enough to manage a prize range," and, if "L." will help me out of my difficulty, he will have my deepest gratitude. For 30 years or more I had been accustomed to the old-fashioned grates, which, luckily for my family, I had "capacity enough to manage;" then I removed to this place, where the range I will try to describe is universal:—An open grate, which can be contracted at pleasure; self-feeding L. boiler and oven, which is my special crux. It is horseshoe-shaped inside, has revolving perforated shelves, ventilator, and lots of polished ironwork outside—very grand to look at. There is a slit close to the top on the side next the fire, through which we clean the under side of the top plate, and a hole at the back. It requires a large fire to heat it, and when hot this is the result:—A cake or tart placed in the centre of either shelf gets black on the side next the fire, moderately brown on the three others, and is raw in the middle. You may turn round the shelf, and blacken all four sides, but the centre is still uncooked. At first I blamed the cook, and undertook to try myself, but failed ignominiously. Then I sent for a bricklayer to take out the range, and ordered him to send for me when it was quite clear of the setting. I found the bottom plate of the oven rested on a solid mass of brickwork; so no wonder the cakes were dough in the middle and heavy—there was no bottom heat to make them rise. The bricklayer said "it wanted a 'ot air chamber—that was it;" so he chipped away a hole about 2in. deep, and re-set the range, and I tried to hope, though my "common sense" refused to believe. The only benefit was to the pocket of the bricklayer. My landlord won't give me a new range; so we go on as usual, and I only wish "L." could have seen the tapioca pudding that was part of my dinner to-day. Perhaps he is a manufacturer of these "fancy ranges;" and, if so, any hint for the better management of mine and similar ones will be gratefully received by many others beside—Delta.

[33595.]—**Leyden Jars.**—Your failure is undoubtedly caused by bad glass. I made six out of confectioner's glasses. They were as clear as crystal, and about the right thickness, but neither from one or the whole lot could I get a spark. I afterwards obtained unfitted jars at very moderate price, and which answered admirably, from Caplatzi, in London. Even Professor Tyndall has had much of your experience, so don't despair.—J. W.

[33596.]—**Powdered Wood Charcoal.**—I fear "W. Foster" will find the tests for charcoal "blacking" detailed by "Anon" and "Jack of All Trades" somewhat cumbersome. If, however, he will take a small quantity of good charcoal and a like quantity of bad, and throw them on a fire or into water, and observe the different actions upon ignition and the different specific gravities, he will at once obtain a ready test of quality for the future. As to price the finest powdered charcoal can be delivered, ex rail at London, at £6 10s. per ton, guaranteed pure. "W. Foster" is perfectly right as to the very common adulteration with "breeze"—*i.e.*, ground coke.—Manufacturer.

[33604.]—**Theta Delphini.**—In my query on p 585, on Theta Delphini, I ought to have said (though no doubt it would be understood) that I saw nothing of it with the naked eye. I have glimpsed it since, though on two clear nights it was not to be seen by myself and another, both having good sight.—Twenty Hours.

[33611.]—**Chemical Food.**—Thanks to Mr. D. Scoffern. If he would kindly publish through our columns said formula, as given in the "Pharmacopœia," I should be thankful.—W. W. B.

[33623.]—**Dido.**—Elisa (surnamed Dido) was the daughter of Belus, who was the son of Phœnix, the son of Agenor. This Agenor had a brother named Belus, whom I take to be the same with Ithobal or Ethbaal, the king of Tyre, and father of Jezebel. This, I own, is only conjecture, as there are several relations of the family about the same period, of the name Belus.—Ernest Sprague, Lynn.

[33628.]—**Diving.**—I think with "B. Snooks" that "Law Student" used the word "diving" as meaning "taking headers." The word "plunging" would have been more appropriate. "Novus Homo" rightly says "in diving (*i.e.*, plunging) the palms of the hands are used to steer with," but in swimming under water they are used in unison with the legs, and not for steerage merely. "Law Student" wants to know as to possible damage to the skull in taking headers without hands in front of head. I do not think damage to the skull need be feared, but there might be injury to the upper portion of the spine and consequently to the nerves, in so plunging from a great height. Doubtless the hands do "make a hole for the head to enter." "Law Student" adds one more reason for placing hands before head—viz., "the hands are thereby ready to strike out *the moment the diver is in the water.*" The hands ought not to be removed from their first position until the force of the plunge is nearly exhausted. The first plunge I ever took from any height was into 6ft. of water in a bath from a board about 4ft. 6in. above the surface. I removed my hands too soon to "strike out," and the result was that I took the skin off my nose for more than an inch by contact with the bottom of the bath.—Amphibian.

[33633.]—**Entomological.**—In asking this query by some mistake I said the insects had 6 legs. They have 8, and 2 short antennæ. Their average size is about a mustard seed.—T. S.

[33641.]—**Portable Equatorial.**—Why does not "Athelstan" get one of the optical instrument-makers who advertise in "ours" to make him one of those very portable equatorial arrangements, larger and stronger than there described though, designed by Dr. Wentworth Erck, and described upon p. 548 of "our" last volume.—F. C. Dennett.

[33653.]—**Repairing a Vice.**—The right way to do this is to twist the strip of iron round the vice-pin, letting it stand up quite 3-16in., so as to form another thread in appearance. This must be filled up with another strip of iron, only much smaller than the other. It should fit tight into the other. This is called a double thread, and, when brazed in proper, will last a lifetime. This will never pull out, and is equal to a solid thread, while single threads are often being pulled out.—Chelt.

[33673.]—**Grey Bricks.**—A mixture of loam and chalk with some of your clay will give your bricks a grey surface when burnt. Try 1 of chalk, 2 of clay, and 1 of loam, washed together. Scarify the surface of your bricks when green with a comb, lattice fashion. A cast-iron mane comb such as is used for horses will do. When the bricks are made a lad can dip them, and strike them over the face and sand. The experiment is worthy the trial. The slip must be like stiff cream.—Jack of All Trades.

[33675.]—**Ventriloquism.**—The best book I ever came across pretending to teach this art (which one of our professors once gravely informed me in conversation was a gift) is that by F. Hardy—one of Warne's 6d. bijou books. Careful study (and practice) with this book, and a couple of hours watching of a public performer made me a proficient. It is an art which must, when learnt, be "kept up." Every one who knows how to ventriloquise is not a ventriloquist. The chief drawback is want of assurance, for a ventriloquist wants it as much as does a conjuror. The eyes and motions of the performer must be kept fully under control, but must still be natural to throw the listeners off their guard. Every one's voice, too, is not fit for this; a high-pitched voice is very seldom a good one to admit of the necessary modifications. A thorough knowledge of this art puts a marvellous entertaining power in the hands of a man. Much misconception exists, however.—*F. C. Dennett.*

[33676.]—**Working Men at the Paris Exhibition.**—The cheapest and most picturesque route is by Newhaven and Dieppe, by night service, leaving London Bridge at 10 p.m. on Saturdays or Mondays. Procure Baedeker's "Guide to Paris." It is invaluable, and the best one extant. If "Montreznous" cannot speak French he will find a French and English pocket dictionary very useful. As to lodgings he will find in some parts they ask the most exorbitant prices, entirely beyond the means of a working man. I can, from experience, recommend the following hotel, where he can obtain a bed for about two francs and a half per night—that is, if he does not mind sleeping near the gods:—Hotel St. Honoré, 38, Faubourg St. Honoré, near to the English Embassy. He could have his breakfast there if desirable. As to dining, avoid the principal boulevards, and seek the narrow side streets. Procure a plan of the Exhibition and a "Guide." No doubt a catalogue of the part most interesting to him would be very useful if he could afford it, but the catalogues are very ponderous affairs. There are two ways of viewing the contents of the Exhibition: taking each country separately, or taking each building or avenue—for instance, the gallery of machinery first. If the first day should happen to be a fine day take the buildings all round the outside of the main building. Be sure and do not miss the Street of Many Nations down the centre. As his time is so limited no doubt his best plan would be to select such parts as are most interesting to him as a working man. I spent four days there. This was not nearly long enough for a superficial glance; it would take a week at least. When dining at the Exhibition seek Duval's Restaurant at the Port Tourville, at the south-east corner of the Exhibition. This is the most economical. Avoid cabs. Bus and tram riding is cheap; 3 sous is the usual fare. Splendid views of Paris are obtained from the top of the Arc de Triomphe, the dome of the Pantheon, and the beautiful Parc des Buttes Chaumont. The latter is well worth a visit. Baedeker's "Guide" gives a full description of all the places of interest, and contains a most excellent sectional map. Stick to the prices of admission to different public buildings given in it; they will try to screw more out of you if possible. At the Arc de Triomphe, for instance, they tried the system of extortion upon us, but failed through our steadfastness to what we knew was right. When I arrived at St. Lazare, for a basin of cold water and a towel, without soap or comb, I was charged a franc and a half, and in addition the garçon required his *leetle* fee. Take what linen you require, such as shirt-fronts or collars. I repented not doing so, thinking I could buy them there, but alas! I did buy them. One has to find soap and candle at the hotels, which, for economy's sake, it is best to buy elsewhere. One word as to sea-sickness. I tried an empty stomach and repented. I believe to go on board with a full stomach is much the best.—Fred. W. Shearing.

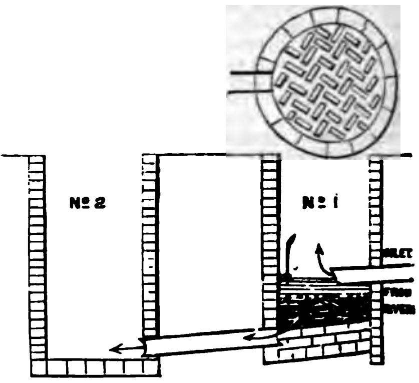
[33677.]—**Gas Holder.**—I should advise "Old Patron" not to attempt this experiment in one holder. The gas, if at atmospheric pressure, condensed from 120ft. to 1ft., would give a pressure of nearly 1,800lb. por sq. in., and considering that every lb. requires a height of 28in. of water, putting this and that together, I think that he may travel a long way before he gets height enough of water to compress what he requires.—Jack of All Trades.

[33678.]—**Chiming Clock.—Repeater.**—A small chiming clock, new, to be worth anything, cannot be had for less than from 15 to 20 guineas. A plain gold repeater, compensated and adjusted may be had from a good maker—any one else would be useless—at from 75 to 85 guineas. The highest price in silver is 75 guineas. But what, in the name of wonder, can a man of small means want with such expensive toys? In these days of night lights repeaters have gone out of fashion, even amongst the rich.—S.

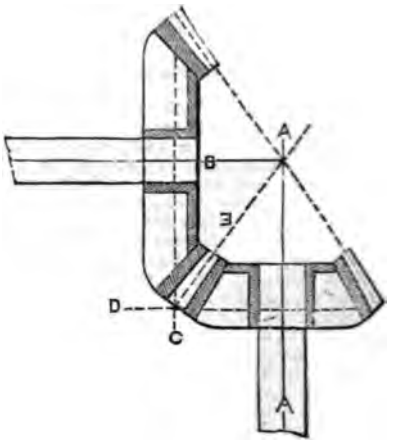
[33681.]—**Cast-Iron Chambers of Pumps.**—I should not make a pump of that size less than ⅜in. thick; half that would probably stand the pressure. I know of no work upon it. There is a rule for it, and I think I have seen it in Weale's "Engineer's Pocket-book," or Van Nostrand's."—Jack of All Trades.

[33682.]—**Cleaning and Rebronzing Old Lamp Stands.**—If iron, take off the brass mountings; take some sulphuric acid, and put it into a stoneware cistern, pan, or foot-bath; proportion one part by weight of sulphuric acid to 12 of water, and place them in pickle; watch them, and when all the rust is gone off transfer to a bath of common soda, ½ to a gallon of water, and scrub with sand and the outside shell of a cocoa-nut or a fibre brush; well rinse in clean water, and thoroughly dry. Coat them with gold size, and with a camel's-hair dabber cover with bronze powder when tacky; they must not be too wet, or you will not make a job of them. Stand aside to dry, dust off, and give them a coat of glaze, with a little water in it. After they are dry lacquer them, and put them in an oven to brighten, and it is done.—Jack of All Trades.

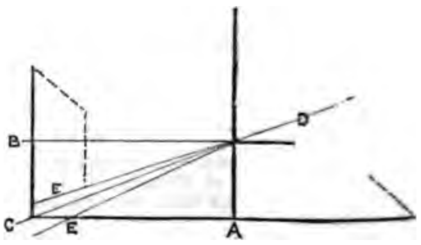
[33685.]—**Filter for Water used in Steam Boilers.**—If you have convenience, sink two shafts as per sketch. Stein them around with bricks and cement if you like. That will depend upon the nature of your soil. If open soil, you will lose your water unless cemented; if clay, it will not be required. Brick the bottom of No. 1—the receiving tank—and make the bottom fall towards No, 2. Over the bottom place bricks on edge, zig-zag, as shown. Upon this put a layer of flats, then good coarse washed ballast 18in., then finer ballast 12in., then 12in. or 18in. of good sand upon the top. You cannot have a cheaper or more convenient filter for your job. When it is choked, pump No. 2 out dry, take 6in. of sand from the top, and add some fresh. The other may be washed and stored for the next time.—Jack of All Trades.



[33686.]—**Bevel Wheels.**—Let "H. W. N. W." measure the diameter of each wheel at the pitch line, then draw lines, A and B, at right angles; then draw lines, C D, half diameter, parallel to A B; draw line, E, through point of intersection. Mark breadth and depth of tooth on E, and draw the wheels out, like sketch. The above is the 9in. and 13in., reduced one-twelfth.—G. Newall.



[33686.]—**Bevel Wheels.**—This I have explained in back numbers. The centre of any and each wheel required, A and B; the pitch line is through C and D; and E, top and base of teeth.—Jack of All Trades.



[33690.]—**Waterproof Covering.**—Let "J." get some yard oakum, and chop it up fine, and make some putty of boiled oil and whiting. Well beat the former up with it, rake out the joints, and caulk with it, and you will be all right.—Jack of All Trades.

[33691.]—**Ciders.**—The best cider is made near Bridgwater, Somersetshire. I keep mine a year before I tap it, and regularly draw from the hogshead; if you bottle it will keep for years. The time to buy is the spring (of the previous year's make.)—M. S.

[33695.]—**Screw Pump.**—It is possible to raise water by the means of a screw, but it must run at a very great velocity and be submerged. The only sort of screw applicable for the purpose is a turbine. I am not aware that either one will draw water, as it is termed. But when immersed it will lift water to a considerable height; the faster it is driven the higher it will lift. Speed from 700 revolutions to 1,000 per minute.—Jack of All Trades.

[33701.]—**Cheshire Lines.**—The answer given on page 585 is not quite accurate. The main line the Cheshire Lines Committee (which, as your aders are aware, is a joint committee of the Mid-ad, Great Northern, and Manchester, Sheffield, and ncolnshire Railway Companies), commences at dley junction, where it joins the Manchester, Shef-ld, and Lincolnshire main line, running to Ape-orne junction, then exercising running powers to oodley junction, a distance of 29 chains, over the e of the Midland and Sheffield Joint Committee, ence through Stockport and Warrington to the ntral station at Liverpool, with branches to Ches-r and other places. Also by a new line om Glazebrook to the new central station at anchester another direct route is established tween Liverpool and Manchester, and hourly press trains are run, performing the journey in 45 nutes. This committee have a large amount of nt rolling stock, which is marked with the letters L. C., but no engines, as the locomotive power provided by the Manchester, Sheffield, and ncolnshire Company. The Midland Company work their own express, goods, and special trains over Cheshire lines with their own engines. The dland and Sheffield Committee, as its name plies, is a joint committee of the Midland, and anchester, Sheffield, and Lincolnshire Railway mpanies. The first part of this line commences at de junction, where it joins the Manchester, effield, and Lincolnshire main line, running thence New Mills junction with the Midland, including Hayfield branch. This line was transferred by reement from the Manchester, Sheffield, and ncolnshire Company to the joint committee on the ening for passenger traffic of the Midland main e in February, 1867. This committee also own the w direct line from Romiley junction to Ashbury, er which the Midland Manchester express trains n; also the curve from Romiley to Bredbury nction, which forms the direct Midland route to verpool, and the curve from Reddish to Brinning-n junction, which forms part of the route direct om Manchester to Stockport. This committee has joint rolling stock, each company running their wn trains over the line.—C. E. S.

[33701.] — **Cheshire Lines Railway.** — I am bliged to "L. L.," page 585, for assisting me, but I m sure that there is a new route at Trent. I have, or years, travelled between St. Pancras and Man-hester, and have always stopped at Trent station ome minutes. Since July 1st I have many times one by the 12 and 3.30 p.m., and up by the 1 and .30. These trains turn on to a line direct for the outh, and do not go near Trent station. I find all rdinary trains run to Derby, but when I came from merica a short time ago we came to London in a pecial express, and did not go to Derby, but over a ew route. As an M. S. and L. shareholder I can say ur main line to Manchester is owned by ourselves. he M. and S. committee have no share in it, only unning powers. Please give running of Midland .30 expresses up and down.—PASSENGER.

[33701.]—**Cheshire Lines.**—The reply of "L. L.," . 585, to the query in respect to the above, contains ome inaccuracies, and as the Cheshire lines are often eing referred to I have no doubt your readers would e glad of further information on the subject. The ailway of the committee from Liverpool does not erminate at Stockport (where the Midland trains eave the system), but is continued 5½ miles further o Godley junction, where it forms a connection with the main line of the M. S. and L., and by means f it with the G. N. "L. L." omits all mention of n important section of the committee's line, which rings very considerable salt and other traffic on to he main systems, and which is, moreover, singularly nough, the only part of the Cheshire lines which is n Cheshire. I mean the one from Chester through Northwich to Altrincham (whence the trains are ontinued over the Man. South Junc. and Altrincham ine to Manchester), with the Helsby, Winsford, &c., branches. Of the lines in progress mentioned by "L. L." only one, the North Liverpool Extension, s being constructed by the C. L. C. The Widnes ines belong to the Sheffield and Midland Committee referred to below); the line from Glazebrook to Wigan is being constructed by the Wigan Junctions Railway Co., and is to be worked by the M. S. and . alone, and the authorised Macclesfield and Knuts-ord has also been undertaken by the M. S. and L. olely. The only unfinished portions of the Cheshire ines system, therefore, are the North Liverpool Extension, and the Central Station at Manchester. These are, no doubt, very costly, but in the case of he latter, at any rate, the traffic is being developed ery largely during its erection in a temporary tation. I think "Passenger" must have been mis-aken about the initials M. and S. C. at Marple, for lthough frequently there, I have never seen them, nd "L. L." is certainly wrong in his explanation f them. There is no "Midland and Sheffield Committee," but there is a "Sheffield and Midland Railways' Committee," and the initials to be seen at Marple are "S. and M. J. L." (Sheffield and Mid-and Joint Lines). The terminus of these lines (in hich the G. N. has no share) is Hayfield, not New Mills, which is the junction with them of the Mid-and line proper. At Romiley the line from Hayfield ivides into three, one of which proceeds to Stock-ort, where it joins the Cheshire lines, thus giving he Midland access to Liverpool, and the other two f which join the M. S. and L. main line, one, "the ld route," at Hyde junction, near Guide Bridge, and the other, "the new route," at Ashbury, nearer Manchester. By means of this latter, the Midland at present obtain their access to Manchester. There is also a short branch from the Cheshire lines at Stockport to the "new route" at Redditch, by which a service of trains runs between that town and Manchester, and, in addition to all these, there are the Widnes lines in progress. The Macclesfield, Bollington, and Marple is vested in another committee of the M. S. and L. and North Staffordshire Companies (whose lines it connects), called the "Macclesfield Committee." These "committees" are composed of delegates from the owning companies, and being incorporated, have a separate legal existence distinct from any of those companies. Their composition is analogous to that of the M. S. J. and A., which is a company (formed before committees were thought of) comprising two shareholders only, the L. and N. W. and M. S. and L. Co's. While writing I may as well correct another apprehension as to the Midland main-line trains. Those from London to the North do *not* go through Derby. With the exception of the midnight train from St. Pancras, they proceed from Trent to Clay Cross over the Erewash Valley line, thus saving 6¼ miles. This route is not available for the Liverpool and Manchester trains, Clay Cross lying *north* of Ambergate, and they are therefore detached at Trent, and proceed through Derby.—R. N. H.

[33707.]—**Strain on Crank Pin.**—The strain on the crank pin (owing to the four tons on the drum), would be a sheering strain of 14¼ tons. The actual strain would be rather more, owing to friction, &c. The four tons act on a lever 8ft. long, and the strain on the crank pin on a lever 2ft. 3in. long. The relation of the forces is inversely as the lengths of the levers on which they act thus:—As 2ft. 3in. : 8ft. :: 4 ton : 14¼ ton.—TRAP ROCK.

[33713.]—**Mechanical Stoker.**—Small coal will make as much steam as you are using with round coal, if you use a proper furnace feeder. See advertisement in to-day's ENGLISH MECHANIC.—FURNACE FEEDER, Manchester.

[33714.]—**Anemometer.**— Dr. Prestel's anemometer is of no value as a scientific instrument. It does, however, roughly indicate the pressure of the wind, and to do so at all effectively the vane should have an area about five times greater than the plate. The holes in the vane will depend upon so many points as to their position. Thus, the size, weight, and leverage of plate must be taken into account, and I cannot give you the positions unless I have all these points to work from. However, you can readily get their positions by having the anemometer fixed upright, and then have a loop at the back, to which attach a string. Let the string go over a pulley, about 18in. behind, and upwards. Now, as the area of the 6in. is ¼ that of a 12in., hence ¼lb. on the 6in. will indicate 1lb. per foot. Weight the other end of the cord with ¼lb., then mark vane (this will be 1lb. per foot). Then weight ½lb. This will be 2lb. per foot, and so on, until the scale is finished. You will, however, be slightly in error when above 4lb. or 5lb., as the plate will be so inclined as to register only a part of what it does when vertical. This is the bad part of Prestel's anemometer, and to obviate this some years ago (when I had meteorology on the brain) I devised several forms of anemometer, one of which resembles in part Prestel's, but is different in so many features, that I then called it "The Lancaster Anemometer." If you feel inclined to make it, you will find sufficient explanation below. Any further instructions you may require you know only requires a query. The Lancaster Anemometer consists essentially of a vane after the usual form, with a tube connected to centre of vane, and working over the pivot. The tube is 18in. long. Near the top of this tube are two pulleys on opposite sides. The tube goes 12in. above vane, and near the top are two arms going down to the pressure plate, which should be 6in. square. Another pair of arms, 6in. below upper arms, go to the bottom of the plate, thus forming parallel arms. The arms may be made of sheet metal, but I prefer wire—about No. 12 B.W.G. copper. This, you will see, keeps the plate always perpendicular, and thus at any point it is accurate. From two points in the plate there are two cords, which pass over the pulleys on tube, and have at the bottom a ring of iron or lead, free to move. Now, when the wind blows, this weight will be lifted, and its height will give an index of the pressure of the wind, rings being painted round the tube to indicate the differences. The leverage of the plate will also indicate the pressure, and if you think proper, you can have holes in the vane; but the ring can be seen anywhere, whereas the holes in the vane can only be seen in one direction on each side. With an anemometer of this description you can get accurate indications.—W. J. LANCASTER.

[33715.]—**Etching on Glass.**—You cannot do better than put a thin layer of wax on the bottle, then work out with a needle or graver in a handle the name, &c., you want to etch. Warm the cylinder and rub the wax over. But if you have a lot to do have a bath of melted wax, and dip the cylinder in cold. Let excess run off.—W. LANCASTER.

[33716.]—**Etching on Glass.**—Proceed as above, then make guttapercha moulds or dishes to hold a small quantity of hydrofluoric acid, and to fit the bottle tightly. When the bottle is ready put it in the tray, and don't let the acid touch any part, or it will leave the depressions clear instead of semi-opaque. Swill when finished.—W. J. LANCASTER.

[33718.]—**Softening of Cast Iron.**—Take some ordinary whiting and pack them in a sheet iron box. Give them three or four hours at a red heat, and let the fire die out. You will find that this will soften the hardest cast iron or steel.—JACK OF ALL TRADES.

[33724.]—**Hens and Eggs.**—Will "Anglo-Dane," who answered this query on p. 609, let me know how he keeps a fowl on 1½d. a week—what he gives them, and how much?—H. T.

[33724.]—**Hens and Eggs.**—"S. M." asks how many eggs is it possible to make a hen lay? The best information that I know of was printed in Thorley's "Almanac" for the year 1864. I remember it gave an account of a henery establishment about 21 miles from Paris, where the owner kept 100,000 hens, which average more than an egg a day. 100 persons were employed to look after them. The hens are fatted after they are 4 years old for the market, as are all pullets. They consume the flesh of 22 horses weekly. The eggs are all hatched by steam. The extent is twenty-five acres of land.—J. STEELE.

[33726.]—**Circulation of the Blood.**—It is impossible to say how long any given corpuscle would be in going through the body, but it is readily ascertained that the volume of blood expelled each systole from the left ventricle multiplied by systoles per minute will give a volume equal to the whole of the blood in the body, and on this calculation it is stated that the blood circulates in so many minutes or seconds. This is a very crude method, and one that is unreliable, for the blood flowing through the coronal arteries and veins circulates in a few seconds, whereas the corpuscle which leaves the left ventricle and proceeds down aorta, thence to one of the toes, then up again, reaching the inferior vena cava, thence to right auricle, through tricuspid valve into ventricle, thence through pulmonary artery into lungs, and down pulmonary veins to left auricle, and into left ventricle, must of necessity take a much longer period of time, so that any hard and fast line cannot be hit upon; but we may safely say that no corpuscle takes more than three minutes going from and returning to the left ventricle.—W. J. LANCASTER.

[33727.]—**Printing Machines.**—I should say a "fast Bremner" would best suit your purpose, which will produce 1,000 perfect 4-sheet demy newspapers per hour.—C. LARK.

[33728.]—**Thunder and Lightning.**—Remember that for every five seconds between flash and thunder the flash is one mile distant. This you will find quite as accurate as any measurement you can get. You may either read the seconds off a watch dial, or count them, the latter preferred when you have learned how to count accurately. The velocity of sound roundly is 1,120ft. per second; hence, in five seconds the sound should travel 5,600ft., or 1,866yds. This is 146yds. beyond a mile, but the difference is inappreciable, for the distance over which every flash travels is so great that it is impossible to get an accurate distance.—W. J. LANCASTER.

[33730.]—**Hexagon Heads to Screws.**—In answer to "A Young Hand" I should say first rub the scale off the head of the bolt with an old file, next turn it down to the diameter required, measured across the corners of the hexagon, and flatten the head, so that you may use a square for getting the sides upright in the subsequent filing. Next, with the aid of a division-plate (if you have one) make a scratch with a sharp scriber for each angle of the hexagon, using the edge of the hand-rest T (or tee, as it is frequently erroneously written) as the guide or ruler along which to draw the line, and then file away the sides down to those lines. If your spanner is got out to a hexagonal form inside, it makes a capital gauge both for diameter of head and also for the angles of all the sides after the first two are done, and, in fact, renders you almost independent of a dividing plate for this purpose. If you bear in mind that each face of a hexagon is in breadth just half of the diameter of the hexagon measured across the corners, or, as a mathematician would say, of the circumscribing circle; and if you set your dividers to that half diameter, and commence filing on two opposite sides of the bolt head, taking care to keep the faces you produce of equal width and parallel to each other, and at the same time square with the flat head of the bolt, using the dividers as test of width, and the square as test of uprightness, and the spanner as test of ultimate size, you can hardly make a mistake. If you had a great many to do it would be worth while to fit up a circular cutter to mill them, but from the nature of your query I judge that you want to learn how to do them without a machine. I have supposed all along that your screw has been centred already for putting in between the cone centres of the lathe. A small rectangular piece of sheet steel, with a notch made in one edge to the angle of 120°, is a useful gauge if your spanner is not filed out hexagonally inside. I never do mine so, but round them out to a half ellipse, as I consider it a better and stronger form. Two three-square files tied together, or merely held in contact while filing, will give the angle of 120°.—J. K. P.

[33731.]—**Barometer as a Weather Guide.**—When the mercury is high it sometimes rains, when low 'tis sometimes fine, but generally barometer rising indicates fine weather; barometer falling indicates wet weather, the position in inches being of small moment.—W. J. LANCASTER.

[33732.]—**A or An.**—Your correspondents generally on this subject lose sight of the fact that long u is pronounced in two ways, and that high authority can be appealed to in support of each way. It is pronounced as a combination of consonant y + oo, and as a diphthong = ee + oo. In the former case, a should should be used before it; in the latter, an would be proper. An before u might, as "A. E. S." says, lead to an equivoque, as "a new tree" for "a yew tree." It is, however, questionable whether yew is ever pronounced as a diphthong by educated persons; but, if it is, it may be retorted that "a ewe" might be taken to mean "a yew." It is amusing to find two of your correspondents derive "an from the Latin *unus*, through the French *un*." They might as well derive it from Irish or Welsh. The English, who certainly did not borrow their five, twenty, hundred, or thousand from the French, would scarcely need French assistance to reckon one. Being derived from and being cognate with are very different things.—OMEGA.

[33732.]—**A or An.**—Is h silent in hair? and is ewe pronounced yew? I think not. Would it not be well to employ some sign or mark to signify how the u was to be pronounced in doubtful cases—say, for instance, the sign or mark made use of in Spanish to denote the consonanta sound? And is not the consonanta sound often employed where it ought not to be?—AN IGNORANT MAN.

[33743.]—**Phlegm in Throat.**—I was sorely troubled with this from the age of 14 up to last Christmas (about 5½ years), when I visited an eminent doctor here (Peterborough). He was very particular in asking me if it was not a mere habit I had of expectorating, but on examining my throat he said it was slightly "relaxed." He then gave me a recipe, which acted like magic, clearing my throat of large quantities of phlegm. It is, of course, in the usual gibberish, which I cannot translate; but I should be happy to forward it to C. Lark, if he will advertise his address. Before taking this gargle, I was at times almost totally unable to speak until I had expectorated.—BELL.

[33744.]—**Swimming Below Water.**—I thank "B. Snooks" and "Law Student" for their replies to my query. "B. Snooks's" reason for keeping his eyes open in plunging (viz., to judge of his dive by seeing his reflection) is, no doubt, a good one; but may not the fact that after a time his eyes get sore be due to that mode of entering the water rather than to swimming below with eyes open? As I have said, I always enter the water with eyes closed, and open them below the surface, and yet I am considered to make a "clean plunge." Will any of "ours" oblige by giving authentic statistics of the longest distances accomplished under water, giving the time, and stating strength of, and whether with or against, the current (if any)?—AMPHIBIAN.

[33749.]—**Plants.**—1. Yes, if syringed two or three times a week, or if kept in a Wardian case. 2. Must have no sun—a north window being the best. 3. No. 4. They are not injurious if you have only a few plants, as the gases are emitted from them in such minute quantities. 5. Beeton's "Shilling Gardening Book," and Carter's "Practical Gardener," 1s.—CLEER.

[33750.]—**Rifling Machines for Guns.**—The simplest rifling machine consists of a long bar of wood, which may be fixed in any convenient manner horizontally, or sloping slightly downwards, the higher end being about breast high. At one (the lower) end is fastened the barrel that is to be rifled, and at rather more than its own length from it is another barrel with any convenient number of grooves (one would do) to serve as a longitudinal guide for the cutter rod, and at the same time to give it the required twist while passing up and down. Of course the guide barrel must have in it grooves of the same amount of twist as is required in the one to be operated on, as, *e.g.*, one-half turn in 39in. for an Enfield, or one turn in 20 or 22in. for an Express or Whitworth small bore, and this would make a simple bench of this kind a very expensive one for jobbing purposes, involving as it does a different guide barrel for every variety of twist. Fig. 1 shows the beam of wood so marked with the barrel, B, fixed near one end, the guide barrel, G, near the other end (these should be strictly straight with one another). At the end of G is a dividing plate, D, for giving the number of cuts or grooves required in the barrel. In this arrangement it is to be observed that the barrel operated on is kept a fixture, and the guide, G, is turned round a portion of a circle for each successive groove. Now for the cutter and rod. H is a steel head, technically called a cutter-box, screwed or soldered on to the rod, R, which, in this case, is a solid one. We may come to hollow ones after a bit. The cutter, C, is let into a mortice in the cutter-box, and is forced upwards by a spring inserted in the bottom of the mortice. It is of the nature known as a saw-cutter, being made with a number of teeth, which are usually placed very diagonally, so as to have a shaving action on the metal in the same way as skew plane irons have upon wood. It cuts both ways when the rod is pulled or thrust indifferently. L is a lump of lead cast on the rod, R, which has previously been inserted in its place, with H inside B, and some greasy tow wrapped round R, for the double purpose of holding R central in G, and forming a bottom to the mould. The portion of the rod inside, L, has been filed clean and *well-tinned, to insure the lead* adhering to the rod when cast on. E is a wooden handle for drawing the rod up and down, and S is a swivel joint, to allow the rod to revolve without resistance. Plenty of oil is used during the operation which cannot require any further explanation. I believe it is pretty well understood now that plain rifling—that is to say rifling that continues equally deep throughout the whole length of the barrel, and of an even degree of twist also—produces as good or better results than any other sort. Some old Enfield rifles used to be ·014 deep in the grooves from end to end, afterwards altered to ·014 at the breech end, diminishing to ·004 at the muzzle. And I have myself obtained splendid results with rifling that actually disappeared at the muzzle entirely. These fancy plans of rifling require a machine made specially, and a machine that is prepared to do all and every sort in combination if required, and to feed its own cut, and to leave off cutting when it has done its work, and to take in double rifles as well as single ones, with a self-acting lubricator to the cutting tool, such as I fitted up some years since for a friend in the gun trade, becomes an elaborate and costly instrument. In this machine the barrel, B (Fig. 2), is held in the "barrel holder," which is a heavy headstock provided with biters lined with hard wood, and with a worm wheel and tangent screw for turning the barrel round after every cut. The cutter itself is hooked with a long spring shank like a note of interrogation (?), and is sharpened inside the hook. It is supported while cutting by a long thin wedge filed on the end of a steel rod, which passes down the rod, R, in this case a tube, and also down the centre of the cutter-box, C, which is drilled through for the purpose. At the termination of each cut the wedge is withdrawn, to allow the cutter to spring down out of contact, and previous to the next cut is again thrust in a little more than before for the next cut. Fig. 3 is a half-size longitudinal section of a cutter-box for an Enfield rifle, the full size being about 9in. long. It shows the cutter, C, supported endwise by a tail screw, S, with its wedge, W, to raise it formed by flattening out the end of a long steel rod, which passes right through the hollow iron rod, R. This latter is made of small gas barrel, and is soft-soldered into the steel cutter-box for about an inch of its length. If the cut is to be a taper one the wedge is withdrawn, not suddenly at the end of the cut, but gradually driving the cut, and I knew one case where a rifle had to be grooved taper for the first half or two-thirds of its length, and parallel the rest of the way, which in this machine is just as easy, but requires a little preparation. The Enfield machines were similar in principle, but had solid rods, and the cutter, which had a sloping back to its crook, was forced down an inclined plane by the action of a screw tapped into the end of the cutter-box, the said screw being held steady during its traverse by a long square rod sliding through a bearing, while the cutter-box was turning round, thus diminishing the cut as it went; and the bearing of the square rod itself was twisted round in one direction to relieve the cut, and back again and a little more to give the next cut by the action of the machine. I do not remember what machines are now used at Enfield for rifling the Henry barrels; indeed, I am not sure that the barrels do not come to Enfield ready-rifled. I think it is the universal practice to cut from breech end to muzzle end, and to cut off a piece of the muzzle after the rifling is done; at least, in sporting rifles it is so. The method of obtaining the degree of twist in the barrels, that is always adopted now, and, I believe, invented by the late Mr. John Evans, of Wardour-street, at least for this purpose, though it appears in old drawings of fusee engines for clocks and watches, is by a rack, R, Fig. 2, turning a pinion, P, attached to the rod, R, the rack itself being drawn to and fro by a guide-block sliding up and down in a shallow trough, T, of cast-iron, which is placed alongside, but more or less inclined to the main bed of the machine, according to the twist required. A curved trough gives an increasing or decreasing twist as required, and a crooked trough was employed at Woolwich to produce the grooves of the so-called shunt-gun. I once rifled a pistol in my lathe, using a piece of sheet-iron with a sloping edge, and bent round to form a portion of a cylinder of which the rifling rod was the axis, as the guide, and a short lever keyed on the rod was kept in contact with the edge of this plate by the force of my wrist as I drew and thrust the rod in and out. The cutter was set forward each trip by a tap with a hammer, and the number of grooves (seven) given by the division plate. It made a very good job indeed, and shot very well.—J. K. P.

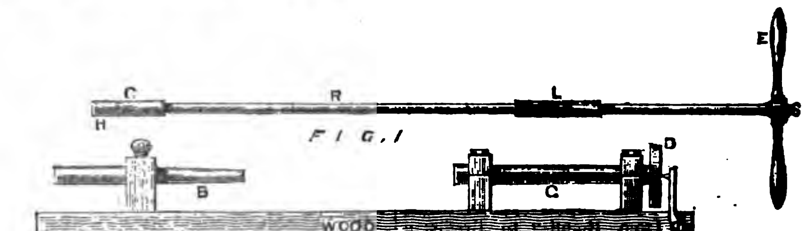


FIG. 1

FIG. 2

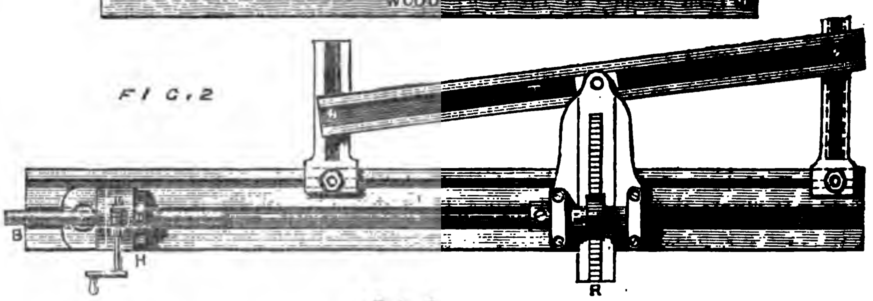
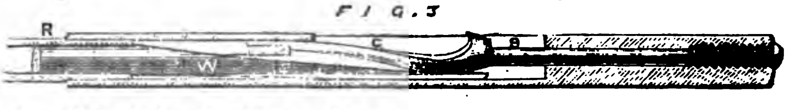


FIG. 3



[33750.]—**Rifling Machine.**—The following sketch will perhaps enlighten "F. M. P.:"—A, a plank of wood, oak, beech, or deal will do, 15in. × 1½in. × 8ft.; B B, two side pieces, 1½in. × 5in. × 4ft., screwed upon the sides; C C, two pieces of light T-iron screwed along the side for carriage, one piece T-iron, D, pivoted at centre, and set screw at both ends, I I. This is the guide for driver. The carriage consists of a piece of beech 2in. × 6in. × 18in., cut to the stage, shown at Fig. 2, and a recess cut of

FIG. 1.

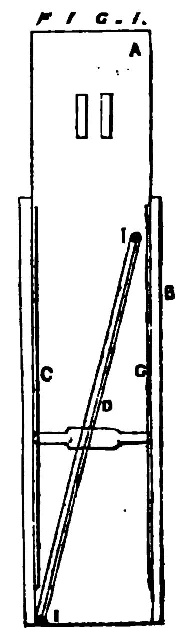


FIG. 2

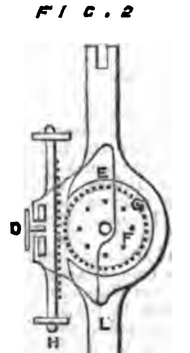
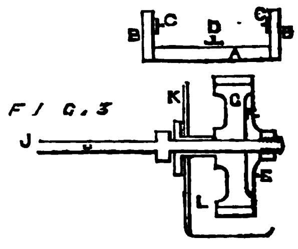


FIG. 3



ntre for the reception of a toothed wheel, C, and iler flange, F, through which passes a piece of ½in. be or steam or gas barrel, screwed fast into the iler flange. Pass through the cog, G, and wood, with a plate of iron screwed on E and K, in which runs loose, and forms a sleeve to fasten your bar r cutter, I, which is shown at Fig. 3. The flange, tter-bar, and tube revolve without the cog, and n-holes for pin or screw are made in the flange, 5, 6, 8, whatever you require, and one hole in the g-wheel, the flange thus made into a dividing ate. There is a traveller at H, consisting of a gun-etal rack running upon two wheels at end. There e two cheeks in centre for two plain rollers along e guide, D, Fig. 2, this giving you the desired rists as the carriage is shoved to and fro, with the ke of D upon the bed of table. The mortices at d of bench are for saddle to fix your barrels upon.—ACK OF ALL TRADES.

[33761.]—**Time at the Antipodes.**—In sailing und the world, starting from England, viâ the ape of Good Hope, it is evident that the ship is oving in an opposite direction to the course of the n—namely, from west to east. For this reason a me will be gained each day, varying in proportion the amount of easting made (say, 10 minutes), d when the mid-day observation is taken the ship's ock (which shows the apparent time) is put forward e number of minutes corresponding to the degrees longitude made, so that by the time she arrives at e Antipodes she will be 12 hours fast of Greenwich parent time. If she continue her course, by the me she reaches England she will be 24 hours, or a hole day, ahead. To avoid this, when the ship gets to longitude 180°, the same day is counted twice, aking the week consist of 8 days. When this has een done she is now 12 hours slow, which, however, e makes up on the return voyage. But supposing e went out by the hour from east to west, she ould be losing time, and would be 12 hours slow hen she got to the Antipodes, and would have to kip a day to make up for lost time. Suppose the two ips to meet (Greenwich time being 8 p.m., August t) before the odd day had been allowed for, the ip's time, whose course had been west to east, ould be 8 a.m., August 1st; the other's, that had een sailing with the sun, would be 8 a.m., August nd; both times being equally correct, or rather correct. Thus it will be seen that the answer to e query will depend on which way the person took get to the Antipodes, and any one living there ould be at liberty to choose whether he would be st or slow of Greenwich time, and would be wrong hichever he chose.—HESPER.

[33761.]—**Time at the Antipodes.**—I copy the llowing from a penny tin plate sold at most fancy hops and ironmongers. When it is 12 o'clock noon n London (population 3,250,000), at Paris it is 2.10 p.m. (population 1,825,274); at St. Peters-urg it is 2 p.m. (population 539,475); New York, .5 a.m., (population 954,613); San Francisco, 0.20 a.m. (population 149,482); Rio Janeiro, 9.8 .m. (population 600,000); Auckland, 11.45 night population 55,605); Sydney, 10.5 p.m. (population 3,688); Yokohama, 9.20 p.m. (population 1,700,000); anton, 7.30 p.m. (population 1,210,000); Calcutta, .50 p.m. (population 600,000); Constantinople, .55 p.m. (population 1,076,000).—DUNDEE.

[33764.]—**Rescue of Drowning Persons.**—The est way to rescue a drowning person is to carefully pproach him from behind so that he cannot grasp ou. Turn on your back under him, get his head pon your chest, and grasping him firmly with either ne or both hands by the hair or else by the neck nder the jaws, strike out with your feet. To prac-ise this method, as I have been doing within the ast week or two, get a friend who can float on his ack, and try as above, and you will be surprised ow easily it can be done. The person does not eem to be any incumbrance whatever. The awk-ward point is to turn underneath, but a little prac-ice will soon get over it. This is not only the best ay, but I firmly believe is the only way suited to escue non-swimmers. There is another way that will do for those who can keep cool in the water which 99 out of 100 cannot) when off their feet. That is for the person to put his hands lightly on our shoulders just so as to be able to keep his outh above water, both being in the ordinary wimming position. You cannot be too careful ith whom you practise this way. All other methods hich I have tried only result in a turning round of he persons in the water without any advance. There has been a little discussion in the columns of he ENGLISH MECHANIC lately about keeping the yes open when under water. There is a common rror which first arose in Franklin's advice to wimmers, that if the water is entered in diving ith the eyes shut they cannot be opened. This is glaring fallacy. I have never had the least diffi-ulty in opening and shutting my eyes when under he water, nor never heard of anybody who had. I annot enter the water with my eyes open when iving in, and I think that the eyes will always nvoluntarily close, dreading the shock with the ater. It may be that the winking may be so quick s to be unnoticed, but still it is there. I cannot magine how a person like Dr. Franklin ever came o circulate this delusion.—LOFTONIAN.

[33765.]—**Photographing Instruments.**—If A." will say what size he requires to photograph is instrument, it will be easy to give a definite eply. A quarter-plate portrait lens will not give accurate and definite actual size over more than a 6in. or 7in. circle, and then it must be closely stopped down. I expect "A.'s" camera, rather than the lens, is at fault. The portrait combination is constructed to give the largest amount of light with average definition. The question about accurate engravings is not quite clear. Does "A." wish to produce engravings from ordinary photo-graph negatives? That cannot be done, but photo-graphs in printing ink can be made from good nega-tives, or engravings can, if of a good colour, be reproduced full size by photo-lithograph. I shall be glad to give "A." further information.—A. PUMPHREY.

[33767.]—**Sore Skin from Shaving.**—I cured myself of this nuisance some time ago by anoint-ing the part with glycerine every night before going to bed, and dusting it with some of Matthews's pre-cipitated fuller's-earth after shaving.—C. J. LEAPER.

[33767.]—**Sore Skin after Shaving.**—Before you begin study the grain of your beard in the glass, and do not shave against the grain. In some beards the grain runs from one ear to the other, instead of both shaping to the chin. In others the grain runs half way down the neck, and then half way up. Next wash very thoroughly before you shave in warm water, which will be lathering No. 1, rubbing the beard with the lump of soap and fingers with good perseverance. Then commence lathering No. 2, using the brush with really hot water, aiming to produce as thick a soapy composition on the skin as possible to fill up the spaces between each hair. Dipping the fingers in a little oil as well softens the beard, and prevents the lather drying so quick. You cannot lather too much. Strop your razor on your own hand, and throw your gritty wooden razor damager away, and preserve your razor from damp by wiping it only on chamois leather. Never lay a razor down open, and put it away safely in its case. If you will take extra trouble in the lathering you will get an easy shave. Hairdressers set razors better than cutlers.—HAIRDRESSER.

[33769.]—**Mechanics—H.-P. of Engines.**—There are almost as many rules for finding the h.-p. of engines as there are engineering firms, and each firm swears by the accuracy of its own formula. The Admiralty rule for obtaining the nominal h.-p. of a condensing engine is the following:—

$$\frac{\text{area cylinder in in.} \times 7 \times \text{vel. in ft.}}{33{,}000} = \text{N. H.-P.}$$

For any engine the following formula is useful:—

$$\text{H.-P.} = \frac{\text{area cyl. in in.} \times \text{effec. pres. in lb.} \times \text{vel. in ft.}}{33{,}000}$$

—T. E. J.

[33774.]—**Depositing Copper on Iron.**—Make a weak solution of sulphate of copper, and add to it a little sulphuric acid. Polished iron articles dipped into this solution will be instantly coated with copper. If the coating has a frosted appearance, and can be removed by the finger, the solution has been too strong. There are other methods in which a galvanic battery is used, and of which particulars can be had in any book on the electro-deposit of metals.—JOHN MCLAREN.

[33778.]—**Photographing.**—I am scarcely in a position to judge of the cause of the colour without knowing what colour you have got, and whether it is after developing only or intensification. I have got varying degrees of "olive green" besides a very dense dirty green, which, by reflected light, looked like black, but I have not been able to satisfactorily account for the differences. With the exposure equal to wet plate, and 1 to 10 drops of the ammonia and bromide solution, I usually get a smoky green much darker than that of commercial gelatine plates with the developer only; but I believe the colour depends more on the original preparation of the plates than would be supposed at first sight—that it is, in fact, the greater or less fineness of grain of the bromide of silver in the film, and that this is greatly influenced by the more or less rapid mixing of the silver with the bromide and gelatine, and the way in which the silver is quickly brought into intimate contact with the bromide after each addition by shaking thoroughly. If this idea is correct, the less silver added at one time, and the greater the shaking, the better the emulsion when completed. You will also find that the more rapid you make (or use) your plates the less dense the film is after development, the developer not seeming to have time to reduce all the bromide before fog comes. I have not tried benzoate of ammonia with gelatine plates, but when experimenting with "Newton's collodion emulsion" I tried benzoic acid, and also gum benzoin, but found them to be "retarders" only, and I think they would so affect the gelatine process. I tried 70 or 80 "organifiers" on the latter, but have come to the conclusion that the gelatine itself is the best and only needful accelerator, and all additions to pure bromide of silver and gelatine are hurtful. Of one thing be sure—however handy you may be in the art, in gelatine you improve as you go, provided you—FINEM RESPICE.

[33780.]—**Teaching Singing.**—Nature having given you a fair voice, your age is no bar to your attaining proficiency as a singer. Send to Cramer's, 201, Regent-street, for a copy of Wilbye Cooper's excellent little book, entitled "The Voice, the Music of Language, and the Soul of Song," price 1s.; and get also Barrett's "Chorister's Guide" (Rivingtons, price 2s. 6d.). By the aid of these works, and with diligent practice of scales and the exercises at p. 111 in Barrett's book, you will soon make satisfactory progress. But if you are within reach of a good teacher of singing you will do well to put yourself under one; but remember that the great Henry Phillips says that for every one good teacher of the art of singing there are ninety-nine bad ones. The "Musical Bouquet" has a very useful book, "Garcia's Singing Tutor," price 2s. 6d. net, which you might also beneficially make use of, as it gives pianoforte accompaniments to the exercises.—NE SUTOR.

[33782.]—**Morocco Leather Chairs.**—Get a 6d. bottle of Judson's dye, the colour you require to match. Pour on it about a quart of boiling water, and apply to the seats. You will have to apply it all over for the colour to dry regularly. When dry give it another coat. After this is dry, make a size by dissolving about ¼oz. of good isinglass in a gill of cold water, then place it on the fire until dissolved, apply with a sponge, and rub in with the palm of the hand. Be careful not to use too much size, or it will look smeary. When dry and nicely done they will look as fresh as new.—CHARLES CUTHBERT.

[33790.]—**Wooden v. Iron Cogs in Wheels.**—Wooden cogs are used in conjunction with iron for various reasons, of which the following may be considered the chief:—1. Iron and wooden teeth work together much better than if both were wood, or both iron, because, when one of the wheels has wooden teeth, the wearing will be more uniforn, for that wooden tooth which receives the principal strain will compress and yield a little under the pressure, so as to allow the adjacent pair of teeth to come into close contact and take their share of the strain; but solid metal teeth cannot yield at all, and if there is the least want of exactitude in the pitch of the teeth they will be worn very rapidly, although iron teeth which are very truly pitched will last a long time. 2. In the action of the teeth of wheels each succeeding pair of teeth which come into contact must meet each other with a slight blow, and if the motion be rapid, and the pressure considerable, the successive blows will make a violent noise, and tremour, which is much greater when both sets of teeth are made of iron than if one set is made of wood, for they will yield a little, and ease that tremour. 3. The cogs of the larger wheel should be made of wood, and those of the smaller one of iron, in order that they may wear more regularly. The thickness of the iron teeth should be rather less than the space between them, in order to allow the wooden teeth to be rather thicker than the iron ones, and thus give strength to the wooden ones. The strength of teeth depends more upon the pitch, and less upon the breadth; but the wearing depends principally upon the breadth, although the rate of wearing depends in a great measure upon the rapidity of action. Wooden teeth are not so proper for slow motions as iron ones, but for quick motions they should always be used.—ADYE DOUGLAS.

[33795.]—**Work on Clockmaking.**—The only practical work is Reid's "Treatise," published by Blackie, Paternoster-buildings, 21s. I have never been able to meet with a second-hand copy.—STYLUS.

[33798.]—**Rheumatism.**—I advise "Borrowdale" by all means to try a purely vegetarian diet—that is, if he wants a thorough cure, and not a "patch up." I know numbers who have been perfectly cured by a vegetarian diet. I have been myself a strict vegetarian and abstainer from all drinks except water for three years, and the result is perfect health, which I was far from having before. This is the experience of hundreds of others who have tried this mode of diet. Don't be influenced by others who have never given it a fair trial. A three months' trial of vegetarianism and you will never again know the agonies of rheumatism.—MILO.

[33807.]—**Boiler Question.**—1. Not necessarily so; the boiler, in use by itself, can be pressed to a higher or lower degree than that of the two in connection. When boilers are connected together, the pressure on each is alike, as is shown by the gauges; this is on account of the steam being able to form an equilibrium in the whole of the boilers, as it has free access to them all. 2. This question is not an easy one to answer, as its solution depends on a variety of circumstances. The boilers may be of different construction—one requiring more fuel for the same amount of pressure than the other. The best way to get a correct solution would be by a practical experiment; but there are few boilers that could sustain the pressure singly where two have been necessary for the work, unless the working pressure was much below the actual working pressure of the boilers.—T. E. J.

[33809.]—**Curing Indiarubber.**—Procure a sulphur bath. This is merely a process of heating sulphur in a pan to 280 degrees, and allowing the articles to be cured to be immersed for one hour at above heat. The heat or time may be varied, just according to what you are curing. To join edges of rubber first see that these are dry and clean, then coat the edges with a very thin solution of Para varnish, allowing sufficient time for drying before putting together.—NEGROHEAD.

[33810.]—**Electric Pen.**—(1) Special paper is not required, and it should not be wet. (2) The ink appears to be ordinary printing ink. (3) The roller appears to be an ordinary printer's roller.—SUB.

[33813.]—**Steel Stoves.**—The following recipe will, I think, answer "Housewife's" query:—Beat into 3lb. of hog's lard 2 drachms of camphor, sliced thin, till it is dissolved; then take as much blacklead as will make it of the colour of broken steel. Dip a rag into it, and rub it thickly on the stove, and the steel will never rust, even if wet. When the stove is to be used again, the grease must be washed off with hot water, and dried before polishing.—C. Lark.

[33814.]—**Steel Stoves.**—If "Housewife" will rub her bright steels over with melted mutton suet, and afterwards dust with powdered quicklime tied up in a bit of coarse muslin, she will find them keep quite free from rust.—Delta.

[33814.]—**Steel Stoves.**—Thoroughly sprinkle with powdered unslaked lime.—Cuckoo.

[33819.]—**Photographic.**—The only name by which the dye is known is "chrysoidine," and it is not sold in the cheap (or packet or bottle) form. The maker being an advertiser in "ours" (much to his profit, no doubt), I presume the Editor will allow me to say that, after inquiry at a good many provincial chemists' and stock-dealers' without success, I saw his advertisement in "ours," and, though he gave no address, I wrote through the post, and got a reply from Daniel Judson and Sons, Southwark-street, near The Grove, S.E., saying they could supply me with an ounce for 2s., post free. I used one pint of methylated spirit, about 80grs. of "chrysoidine," and 3oz. of good shellac, and it took a week to dissolve, shaking occasionally. This covered 9 square feet of glass with two coats.—Finem Respice.

[33820.]—**Damp Walls.**—All who are troubled with damp inside walls should know that the old remedy is the best and effectual—laminated lead. If it comes off, try it again.—Mechanical Stoker.

[33821.]—**Pressure of Air.**—The atmospheric pressure at sea level, under ordinary degrees of temperature, is 14·6lb. per square inch; the barometer would stand at 30in. for the pressure. In your second query, for the greater simplification of the calculation, we will assume that the water-gauge for 76,500 cubic feet of air is required instead of for 75,000, as the former amount is exactly three times the quantity whose water-gauge is given. 25,500 cubic feet of air has a water-gauge of ·71in.—it would be necessary to employ 2·85 h.-p. to produce it. Quantity is in proportion to the cube of the power, so that if 2·85 h.-p. is necessary for 25,500 cubic feet of air, 27 times that horse-power would be required for 76,500 cubic feet—that is, 76·95 h.-p. would be necessary. This power produces a drag, as shown by the water-gauge, of 6·4in., which is something enormous.—T. E. J.

[33822.]—**Black Dyeing.**—The following recipes are from "Chambers's Encyclopædia:"—*Common Black:* Take 3lb. sumach, and treat with hot water; steep the goods in the hot decoction for some hours, wring out, wash for ten minutes in lime water, and for thirty minutes in a solution of 2lb. copperas. Wash the goods well in cold water, sometimes repeating the treatment with lime, and re-washing; then work the goods for thirty minutes in a warm solution of 3lb. of logwood, and afterwards with 2oz. copperas; work again for ten minutes, wash, and dry. *Jet Black:* Proceed as before, adding 1lb. of fustic with the logwood; and when 3 pints of iron liquor are used, instead of the 2oz. copperas, a more brilliant black is obtained. The above is sufficient for 10lb. weight of cotton or woollen goods.—C. Lark.

UNANSWERED QUERIES.

The numbers and titles of queries which remain unanswered for five weeks are inserted in this list, and if still unanswered are repeated four weeks afterwards. We trust our readers will look over the list, and send what information they can for the benefit of their fellow-contributors.

33231. Bagpipes, p. 379.
33251. Parallel Motion, 379.
33252. Induction Coil, 379.
33263. L. C. and D. R. Engines, 379.
33264. Centre of Gravity, 379.
33265. Punching Machine, 379.
33276. Organ Stops, 380.
33281. Lathe Castings, 380.

33463. The Lemon Cure, p. 482.
33466. Sizarships, T.C., Dublin, 482.
33467. Engine for Boat, 482.
33468. Purification of Manganese Chloride, 482.
33469. Distillation of Shale, 482.
33470. Equatorial, 482.
33474. Adulteration of Whiskey, 482.
33476. Trotting Machine, 482.
33478. Electrical Indicator, 482.
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33499. Metal Flute, 483.
33500. Communication, 483.
33503. Injection Water, 483.
33532. Cutting Pebbles, 483.
33534. Screw Cutting, 483.
33536. Lathe Bands, 483.
33537. Jewellers' or Silver Soap, 483.

QUERIES.

◆◆◆

[33900.]—**Paint for Lanterns.**—Can any one tell me of a substitue for the japanned preparation generally put on lanterns, as I use mine for house work, and the above preparation produces an unpleasant smell?—G. T. Burton.

[33901.]—**Smith's Work.**—Will any reader oblige by informing us what illustrated or other books are published on smith's work in general, also farriery?—J. Briggs.

[33902.]—**Saddle of Von Zubovitz.**—Can you give us a sketch and description of the double indiarubber saddle, inflated by air, which keeps the horse and rider afloat with ease, and used by the Hungarian Lieutenant, Von Zubovitz, in his swim on horseback down the river Thames? Also its weight and size.—Horseman.

[33903.]—**Composing Machine.**—Would some correspondent describe (with drawing if possible) the construction and mode of working the type-composing and distributing machines used in the *Times* printing office? How many types does it take in, and how many different kinds of type are used in that office?—A. D.

[33904.]—**Seeing the Bottom of the Sea.**—I require an instrument of some sort to enable me to see the bottom of the sea when a boat is moving through the water. Any information how to make same, and what depth I could see the bottom clearly with will oblige—One at a Loss.

[33905.]—**Arc of Circle.**—Will some one kindly give me a rule to find the points for the arc of circle by ordinates from a chord line, having the chord and versed sine given, so that I can use it for striking engine beams, &c.?—Ordinates.

[33906.]—**Model Steamer.**—I wish to make a model steamer, something like the White Star line of vessels in shape, 4ft. to 4ft. 6in. long, with engines, two boilers, and two funnels. Now what I want to know is the best sort of wood to make the hull of, and the best way to make it. What width and how deep should it be? How, and of what, are the engines and boilers to be made, or would it be cheaper to buy them ready made? If so, where can I get them, and about what price would they be? They must be fixed cylinders and not oscillating. The boilers I want fitting, so far as possible, same as the large ones; in fact I want the model to be as perfect as it is possible to make it. Rough drawings, especially of the hull, would greatly help and oblige—W. H. B.

[33907.]—**Chemical.**—Would "Daghbert," or other correspondent, kindly say what is the proper technical name and symbols of sulphuric ether, and from what materials can it be best and cheapest produced? What quantity of materials are required to fill a space of 15 cubic metres with the gas. I am aware of the inflammability of the gas, but require it for trade.—Not a Chemist.

[33908.]—**Concrete Buildings.**—I shall be much obliged to any of the numerous readers of the Mechanic for particulars as to concrete buildings, the cost in comparison to brickwork. I want to build a small house: two rooms on ground floor, two upper, with a shed or lean-to at back. A friend of mine requires a porch, such as he could put up himself. He would be obliged for plans and estimate of probable cost.—Asphalt.

[33909.]—**Moderator Lamp.**—I do not think in all the numerous volumes of "our" Mechanic can be found a detailed description of the internal mechanism of a moderator lamp of the best kind. If any one conversant with them would contribute to an early number a good description of construction, as well as the method of taking out the inside spring, it would add an item to our store of useful knowledge contained in the English Mechanic, and oblige one of the oldest members of our fraternity, as well as probably prove useful to others.—Ignoramus.

[33910.]—**L. and N.W.R. Engines.**—"Itzaex," p. 504, replying to query 33414, says "there are three engines of the 'Caithness' class—viz., 'Delamere,' 1,198; 'Caithness,' 1,199, and 'Maberley,' 1,200." Are these the three which were built by McConnell, with 7ft. 6in. driving wheels and inside cylinders, one of which (then No. 373) was in the 1862 Exhibition? Were they the same build, or have they been re-built in pattern like the "Bloomers?" What is the original date of construction, and where do they run?—R. N. H.

[33911.]—**S.E.R. Locos.**—Will "G. L. P." please say if the cylinders are inside or outside, as his reply, p. 585, does not state, and if the framing is inside or outside, whether flush boiler or not, &c.? While greatly indebted to those correspondents who supply information for the readers of the English Mechanic, the latter are frequently placed in a dilemma as to some particular which, probably, to those who reply is an insignificant matter, or an oversight, but for those seeking information is really an important item; for example, in giving description of an engine, in some cases, the position of cylinders or framing is entirely omitted.—R. N. H.

[33912.]—**Lime Juice or Lime Cream.**—I beg to thank D. Strathearn for his reply to my previous query as to how the above preparation is made. I have tried the receipt he then gave, and found it is not a success. The ingredients do not mix thoroughly, and on standing a very short time they separate into three layers. I added a little CONaoHo to one portion, with the result that only two layers have been formed. I should esteem his promise of further receipts, and also how to mix, a favour. Will he or any other correspondent oblige?—J. T. W.

[33913.]—**Railway Brakes.**—In March last a return was sent to Government showing how many brakes each line has. Can any one give the result? Also how is a passenger to know by the look what each brake is? Can those who understand it tell by the tubes what each one is? If so, please enlighten us. I saw a dispute a few nights ago: a railway man could not fasten the two pipes of a Smith's vacuum to the train of a new patent with one pipe. The engine was (Dubs and Co., 1877) No. 1,343, the train the 5 p.m. ex-London, 8.15 ex-Derby (M.R.). Is it true that no more Smiths are to be fitted up, as the one pipe brake is to run in place of it?—Passenger.

[33914.]—**Paper Slates.**—Can any of our readers give me the composition of these paper or parchment slates, and describe how the composition
Tobit.

[33915.]—**Royal School of Mines.**—
tell me the conditions on which the Scie
scholarships to this school are held—wheth
of such scholarships can have any business
during the three years of tenure, and if be
both morning and evening classes? Any in
this subject will greatly oblige—Tobit.

[33916.]—**Turning Crank Sha**
"J. K. P." give me a little instruction ho
with turning a crank shaft for a pump? I
how to turn the bearing for connecting
never seen one turned. We have a good
lathe. The height from top of saddle to c
and the crank will be 12in. stroke, so I am
shall have to raise the headstocks. A rough
ing how to fix the shaft in the lathe would g
—Anxious to Learn.

[33917.]—**Burning Sawdust.**—Will
correspondents inform me what means are ad
mills to burn sawdust? I find that by thro
the coal fire it deadens it and makes it impos
up a proper supply of steam. I should be
of some means whereby its combustion can b
and enable me to have a bright fire with only
portion of coal.—A. W.

[33918.]—**Leather Suction Hose.**—Ca
tell me how this is made by machinery or oth
the solution for coating the canvas? I mean t
for fire engines, having a spiral wire inside,
five plies of canvas, and finally covered with
bound with copper wire.—M. W.

[33919.]—**Size of Battery for Electr**
lurgy.—Would "Sigma," or some other corr
kindly give me the following information
should be the dimensions of a carbon or coppe
be used with a zinc plate of about 14in. × 10in
tery used for electro-plating or metallurgy? 2.
sulphuric acid and nitric acid the best for
should sulphate of copper be substituted for
acid? 3. What number of cells should I req
posit a pound of copper from two quarts of a
tion of the sulphate, and how long would it ta
it necessary to use the cyanide of potassium wit
tion of the salt?—Common Sense.

[33920.]—**Derby Cream or Furniture**
—Can any subscriber kindly give me a recipe
the above?—Charles Cuthbert.

[33921.]—**Making Ice.**—Would some rea
inform me how I could make the above in
tities of about one pound in weight, what
would be required, and if an amateur could ma
so, a few instructions would greatly oblige—Cu

[33922.]—**Skeleton.**—Will any geological
dent kindly say where the skeleton was found
on p. 45, Vol. 1, "Popular Educator," as h
30 feet below the earth's surface? Any particu
be of great interest to general readers.—J. St

[33923.]—**Circular Cog Wheels.**—Can
readers tell me if circular cog-wheels have eve
eccentrically, as some people say they c
together? Is this the fact?—Member Amateu
cal Society.

[33924.]—**Chemicals.**—I am informed th
other iron manufacturers are now making use
phite of soda. Can any of our readers give m
mation as to the service it performs and object
the manner in which it is used, or could the
the way of obtaining reliable information on t
which is of much interest to the writer?—An

[33925.]—**Building Societies.**—I shoul
the opinion of some correspondent on the adv
disadvantages (if any) of building societies.
there are a very great number of such societ
local papers lately contained letters from sev
complaining that there were too many so
affirming that they keep up the prices of p
bubble figure, which will cause collapse and
day. It is important to know whether this co
happen, under any circumstances, and I trust
will interest other subscribers.—Jib.

[33926.]—**Thickness and Weight**
proof Steel Armour-plate.—Will some
me what thickness and weight per foot of s
plate would resist a Martini-Henry rifle-ba
range?—Cyprus.

[33927.]—**Money Lenders.**—Can any
kindly inform me the maximum interest
lenders can legally charge on different securit
(too many) unprincipled lenders not only ge
interest from their victims, but also take p
goods (under bill of sale) at the shortest notic
no legal remedy?—Jib.

[33928.]—**Mock Moon.**—A curious phen
witnessed at Haverhill, Suffolk, on the mor
13th inst., shortly after the eclipse of the
ended. At about 2 a.m. there appeared a se
under a thin cloud, to the left of the real o
exhibited beautiful colours like a rainbow,
after that it vanished. Very shortly afterwa
appeared to the right of the moon, at just t
tance, and vanished as the first had done.
appeared at about 2h. 10m. a.m. Will som
kind as to furnish me with an explanation o
menon?—Vaughan Cornish, Debenham, Su

[33929.]—**To "Organon."**—I am abou
your instructions (of last winter) in the m
American organ. I intend to have two ro
8ft.) and sub-bass, but, wishing to have t
should be glad to know (1st.) will the two
that scale, or must I have 2½ rows to obta
Wishing to have a good full tone, how muc
supply sub-bass) must I have the reservoir
than your dimensions? 3rd. How are sub-bas
actuated? Kindly illustrate and state if exte
lowest octave for this purpose can be bough
extend them myself, and how? Also is the
frame sold with, and included in, the cost
Are the keys to have screws in them as in h
4th. In your reply—page 505, present volume
you state, "you need only buy the 4ft. voic
them for the 8ft. row." As I am an gno

ies, should be pleased to know what copying
/ould unvoiced 8ft. reeds be as soft and service-
ced, and would they chord well with 4ft. voiced
arly reply will oblige—Cecilian.

—Railway Situation.—I am desirous of
er an engineman or fireman, and am recom-
apply to either Carlisle or Crewe, as I will get
t of the shed. Will some kind subscriber give
as to best company, and wages while cleaning
?—W. Stephenson.

—Mercuric Ethide.—What apparatus is
or the preparation of mercuric ethide ($Hg\ Et_2$) ?

—Orrery.—Could any one give plain directions
of which a mechanic could construct an orrery
e movements of the planet round the sun ?—W.

—Copyholds.—Would "Lex," or some other
it, kindly explain the following ? In a certain
ere the copyhold tenants are admitted by the
f the manor, the words "to whom the lord of
manor by his said steward did grant seisin
the rod, &c.," are used in the admittance. Is
aracteristic of copyhold that the lord is actually
l the copyhold lands of his manor ? What then
ing of the word "seisin" as used in this admit-
oes the lord in this case actually part with his
retain a mere seignory over the estate thus
Student.

—Chinese Sea Weed Isinglass.—In a
nber of the *Manchester Weekly Times* it is
e weeds are sorted, dried in the sun. Simply
ater they yield a clear gelatine, which finds its
rge quantities into Europe under the name of
As I occasionally use isinglass pretty largely
bscriber tell me if this Chinese isinglass is to be
n England ? If any correspondent has it on
advertise my address.—S. B. S.

—Boat Building.—Several articles have
n these columns lately on this subject, but
iefly of flat-bottomed craft. "Backwoodsman"
No. 666) gave a very clear account of building
s, and the modus operandi seemed so simple
been surprised at not seeing it touched upon
ppears to me that after getting out the tem-
vork is as plain and straightforward as build-
ottomed boat. I intend building a small sailing
worked single-handed; a model, on the scale
the foot, of a sea-boat (with full lines), 29ft.
all, 10ft. 6in. beam, 5ft. 3in. deep amidships
ale to keelson. I propose rigging her as a cut-
all be very glad of information on the follow-
—Is the style of building "Backwoodsman"
s suitable for so small a boat ? Although the
s a cutter and a good sea-boat, would that rig
9ft. 8in. long be likely to give satisfaction ?
keel the depth from water-line to bottom of
be about 1ft. 3in. Which would be better, a 4in.
ntre-board ?—H. Boswell.

-Petroleum.—Will any of your readers
m me if petroleum is explosive, as well as in-
If so, under what circumstances will it
What is the law regulating the storage of
n large quantities ?—E. W. V.

-Automatic Tension in Sewing Ma-
should be glad to see a description of this. It
ched to the best machines of Willcox and
e, and is said to accommodate itself to any
f work without adjustment of the tension.—

-Plaiting Spun Yarn and other Pack-
any of our engineering or fitting friends oblige
ation how to plait the square packing (9, 16,
strands) as used in the large cylinders and
ncipally, I believe, in the navy ?—Young

-Miners' Questions.—1. There are 30,000
f air passing down a shaft 5 × 6; after passing
workings, and over the furnace it expands 15
t what velocity, and also what quantity, will
9ft. in diameter ? 2. What size of airway will
to pass 40,000 cubic feet of air per minute with
water gauge hard roof and fake pavement ?—

·Rotary Pump.—In your impression of
"Jan" describes a rotary pump, No. 33593,
e simplest, and, perhaps, the most effective,
as Eurard's or Grundle's. I shall feel greatly
e will kindly say where further information
—W. H. Ottewill.

nilar queries are to hand. The maker would
lvertise.—Ed.]

- Railway Engine Drivers.—Could
or any other reader, say if it would be pos-
lists of the names and addresses of the railway
be different systems ? Are there any trade or
ocieties of whom such lists might be obtained ?

Electric Engine.—Would some of "ours"
me the necessary instructions for the con-
the above—one that would work a model
perfume spray ? If possible, please give a
d oblige—D. Strathearn, Med. Stud.

Gilding Leather.—Can any one of your
eaders inform me how to gild basil leather
onze, so that it will keep its colour ? There
a certain amount of grease in the leather,
is how to so prepare it that the grease can-
gh. I find that wherever there is grease in
the gold bronze turns of a dirty verdigris
r.

Spasm of the Neck.—This is known, I
edicine as "torticollis." Can any reader
reliable information as to the possibility of
lief for this distressing ailment ?—One

The Pythagorean Theorem.—Will
readers please demonstrate the Pythagorean
superposition—that is, show how the two
may be cut so as to occupy the space of the
Autos.

[33946.]—**Cleaning Walls.**—Would one of your readers kindly tell me the proper salts or alkalies, and how to use them to clean the white-washed walls of a room that is almost black from the effects of a smoky chimney ?—A Constant Reader.

[33947.]—**Leclanche Battery.**—I have three Leclanché cells with sealed tops. They want cleaning out and renewing. Will any correspondent kindly inform me how to remove the composition with which they are sealed, and also whether it would be necessary to reseal them ?—Jacobus.

[33948.]—**Lawn Tennis.**—Can any reader inform me whether it be possible to obtain a good firm surface (suitable for a lawn-tennis court) by strewing ashes on the ground, and having them well rolled ?—E. F. Johns.

[33949.]—**Fine Compo-Tubing.**—How can I make short lengths of fine compo or pure tin tubing about 1-16in. bore ? Wanted for experimental purposes. Glass will not do.—William Cox.

[33950.]—**Canoe.**—I wish to make a canvas canoe for cruising in a harbour where the water is often rough. Could any subscriber give me information how to proceed; also what kind of sail I should use, and the size ? Would it be advisable to use a centre-board, as I believe with this they will sail on a wind very well ? I should wish the ends to be water-tight, so that, if capsized, the canoe would not sink. Any information on the above, and the probable cost of bare materials, will greatly oblige—Pacha.

[33951.]—**Repairing Leaky Water Pillow.**—I have a water pillow which leaks; can any fellow-reader tell me what material I can use to close the cracks ? I have tried solution of indiarubber and chloroform, but it peels off. Would be very thankful for any hints and recipe; also would be glad to know what will repair cracks in indiarubber flexible tubing.—X.

[33952.]—**Battery Power.**—To Mr. W. J. Lancaster.—Many thanks for your kind answer. I am afraid I have "gone wrong," and it is a great pity, for to do what I want would be the saving of time and labour to some half dozen different manufacturers. I send a sketch, and you will be able to see more from it than a mere explanation. The sketch is of the exact size—namely, five wires to the inch. Fig. 2 is the section across, showing the space at my disposal. Fig. 1 is a section longways. B is central iron wire, 1-12in. in diameter; A the fine wire wound round it; C is part of the wooden framework that holds them all together with the centre wires projecting slightly; D is a vulcanite plate containing the short wires E, which I wish to be acted upon as represented in the bottom three of the figure. The questions appear to be these:—Can the deficiency in the thickness of the core be made up by length, as there is no limit to that, and there is to the thickness, and will one coil interfere with the others ? I cannot limit the wires, and the battery is only to experiment with, to try and find out for myself what I am afraid I am troubling you with.—Would-be Inventor.

FIG. 2

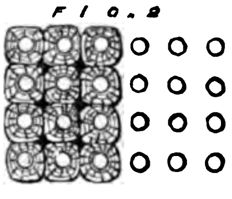
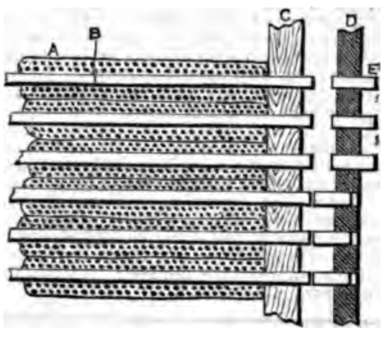


FIG. 1



[33953.]—**Magnetising.**—I have a 12in. horse-shoe magnet, and want to magnetise two 4½ by ½in. bar magnets, which have been received from England with so little magnetism in them that they would not lift each other. How should I proceed ? I have tried rubbing them against the large magnet in every conceivable way, but without effect. If the 12in. horse-shoe magnet is insufficient, how should I proceed to magnetise them with a battery ? How much wire should be wound on them ? strength of battery, &c. ?—R. S. J. (India)

[33954.]—**Railway Mile-posts.**—Can any of the readers of the English Mechanic give me any information as to the mile-posts on the following railways:—N. British Railway—Carlisle to Edinburgh, Edinburgh to Glasgow, and Berwick to Edinburgh; Midland Railway—Trent to Carlisle; North Western—London to Carlisle; North Eastern Railway—York to Berwick ? What I want to know is the side of the line on which the posts are placed, and the points from which they commence.—H. B.

[33955.]—**Planing Machine.**—Would a correspondent kindly give information as to the best means of fixing brass or other metal to the table of an 18in. planing machine by stucco, marine glue, or other cement ? How to prepare the stucco or other substance ? Whether the thing to be planed should be first attached to a separate board or flat metal plate ? How to clear off from machine ? Any other information as to attaching to a planing machine, and whether a cement can be used for heavier than thin plates.—G. T. M.

[33956.]—**Gas-Air Engines.**—Some years ago I saw at the Dublin International Exhibition a small engine at work, the motive power of which was gas and air mixed in due proportions, and exploded by the electric spark. It was very compact, almost noiseless, and appeared to do its work very efficiently. Perhaps some of your readers acquainted with such matters would kindly say whether engines of the kind are still made. They appeared to me admirably adapted for the use of aëronauts experimenting on the control of balloons, heavy boilers being unnecessary, and a supply of gas always at hand if required.—Aeronaut.

[33957.]—**Cutting Spiral Grooves in American Twist Drills.**—I should feel obliged if any reader would inform me the way the spiral grooves are cut in the American twist drills. Also the mode of tempering them.—J.

[33958.]—**Staining White Flowers on a Crimson Carpet.**—Is it possible to stain white flowers on a crimson carpet the same colour as the carpet ? Would it look smudgy if I painted each flower with crimson dye ? I want to do it without taking the carpet up. Do not mind making the boards crimson underneath.—Hosnikos.

[33959.]—**Small Spiral Revolving Cutter.**—Is clock-spring sufficiently tempered and hard enough to keep a sharp edge, or must I have special blades made at Sheffield ?—Dundee.

[33960.]—**Mining.**—Would any miner solve the following problem for me ? I have a downhill 80 yards, dip. 1 in 5; would like to draw two tubs, weighing each 12cwt., tub included, with a pony. I have a drum 2ft. 9in., and would like to know what size cogs should be, and how best fixed, to have sufficient power to overcome say 80 or 100 tons. Sketch would much oblige, with pump attached.—Young Mechanic.

[33961.]—**Torpedoes.**—Can any correspondent tell me of any good books published recently on torpedoes and torpedo warfare ?—R. B. W.

[33962.]—**Polishing Paste.**—My brother, who is a barman, whilst living in town used Needham's polishing paste for cleaning brass, and Harris's for pewter, but having gone to live in a remote country place where his predecessor made his own he is expected to do the same. He has tried several receipts, and has made one that cleans very well, but goes dull very soon after. This to him is a continual source of work. How can he avoid it ?—Barman's Brother.

[33963.]—**Royal Exhibition.**—It is my intention of competing for a royal exhibition at the next May examinations. 1. How am I to proceed ? 2. I shall take 12 subjects, eight in the advanced, three in the honours, and mathematics in the third stage. If I pass fairly in these subjects, shall I be likely to obtain the royal exhibition ? If not, what is the best advice your correspondents can give me ? 3. What books must I read for advanced in practical plane and solid geometry, theoretical mechanics, applied mechanics, geology, and vegetable physiology ? Also for honours in physiography.—A Science Student.

[33964.]—**Songs of Birds.**—A work on the songs of birds and other animals, as related to human music, and as furnishing a basis for a theory of malady, has occupied me two years. The chief impediment is the lack of recorded observations. I should be most grateful if some of your readers would kindly assist me in any of these ways, viz.:—1. References to books, &c., containing songs of birds and other animals in musical notation. 2. Results of observations on bird or other songs. 3. Is there noticed with any frequency in these songs the occurrence of any fundamental intervals of human music—as the octave, fifth, fourth, and third ? 4. (A question only seemingly irrelevant.) If singing in the ears has ever happened to your readers, have any of the fundamental intervals above mentioned been observed between the minute tones ? 5. Any information that may occur as bearing on these subjects. All contributions will be acknowledged.—Xenos Clark, 916, Washington-st., San Francisco, U.S.A.

[33965.]—**Radiometer.**—I should like to ask what explanation can be given of the following:—Clasp the bulb of a radiometer, with the arms at rest, with your warm hands; it rotates in the ordinary direction for some little time, and then comes to rest; remove your hands, it begins to rotate in the oppsite direction and soon comes to rest.—C. H. J.

[33966.]—**Incrustation on Tiles and Cement.**—On the surface of a new hall floor, consisting of encaustic tiles set in Portland cement, a whole incrustation is frequently observed. What is the cause of this ? Does it come from the tiles or from the cement ? Is there any remedy except washing and patience ?—L. S. Y.

[33967.]—**Dissolving Gold.**—I want to dissolve 1oz. of pure gold in the smallest quantity possible of aqua regia. Would some of our chemical readers kindly inform me the quantity, and in what proportion the acids should be mixed, as it is absolutely necessary that the whole of the gold should be taken up ? I do not want to precipitate it, but to use the whole of it together.—De Verre.

[33968.]—**Cryolite and Rutelite.**—Would some of our mineralogists kindly inform me where cryolite and rutelite are found and their composition ? Also please say to what uses they are put in the arts.—De Verre.

[33969.]—**Iron in Sand.**—Would some of our readers please say if there is an easy way of testing for iron in the ordinary silver sand obtained from the French coasts ? Also please say in what form the iron presents itself in this and other kinds of sand ?—De Verre.

[33970.]—**Red Oxide of Lead.**—Would some of "ours" kindly give particulars how the ordinary red oxide of lead of commerce is prepared, and, at the same time, give a few simple tests for any foreign matter that is likely to get mixed with it in the process of manufacture or otherwise ?—De Verre.

[33971.]—**Super Heater.**—Will some correspondent tell me of some way of super-heating steam in a small manufacturer's works ? The steam is supplied from the boiler at about 45lb. pressure, but the heat is not sufficient for my purpose; I want some way of heating it after it leaves the boiler, with as little expense as possible. If any special heater is made I should feel much obliged to any one for a description of it. I was thinking of having a coil for the steam to pass through, with gas under it, how would that answer ?—Labor Omnia Vincit.

ANSWERS TO CORRESPONDENTS.

◆

*** *All communications should be addressed to the* Editor *of the* English Mechanic, 31, *Tavistock-street, Covent Garden, W.C.*

HINTS TO CORRESPONDENTS.

1. Write on one side of the paper only, and put drawings for illustrations on separate pieces of paper. 2. Put titles to queries, and when answering queries put the numbers as well as the titles of the queries to which the replies refer. 3. No charge is made for inserting letters, queries, or replies. 4. Commercial letters, or queries, or replies are not inserted. 5. No question asking for educational or scientific information is answered through the post. 6. Letters sent to correspondents, under cover to the Editor, are not forwarded; and the names of correspondents are not given to inquirers.

The following are the initials, &c., of letters to hand up to Tuesday evening, August 27, and unacknowledged elsewhere:—

S. Taylor.—Rev. F. Carre.—Miss Allan.—H. Pratt.—G. Tolman.—New Subscriber.—H. Ford—R. Gascoyne.—T. Taylor.—V. Cornish.—A. H. Bateman and Co.—Col. Mainwaring.—Chemical Student.—R. W. Russell.—Lathey.—W. S. T.—T. E. J.—Diver.—A. E. Dancaster.—An Old Literary Man.—F. J. Nelluc.—Cymro.—Aspirant.—S. P. W.—James Adams.—Antipodes.—D. Kirkwood.—G. B. S.—E. B. Fennessy.—W. A. C.—R. Smith.—J. E. Floyd.—Finem Respice.—J. F. E.—J. R. Warren.—D. D. Redmond.—J. Pressdee.—E.W. A.—D. Fernie.—Zinco. — Serendib. — Novocastrian.—A. Palmer.—F. C. Hawks.—R. P. G.—A. S. Woodward.—Thwirthwo. — C. Lark.—Willesden.—Essex.—G. S.—Spring Coil.—Ram Chand Biswas.—A. P.—Astronomer.—Gimcrack.—W. S. Travis.—Helios.—W. A. R.—Progresso.—Aeshtuos.—E. R. Dale.—J. A.—Open Pan.—Mouldiness. — Accinctus.—Wildfire.—Ploni Almoni.—Brickwall.—Kernel. — Cupola. — Murano.—W. J. S.—Jack.—W. Hobbs.—A Colonist.—Trevelyan.—Jasper.—J. Alexander Smith.—A Constant Reader.—A. Clarkson.—Idris.—Hosnikos.—Ne Sutor.—H. King.—Clerk.

A. M. (It can do no harm.)—W. G. H. A. (The Léclanché is only capable of furnishing small currents for occasional use.)—Glasgow. (Questions as to prices must be addressed to him direct. See his advt. on front page.)—L. S. Y. (Write Hardwicke and Bogue, Piccadilly.)—W. E. H. (Waste of time to trouble the correspondent referred to. Such paragraphs are written by people who have not the faintest notion of what they are writing about.)—Dyspnœa. (Your doctor is undoubtedly correct. At your age there is no probability of cure, but it is most likely that the more distressing symptoms will mitigate themselves as you grow older. Residence during winter in a mild dry climate would relieve you.)—Old Papers. (The only effectual remedy would be to steam the cuttings, remove them, and repaste them in a new book with fresh paste.)—F. Morrell. (We very much doubt the practicability of working your elaborate contrivance. Try it first, and then let us hear from you again.)—S. N. (At Guy's, St. Bartholomew's, or any of the great hospitals. There is no special hospital for the treatment of the disease.)—W. H. Skelton. (Thanks for your kind appreciation; we have thought, sometimes, of adopting your suggestion, but judging by past results when we published the indices separately it would meet the approbation of but a minority of our subscribers.)—G. W. B. (Gore's "Text-Book," in Longman's series, published by Longman and Co.)—M. M. (None that we know of.)—W. H. B. (The wife will, of course, claim, unless the policy is assigned to the sister. For instructions to make oatcakes see p. 669, Vol. XXII.; and pp. 19, 45, 101, 152, 203, 231, and 285, Vol. XXIII.)—W. W. Webster. (Weale's Series, Lockwood and Co.; send for a catalogue, and select the volumes you require.)—Londoner. (Three terms for each subject would be the least time in which you could hope to attain any knowledge worth possessing.—Bijou. (There is no such book, and no amateur could hope to learn what experienced jewellers often find themselves unable to do.)—A Student. (Lockwood and Co., Longmans, and Cassell, Petter, and Galpin, all publish such text-books.)—J. Liggins. (We cannot spare the space, and if we could, any adequate reply to your query would be a miserable record of wasted talents and opportunities. "Perpetual motion" is a delusion, and its pursuit worse than folly.)

The Land Question.—The letters we print on this subject are necessarily only a selection from a large number which have reached us. Some are excluded simply because the writers say what has been said by others, but a larger number do not appear because they are irrelevant to the question propounded for discussion. While some correspondents kindly caution us against permitting the English Mechanic to become a vehicle for the dissemination of Socialism and Communistic ideas, others of an opposite type want to discuss primogeniture, the influence of the landed gentry and the clergy, and the advisability of an immediate redistribution of all property. These are doubtless interesting questions, but they are beyond the "World of Science." There is a scientific method of discussing questions like that mooted by "Pioneer," as some letters we have published show. It is unfortunate that readiness on the part of correspondents to adopt personalities and to travel beyond the region of calm argument render the admission of such subjects a matter requiring considerable caution.

P. R. T., Querist, Scribe, J. W., A. B. C. D., Ceres, Ink, Rubber, I. R. D., Phœnix, Vice Worker, Jack-of-All-Trades and Master of None, Gout, Folko.—See indices to back vols.

K. G., Nave, Sonnerie, E. M., J. B. W.—Your queries are advts.

Samuel Smith, M. Dempster, Stylus, E. F. G., and others have replied to queries already similarly answered.

Lamplough's Pyretic Saline is refreshing, most agreeable, and the preventive of FEVERS, BILIOUSNESS, SMALL-POX, SKIN DISEASES, and many other spring and summer ailments. *Sold by chemists throughout the world and the maker, 113, Holborn Hill. Use no substitute.*—[Advt.]

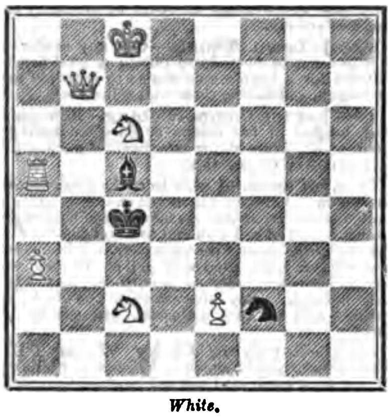
CHESS.

◆

All Communications intended for this department must be addressed to J. Pierce, Copthill House, Bedford.

PROBLEM CCCCXL.—By James Pierce.

Black.



White.

White to play and mate in three moves.

This problem is published in "Chess Gems," but without the P at Q R 3. The Pawn prevents a second solution.

Solution to 438.

White.	*Black.*
1. Q takes Kt (ch).	1. K takes Q.
2. B to Kt 6.	2. P checks.
3. K to K 3.	3. P moves.
4. B mates.	

Notices to Correspondents.

Correct Solutions to 436 by Agregog (neat but easy) and W. J. Jubb.

Problems received with thanks from J. W. H. and H. M.

J. P. T.—Thanks for notice.

Grafting the Tomato on the Bitter Sweet.—The experiments which have been made in this country by Mr. Maw and by Mr. Alexander Dean with reference to the grafting of the tomato on to the bitter-sweet (Solanum Dulcamara) are no doubt within the recollection of some of our readers. M. Carriere has been repeating some of these experiments in Paris, and with the result of obtaining regular bushes 2 metres and more in height (nearly 7ft.). Two such plants placed in pots in a greenhouse continued to grow all the winter, and were planted out in the open air in the beginning of June. One of the plants has now (end of July) a ripe fruit, so that a plant generally considered as an annual has been converted into a woody perennial, not the least curious of the many curious phenomena connected with grafting. The *Revue Horticole* of Aug. 1 is our authority for the statement above made.—*Gardeners' Chronicle.*

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English Mechanic
AND
LD OF SCIENCE AND ART.

RIDAY, SEPTEMBER 6, 1878.

ARTICLES.

RAILWAY BRAKE TRIALS.

railway world and the travelling
blic are certainly indebted to the
and Brighton Railway Company for
ner in which they have regarded the
uestion, and the facilities they have
Capt. Douglas Galton and Mr.
house in carrying out their elabo-
es of experiments. Already a mass
ble data has been accumulated—
which formed the subject matter
teresting paper read by Capt. Galton
eeting of the British Association.
respondent, "C. E. S.," has, however,
p that branch of the subject, and
d not further refer to it here.
series of experiments was made
2nd and 23rd of August, in the
of Mr. Calcraft and Major Marin-
some valuable knowledge was
as to the action of brakes. In-
much is now known that it becomes
n whether some pressure should not
ht to bear upon railway companies
ape, first of all, of public opinion.

travellers, as a rule, may not
nd the technical details of the dif-
stems of brakes, nor appreciate the
es under which some of the com-
bour, but they at least comprehend
difference between a sound and an
principle. The directors of some
ting possibly on the advice of their
s, perhaps on the representations
eads of the spending department,
en a course diametrically opposed
ecommended by the most competent,
disinterested, judges, and there is
suspicion that they have taken a
p. If it were not for the serious
f the question, the remarks of the
of the Great Northern at the
eneral meeting would be highly
for their *naïveté* and simplicity.

readers are aware, the Smith
brake is applied to a considerable
f the stock of that company, and,
ay trust the reports that reach us,
what was predicted does happen
ally. A letter recently written by
ger has created so much alarm that
man was obliged to notice it in his
In the Smith vacuum brake the
e applied to the wheels by creating
n in the pipes and bags of the
s, and it is obvious that if any
ises during the interval between
cation and the next attempt, un-
river is made aware of the fact,
is in great danger, because it is
ntrol. It has been pointed out in
umns and elsewhere that unless
ns of indicating the state of the
s at any moment can be devised, a
brake of the kind described may
the cause of a so-called accident.
, a vacuum brake should be so
that the blocks are kept off the
ly so long as the apparatus is in
rder—in other words, the vacuum
e constant, and the brakes be
destroying the vacuum. Whether
ese conditions sufficient power
btained is another matter—at any
principle would be sound. On a recent occasion, when a Great Northern train arrived at Holloway, the vacuum brake, according to the chairman of the company, was found to be unworkable; "but," said he, "we endeavour to meet all this by certain printed directions, which are in the hands of every engine-driver. By those directions they are compelled or ordered to try the brakes continually during the journey, to see if they are in working order. . . . . The directions are all in print. I have them here, and, therefore, I hope that this alarming state of things, in consequence of the brake failure, will never in practice occur again." We are almost inclined to think that the "reporter" is to blame again; but, we would ask, do those who are really responsible for the management of the traffic accept the chairman's explanation as a true statement of their method of working the trains? We will say nothing of the vast difference between "compelling and ordering" the drivers to try their brakes, but we must ask what is meant by the word "continually"? We will take it to mean "at intervals," and then follows the question *cui bono*? To try such a brake and to find it in order is simply proof that it was not defective at the time it was tried; it is no proof that it is in good order at any moment after the trial. The very application that was to test the condition of the apparatus may produce some derangement that will destroy the efficiency of the brake, and before the defect is discovered the fatal emergency may arrive. The chairman's remark that "the directions are all in print," and therefore he hoped the "alarming state of things" would never occur again, must have been heard with astonishment by even the most untechnical shareholder, for he would naturally argue that if a brake is so untrustworthy that it must be continually tried, no "printed directions" will in any way improve it. He will thus be brought face to face with the fact that his directors are adopting a course that is practically condemned by the apologies of their chairman.

To turn, however, to the practical part of our subject, the experiments recently made on the Brighton line show that, for the proper control of trains running at high speeds, a brake-block pressure of about 200 per cent. of the weight on the wheels must be available, with an automatic arrangement for reducing the pressure as the speed diminishes. It is also essential that the pressure can be immediately applied with the maximum force, for the saving of even a second at the commencement of a stop is of great importance. In many of the recent experiments the van was detached by a slip coupling, the brake being applied automatically at the moment of separation. As nearly as possible, a uniform speed of 50 miles an hour was attained in all experiments intended for the purpose of comparison, but other experiments were made under varying conditions of speed, pressure on blocks, and state of rails. From a speed of 60 miles, with a maximum pressure of 200 per cent. on the brake-blocks, a stop was made in 11¼ secs. after running 189 yards, and in a similar experiment the time required was only 11 secs, and a distance of 185 yards. Skidding was prevented by the pressure-reducing valve designed by Mr. Westinghouse, but in those cases where skidding was allowed to take place, the distance run was much further, especially if the skidding occurred at the beginning of the stop. In one case a stop was made from 50 miles per hour in 119 yards, and occupied 10¼ secs., the result mainly of the fact that the brake-block pressure exceeded 200 per cent., and was rapidly reduced to suit the decrease in speed. The effect of pressure is well seen in a series of three experiments made at a speed of 50 miles:—

Pressure.	Distance.	Time.
75 per cent.	255 yards.	18¼ secs.
50 "	300 "	24 "
30 "	520 "	44¼ "

In another series the effect of bringing the maximum force to bear after the lapse of two or more seconds was tried, and the result was as expected, skidding being produced towards the end of the stop, which was thereby prolonged. The pressure employed in this series was a maximum of 125 per cent., and in the first experiment half of it was applied in 2secs., and the full force in 5secs., the stop being made in 180yds. and 15¾secs. In the second case half force was applied in 5secs., full in 10secs., the distance run being 215yds., and the time 15secs. The discrepancy in the time of these two stops is accounted for by the fact that skidding took place earlier in the first instance. In the third case half force was applied in 8secs., full in 15secs., the distance run being 288yds., and the time 18secs. In the last trial of the series the half force was not attained until 10secs., and full in 20secs., the result being that the distance run was 334yds., and the time 20½secs. It will be seen from the figures we have given that "time" is an element of the question that may be eliminated altogether, as it is no guide whatever to the efficiency of a brake; and as distance run is practically the only important consideration in actual working, the question resolves itself into which brake can stop a train in the shortest distance. It could be only in very exceptional circumstances that the time element would be of importance in avoiding a disaster, and, as a rule, if a train can be stopped in a given distance it matters little whether 20 or 200secs. are occupied to effect the stop, so long as the distance is not exceeded. The only "time" that is worth studying is that occupied in bringing the pressure to bear on the wheels, for these experiments show that a brake applied instantly with a moderate force is more effective than a brake of twice the power, when some 10 or 15secs. are required to bring the power to bear. At one time it was thought that the sudden application of immense force to the wheels was a source of danger, but these experiments show that, so long as the blocks are applied with equal force to all the wheels, no risk is run. The friction between the blocks and the wheels under different conditions of surface, and the effect of wet rails and sand upon the rails, were also tested by experiment, but the differences obtained cannot be given with accuracy until the tables are properly worked out. In another series of trials the effects of smaller brake-blocks were noted. If a smaller block is used under the same gross pressure, the pressure per sq. in. will be increased proportionately, and it was found to increase so considerably that a pressure which would not skid the wheels with ordinary blocks at 50 miles an hour, was sufficient to skid them at 60 miles with the smaller blocks—about one-third the size. We should mention that the whole of the apparatus in the experimental van has worked admirably, and with the checks and precautions taken to insure accuracy, there is reason to believe that the records are absolutely correct. If so, we have not only a valuable mass of data bearing on the brake question, but some mechanical doctrines will need revision—notably that relating to friction. We await the publication of Capt. Galton's report with something nearly akin to impatience, although we believe he is endeavouring to induce other railway companies to give him the opportunity of testing the various brake systems on the principles laid down from a consideration of the results already obtained. There is very little doubt as to what the ultimate verdict will be, and those who have accused the advocates of the Westinghouse brake of a want of disinterestedness will find that they have made a mistake as great as that of the companies who have adopted brakes which require continually testing to ascertain if they are in order.

REVIEWS.

Sketches for Cottages, &c. By R. Norman Shaw, R.A. Drawn by Maurice B. Adams, A.R.I.B.A. London: W. H. Lascelles.

DESIGNED primarily to illustrate the facilities afforded for cheap building by a new concrete-slab system introduced by Mr. W. H. Lascelles, the well-known builder of Bunhill-row, this unostentatiously-named treatise has a value far above its avowed purpose. The buildings illustrated, which comprise working men's cottages, middle-class cottage-residences, village clubs, mission churches, and the like, are, without exception, conceived in a pure and interesting style of architecture, and considerable attention has been paid to the plans. We are constantly receiving queries from correspondents of all classes who are anxious to build, but are equally anxious to avoid the abominations perpetrated by too many so-called architects in the way of "ornamental villas," while unwilling to content themselves with the bald conceptions of the ordinary house-builder. In this volume of sketches the working man who wants to build a cottage, the middle-class resident desirous of erecting his own house, and the country gentleman or landowner on the look out for designs which shall really accommodate his tenants and workmen, and adorn his estate, will find all they want.

Local Taxation and the Rating of Machinery. By T. F. Hedley. London: Knight and Co.

Local taxation has ever been a sore point, especially in those parishes where the rates are double and treble those of possibly an adjoining district or union. The present work, though nominally dealing with the rating of machinery, opens out the wide question of what is, and what is not, rateable property. From 1783 to 1866 machinery was uniformly held by the superior courts to be rateable, but on the 5th of June, 1867, the Court of Queen's Bench held that looms, &c., in a silk-mill were not rateable. On the 24th of January in the present year, however, the High Court of Justice, Queen's Bench Division, held that the machines employed by a shipbuilder, were rateable, thus leaving the overseers of parishes in considerable perplexity as to what machinery they may, and what they may not, rate for the relief of the poor. The book before us is a "report" on the rating of machinery, with all the decided cases thereon, including the short-hand writer's notes of the special case, arguments, and judgment in Laing *v.* Overseers of Bishopwearmouth. It has been carefully compiled, and is prefaced by a letter to the President of the Local Government Board, Mr. Hedley holding that the land is unduly taxed because manufactories, mines, &c., are under-rated. There is no doubt that in many parts of the country railways, manufactories, and mines are considerably under-rated, but the evil is not confined to them, and is only part and parcel of the want of system that characterises the working of assessment committees. Mr. Hedley gives an instance of a colliery rented at £3,000 and rated at only £497. The overseers admitted that they knew the rent, but as "they were servants of the colliery" *they could not alter the rate!* This book will be useful to those who seek information upon rateable property.

A Handbook on Gold and Silver. By An Indian Official. London: Longmans.

This work is entitled a handbook on gold and silver, but, in order to obtain a notion of the contents, we must understand the title in its very broadest sense, for "gold and silver" are here synonymous with trade and commerce. The silver question is dealt with, as is also the cause of the depression of trade, the writer stating his opinions and giving his reasons for them in such a way as to render his book profitable reading. The "Indian Official" speaks warmly against the policy that has induced English capitalists to lend their money abroad—to lend freely "the capital which should have cherished agriculture and industry at home, but which abroad has made England powerless to obtain a general disarmament." The remedies proposed are, first, to demonetise silver in India; secondly, to regain command over foreign markets, by increasing the efficiency of British labour through a resolute unflinching suppression of drunkenness, by invigorating British agriculture through the free application of capital to the land, and by thereby enlarging the home market for British manufactures, and consequently enabling the manufacturer to sell abroad more cheaply than now. The writer alludes to the opinions of Lord Leicester and the Earl of Derby that the unstinted application of capital to the land would nearly double its produce—a fact amply demonstrated by, amongst others, Mr. Mechi and Mr. G. Hope—and he points out that the objection raised against the outlay of capital on certain soils is not of much account, because those districts are best adapted for applying the lessons taught us by France. The application of labour to land is the application of capital, and the peasant proprietors of France, together with the solid position of the Bank of France, and the ease with which the great indemnity was raised, all testify to the value of the system. The book deserves a much more lengthy review than we can give it here, but if we succeed in calling the attention of political economists, financiers, and statesmen to its pages, which contain a vast amount of valuable statistics, we shall have done our part.

The House of Life. By Mrs. F. Fenwick Miller. London: Chatto and Windus.

This is a popular handbook of human physiology sufficiently full of "science" to make it a textbook for schools and classes, and yet attractive enough to engage the attention of the general public. Mrs. Miller believes that physiology and hygiene should be treated together; she thinks that every person, especially every woman, ought to have some knowledge of physiology, and in teaching it she endeavours to show the bearing of the science upon daily life and personal health. The descriptions of the various organs of the body and the explanations of their functions are given in clear and simple language, and are illustrated by, in most cases, excellent wood engravings. The statments made by Mrs. Miller appear, as a rule, to have been obtained from the standard authorities, but here and there we find some that a careful writer would either qualify or omit. For instance, we find in the chapter on food, an illustration of the measle-worm of the pig, which is said to produce tape-worm in the human subject when the *eggs* are eaten. The measle-worm is the "scolex," and is two stages from the egg. On the same page we are told that John the Baptist subsisted on the "fruits of the earth," although it is generally conceded that the locusts mentioned were pounded specimens of Gryllus, not the carob-bean or Ceratonia. Too much stress is laid on the old notions as to the special value of nitrogen, for there is much reason to believe that the non-nitrogenous portions of food contribute, as well as the nitrogenous, to the production of muscular force. On page 76, Mrs. Miller states that charcoal "has the power of cleansing impure water, and of turning hard water into soft;" that claret wine contains "scarcely any" alcohol; and on page 155 the mammalia are defined as "animals which have *four limbs* and suckle their young." These defects are, however, small blots on a little book that will, we hope, be widely read by those for whom it is intended.

The Theory of Sound. By John William Strutt, Baron Rayleigh, M.A., F.R.S. London: Macmillan and Co.

This is the second volume of Lord Rayleigh's elaborate treatise on the theory of sound, in which the various problems are examined in a manner that delights the mathematician but frightens away ordinary students. To master the subject, however, the latter must read Lord Rayleigh's book—the best of its kind in the English language. The present volume treats of aërial vibrations, vibrations in tubes, the theory of resonators, spherical sheets of air, with chapters on special problems, and general equations. Throughout the work, in between the pages of formulæ, are many interesting notes; as, for instance, where Lord Rayleigh differs from the Astronomer Royal as to the cause of the phenomena of the Whispering-gallery at St. Paul's. The effect has been ascribed to reflection from the surface of the dome overhead, and is to be observed at a point diametrically opposite to the source of the sounds. Lord Rayleigh finds that the abnormal loudness with which a whisper is heard is not confined to the position diametrically opposite the whisperer, and therefore does not depend upon the symmetry of the dome. The whisper seems to creep round the gallery horizontally, not necessarily along the shorter arc, but rather along that arc to which the whisperer faces. That is a consequence of the very unequal audibility of a whisper in front of and behind the speaker—a phenomenon which may easily be observed in the open air. A part of the observed effect is, in the case of a nearly spherical dome like that of St. Paul's, probably due to symmetry, but the greater part seems referable simply to the concavity of the walls—sound having a tendency to "cling" to a concave surface. There are many pages in which similarly interesting facts are mentioned, and it is to be hoped that their occurrence will induce the student to master the formulæ which, after all, are the most valuable portion of the work, because they are the mathematical demonstrations of the truth of the theory.

Flowers: their Origin, Shapes, Perfumes, and Colours. By J. E. Taylor, Ph.D., F.L.S., F.G.S. London: Hardwicke and Bogue.

The author of this work has endeavoured to place before that portion of the intelligent public who have the desire, but neither the time nor opportunity to make themselves acquainted with natural science, the charming and suggestive results of modern botanical investigation. That is a very laudable endeavour, and Mr. Taylor has done his work fairly well. Unfortunately he has relied too much on old books for his information, and consequently has not kept his ideas up to the latest accepted theories on the sciences which this book is made to embrace. Mr. Taylor's bolder-visioned confrères are told they must pardon him if he refuses to admit of "such designs without a designer," as if some one had specially asked him to believe in such an absurdity. But why does the author tell us that white or light-yellow flowers usually open at night, and subsequently correct it to "night-blooming plants are mostly white"? And why does he affirm that white flowers have the greatest average of sweet-smelling ones? Night-flowering plants may usually be distinguished, says Mr. Taylor, by the clear white flowers they bear—their whiteness being intended to attract the attention of night-flying insects. But, apart from the fact that many white flowers close at night, while thousands of coloured ones are open, and that white flowers can scarcely claim to be favoured above their coloured sisters in the way of perfume, why does not our author explain the reason that moths fly at night and require white, and at the same time powerfully-scented flowers? Perhaps a little deeper study of natural selection and the survival of the fittest would explain the phenomena in a more satisfactory manner. The book is abundantly illustrated with woodcuts that have done duty before, some of which have been inserted for no apparent reason, except to form pictures, and eight plates of coloured representations chiefly of wild flowers. There is much interesting matter in the book, as there could not fail to be, seeing that Darwin, Wallace, Lubbock and others have supplied the facts, but it is loosely put together, and consequently, is scarcely more than a book to while away a tedious hour.

Ceded Cyprus, by John Joseph Lake (Effingham Wilson), is a useful little brochure, giving an account of our new possession, its history, condition, products, and prospects. We have received from the United States Commission of Fish and Fisheries the third and fourth volumes of the report of Spencer F. Baird, containing many interesting papers on fish and fisheries in different parts of the world, and an enormous mass of information concerning the United States fisheries. From Mr. S. C. Chamberlin, chief geologist, we have the second volume of the *Geology of Wisconsin*, accompanied by an atlas of maps. The style in which these are turned out is worthy of the matter they contain. The determination to make the survey and to publish the results is creditable to the sagacity of the Senate and Assembly of Wisconsin, and the manner in which it has been done reflects credit on the geologists engaged in the work. *Locomotive Engine Driving*, by Michael Reynolds (Crosby Lockwood and Co.), is the third edition of the manual we noticed at length on its first appearance. Much additional information is given in this edition, especially in the "Key" to the locomotive, so that a still greater demand may be expected for a work that will become a recognised text-book for drivers. *Elements of Descriptive Geometry*, by J. B. Millar, B.E. (Macmillan and Co.), is well adapted for beginners, and is, at the same time, comprehensive enough for those who have advanced beyond the threshold of the subject. *The Road-master's Assistant and Section-master's Guide*, by W. S. Huntingdon, revised by Charles Latimer (*Railroad Gazette* Office, New York), is a useful book on railroad work, so far as relates to permanent way in America. *The Distribution of Rain Over the British Isles*, by G. J. Symons (Stanford) is the now well-known annual mass of records compiled by Mr. Symons. *A Handbook of Practical Telegraphy*, by R. S. Culley (Longmans), is the seventh edition of a standard text-book of the subject upon which it treats. It has been revised and enlarged up to date, operations it has undergone so frequently that one can judge of the progress of the telegraph by the number of the edition of Mr. Culley's book.

We have also received *Treatise on Mills and Millwork*, by Sir W. Fairbairn, fourth edition (Longmans); *Supplement to Ure's Dictionary*, by Robert Hunt (Longmans); *Mechanical Dentistry*, by C. Hunter (Crosby Lockwood); *The Bulb Garden*, by Samuel Wood (Crosby Lockwood); *Tables of Curves*, by Alex. Beazeley (Crosby Lockwood), consisting of cards in a case; *Habitual Drunkenness and Insane Drunkards*, by J. C. Bucknill, M.D. (Macmillan); *Handbook of Patent Law*, by W. P. Thompson (Stevens); *Newport and Cardiff as Shipping Ports*, speeches by J. G. Parkinson and others (Newport: Mullock); *Elements of Chemistry*, by W. A. Miller, sixth edition (Longmans); *The Governing Principles of the Elements—"Original Research"*—by Herbert Masson (11, Bedford-street, Bedford-square, W.C.); *Directions for Tuning and Regulating Mason and Hamlin's Cabinet Organs*, by C. Spanswick (Metzler); some of which will be noticed at greater length at a future opportunity.

THE ORGAN: A COMPREHENSIVE TREATISE ON ITS MANUFACTURE, PROCURAL, AND LODGMENT.*

By John Watson Warman,

Associate of the College of Organists, London.

PART I.—GENERAL TREATMENT IN MANUFACTURE.

y. 4. That where there are Great, Swell, and Choir, the Swell should in all cases when funds are limited, stop at Gam. G, borrowing from Choir below that note.

z. 5. That when there are, as before, Great, Swell, and Choir, but funds *less* restricted, Swell may go to bottom; but money would be better employed in provision of small Solo to Gam. G, of course not powerful enough for its entry to cause an unpleasant break.

[24. a.] 6. That where there are Great, Swell, and Choir, and funds are *not* limited, Swell may well go to C C. But even here author would prefer the laying out the extra money on a rather larger Solo to Gam. G and Pneumatic to Great and Couplers, taking care that all other Claviers be ample in power and Register.

b. 7. That where there are Great, Swell, and Solo, but no Choir, the Swell should, unless funds be really limited, go through, for otherwise Supplementation of Ped. will be poor.

c. 8. That in Four-Man. Instruments of the cheapest kind the Swell may well borrow from Choir below Gam. G, taking care that Solo be not loud enough to cause at its entry an unpleasant break. (*Ibid*, No. 5 and 6).

d. 9. That as soon as the Solo receives its full and proper power and development the Swell should go to C C, to assist in covering the break of the former and preventing too great a falling off below Gam. G in the Full Organ. Even here, however, the whole of the Swell *Stops* need not go through.

e. See more fully in Specifications (own *Depart.*)

f. We have now to consider the actual *Extent* to which Primary Borrowing is, if at all, permissible.

g. It will have been already seen in the Examples (22, 1 to v.) in how very extended a manner and by what eminent names this more important subdivision of the expedient of Borrowing has been resorted to; entire Registers and in some cases almost entire Claviers, in both instances often of the greatest importance, having been thus obtained.

h. In spite of the great weight and excellence of some of the Names here presented, and in respect for which the author begs to say he yields to no man, yet in this matter it will perhaps be as well for him to state, without further circumlocution, his settled opinion that they were here *totally and radically mistaken* (so far as really answerable, but the instances show that in many cases the Builder was not a free agent). What can be the borrowing of an entire Clavier, or the entire Chorus of a Swell or Pedale, or the Swell Reeds, or the chief Flue Stops of the Pedale, or the whole of a Manual below Ten. F—and from departments which, in the very nature of things, *cannot* supply them properly—but a great and deplorable mistake and sham? The *power* total cannot benefit one iota; and the occasional effects producible by the various expedients are almost, if not entirely, couterbalanced by the extra work involved, the additional chance in many cases of cypherings or other defects from elaboration of mechanism; or, as an alternative, the risk of Pipes being out of tune, or insufficient in power from loss of wind by grooving. It is only right to add that the well-known Builders instanced in connection with the Birmingham Organ have, *since* that time, seemed to show themselves among those *least* willing to provide their Instruments with these artificial additions.

i. I will now finally indicate the only ways in which, as I think, Primary-borrowing may be, as a rule, really commended.

j. 1. *On the Manual.* In cases where funds are very limited it may be permissible to obtain a certain proportion of the Stops thus, but only in special cases should these borrowings be from one Manual to another.

k. 2. *On the Pedale.* This is the only Department or *Section* in which Primary Borrowing has real value, chiefly owing to the size and costliness of the Pipes and the circumstance that, generally, only one note is down at a time.

l. Full Examples and Directions will be given in Method (next).

* * Method.

m. It is now necessary to say a little about the actual Method or Structure employed in obtaining the desired Borrow: the Borrowing from one Clavier to another, although it has been hitherto placed first, is treated here last because, in author's estimation, as a rule the least advisable.

n. It is only required here to go into two methods—viz., borrowing by *Wind* and borrowing by *Action*.

* Borrowing from Same Clavier.

o. Borrowing by *Wind* is, as its name imports, providing additional suitable Channels, Grooves, or Tubes for the borrowed Stop; and the simplest and only method that the author would here recommend is that of Blank or Dummy Slider leading into Grooves or other channels slanted or skewed so as to reach the desired Pipes. Thus supposing it wished to borrow a Double Open Diap. the Stop selected would, of course, be the smaller of the two Open Diaps., or Viola or other similar Stop if only one Open Diap. present; the section of Upper-board would contain two Sliders in usual way, except that the one for the Double need not be of greater width than sufficient to hold amply large *holes*, the other for the Open Diap. will be as usual: the Borrowing cannot, of course, commence till Ten. C is reached, then a Conveyance will run from the Ten C. hole in the Doub. Diap. Slide to the C C Open Diap. in front, and so on till all the Show Pipes have been thus treated: the rest will, obviously, come regularly. If the distance between the two Sliders, and also the space from Hole to Hole (that is, from groove to groove in the Soundboard), be large enough, little difficulty will be experienced, as the whole of the skew grooves can run direct from hole to hole, of course lying parallel side by side throughout. But excepting on the Pedale this will rarely be the case, and the best method in general will be to groove half and conveyance half (*see* p. next.) The best material for latter will here be cartridge-paper (I am not including those running to Pipes already conveyanced—these are always of metal), not only for cheapness, but because they will then admit of being firmly glued at ends, so as to be quite wind-tight.

No existing example is known to writer.

In using this method it will be necessary to observe the following:—

p. 1. The Soundboard grooves must be a sufficient distance apart. 2. The Slides must be a sufficient distance apart. 3. The upper-board must be thick enough—say, at least 1¼ pricked—to hold a good deep Channel, as the width of the latter may be limited: Pine may be used, but it must be very sound, and worked with a sharp tool; use an under Veneer—generally of mahogany—and do grooving from beneath. 4. The zig-zag of the two Slides must often be reversed, so that the two rows of holes nearest each other will be in communication. This is necessary when half are grooved, and half conveyanced; when all are grooved it is of no consequence; when all are conveyanced it should *not* be done, the zig-zag of both being in such case best alike.

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p. p. It will be understood that by half-grooved and half-conveyanced is meant, as already said, that the two inner rows of Holes —that is, the row (in each Slider) that is nearest the other Slider involved in the Borrowing—shall be connected by grooving, and the two outer rows of Holes then united by conveyance-pipe, thus spanning or bridging over the groovings. 5. As there is no weight on the Dummy-slider, Arch-springs (*see Depart.* of Soundboards) must be used with the Screws; where the Dummy has a Bass completing portion, Springs are of course discontinued there. 6. Holes in Dummy Slide and Grooves or Conveyances must themselves all be extra large to prevent flattening by the additional wind-friction.

q. It will be obvious that Borrowing by Wind is much favoured by a short and deep Soundboard rather than a long and narrow one; and that it is demanded that the order of notes be alternate—that is, either the largest or smallest in centre—for, if semitonally, the octave note will be too far off.

r. In Borrowing by *Action* there is not, of course, any additional grooving at all involved. Thus, supposing a Harmonic Flute of 8ft. to possess a separate Pallet, it will be easy to have two sets of Action to it, one giving it as the 8ft. Stop and one as the octave above: each Action and its Knob will have communication with the Slider (this latter will here be only required for Composition-action), so either knob will move the Slider; but to prevent the latter always pushing out both knobs, they will only *draw* the Slider, the latter being returned by a spring on being released by pushing in knob. Thus the single rank of Pipes will give either an 8ft. or a 4ft. or both at pleasure; but it will be manifest that the Action is a formidable affair for so comparatively small a result. No example of this exact treatment is known to writer.

s. It will be now well just to compare the two Treatments. The first or Wind method has the advantage of not adding any Action, therefore of not increasing the liability of the Instrument to stick, cipher, or fail in performance; at same time it risks a throwing out of *tune* by channels being incommensurate, and this risk will be much increased if Soundboard be crowded. On the Pedale there is, generally, better room. The wind method is, of course, *not* recommended for Reeds.

t. It must be remembered that, though the *being in tune* is risked, the *tuning itself* is simplified, for the tuner will always tune each Stop by the Slider under it, and any flattening by groove when speaking as another Stop must be *accepted*. Remember also that, if additional space between the Ranks be involved, yet that this undoubtedly helps the volume of tone, particularly inside a Swell-box (see *Depart.* of General Arrangement).

u. The advantages of the second or Action method are that it insures the regular supply of wind in all cases. The disadvantages are the action involved, and consequent chance of cyphering, &c.; also the inconvenience of applying successfully to a large number of Stops, for the number of Pallets would obviously be much increased, and corresponding Action also involved.

v. Altogether, with regard to the two Wind methods it may be laid down that, for the Manuals, the first is more *suitable*, but that it is out of question to attempt it unless good room be allowed—exceptions will be seen directly. As regards the Pedale it may be considered that Wind method is much more easily *carried out*, but that on the other hand there is risk of shortness and consequent difference of wind. For the Pedale of a *Chamber* Organ or in any other case where room is scarce and only a soft tone is required from that Section or the stops involved in the Borrowing, there can be no doubt that Wind method is the better.

w. The second or Action method is obviously not adapted for borrowing more than one Stop on a Clavier; *for* such number, however, being (except that the extreme octave is rather difficult to provide for) the *better* method whenever such Stop is *already* furnished with a separate Pallet; as, to provide a 4ft. Tuba on Solo, or ordinary Clarion to Great, or, better than either, a Ten. C Double Reed to Swell. On the Pedale, of course, the same thing holds good, only that as this Section is generally so very much smaller (of only one Stop, in very many cases), it follows that the Action method will, on the Pedale, be more *generally* useful; indeed it may *always*, in this Section, be adopted by *preference* where a full tone is required, as in Church Instruments, &c.; and the necessary space should be *insisted* on. It will, however, be seen farther on that the treatment of *Part* Octave Couplers so strongly advocated by author, very much diminishes value of Borrowing in usual way, except with a very small Pedale. It is necessary to bear in mind that in cases of Register inside a Swell-box, the Action-method has the advantage over the Wind-method of keeping the Box smaller (*see Dep.* of Gen. Arr.)

(*To be continued.*)

ON THE ATOMIC VOLUMES OF THE ELEMENTS.

An extensive series of experiments on the volumes and specific gravities of the chemical elements and their compounds has been lately described by M. Hermann, partly in the proceedings of the Moscow *Naturforschende Gesellschaft*, and partly in the *Journal für Praktischechemie*, and in a recent number of the latter journal he makes a survey of the results, and gives some deductions from them, among which are the following:—

1. The chemical elements consist not only of weighable matter of different qualities, but also of an unweighable material, which, however, takes up space, and on whose proportion the size of the volumes of the atoms depends. This unweighable matter, in its resting condition, may be denoted as latent heat.

2. The latent heat can, by various operations, be partly withdrawn from the elements, or, in great portion, added to them, thereby the volume of their atoms is altered, though this alteration has no influence on the weight of the atoms. The elements, however, thereupon pass into allotropic modifications, and assume a quite different physical character, and also different chemical properties.

3. Such variations in the size, and the variations of atoms, also take place frequently, and the condensations of the atoms are greater the greater the affinity of the elements entering into combination.

4. The developments of heat, and the phenomena of fire, occurring in chemical combinations, are a consequence of the condensation of the columns of the atoms taking place, and of the heat thereby liberated.

5. Iso-chemical elements, and iso-chemical compounds, have atomic volumes which stand to each other in rational proportions. Their atomic volumes are either the same, or form homologous series with equal differences.

6. The crystalline form also of the elements, and their compounds, is closely related to the size of their atomic volumes. Thus, *e.g.*, the polymorphism of isomeric substances is the consequence of the different sizes of their atomic volumes.

7. Nitrogen may assume very various sizes in its atomic volumes, and the compounds of such allotropic nitrogens, on account of the facility with which they are decomposed, the violence with which they explode, and their remarkable relations to the life of plants and animals, are of great importance. Cyanogen and prussic acid are poisons; the protein matters are the most powerful means of nutrition for animals; and in urea the partly sustaining partly destroying force of the compounds of allotropic nitrogen is extinguished.

8. The imponderables—light, electricity, and magnetism—are modifications of the latent heat contained in the elements. Electricity and magnetism are polarised heat, for, on removal of their polarity, they are transformed into light and heat. Light is heat transformed into vibrations of exalted rapidity, for substances heated to certain temperatures become luminous, and emit light rays of various quality, producing variously coloured spectra, in whose colours the elements of the luminous substances can be recognised.

AN IMPROVED BLASTING POWDER.

Occasional accidents with dynamite and other modern explosives demonstrate the fact that, however safe, as a rule, those blasting agents may be when carefully handled and stored, circumstances do arise now and then which prove the rule by supplying the exceptions. A thoroughly safe and trustworthy explosive, that may be placed at the disposal of miners without fear of a disaster, is still a desideratum, unless a new powder, recently patented by M. Cahuc, of Toulouse, should prove to be the long-looked for substance. This new or improved powder is made as follows:—In 100 equal parts by weight there are from 48 to 70 parts of nitrate of potash, or other equivalent salt, the quantity being regulated according to the strength of powder required; 8 to 16 parts of sulphur, according to the quality and the rapidity of explosive power desired in the powder; and 3 to 5 parts of lampblack or soot (soot from wood is preferable to that from coal, and lampblack is preferable to soot). The remainder of the 100 parts are made up of spent tan (if containing refuse animal matter preferred), or sawdust, or the two combined in any proportions. The spent tan is preferred, but whichever is used it should be well dried before being employed. The above ingredients are finely ground, and then mixed together in a boiler, being moistened to the consistency of a stiff paste with water in which has been previously dissolved sulphate of iron to the extent of from 1 to 5 per cent. by weight of the other ingredients or substances, the quantity being regulated according to the purity of the soot or lampblack, and the tan or sawdust, the smaller quantity only being necessary with purity of the other ingredients. The mixture is then subjected to a heat of about 300° Fahr., under which the whole first liquefies and afterwards solidifies. Whilst subjected to this heat the mass should be constantly stirred with a wooden instrument, especially whilst settling, otherwise the whole may harden into a lump, but if stirred will become powder. On this stage being reached the compound is removed from the fire and subjected to a lower heat sufficient to dry it, say about 230° Fahr. The compound is then ready for use, and, according to the patentee, may be stored and carried with the utmost safety, as it will not explode unless confined and compressed. To obtain the full results and benefits of the powder it should be well compressed before being exploded. The boiler in which the mixture is heated should be much larger than necessary to hold the ingredients whilst cool, as on being subjected to the heat the mixture increases greatly in bulk.

In practice the patentee has found the following proportions of the ingredients produce the best powder for the respective purposes named for the blasting of hard material offering great resistance:—Saltpetre, 70 parts; sulphur, 12 parts; lampblack, 5 parts; tan or sawdust (well dried), 13 parts; and sulphate of iron, 2 parts. For substances offering less resistance and for coal getting:—Saltpetre, 64 parts; sulphur, 13 parts; lampblack, 4 parts; spent tan or sawdust, 19 parts; and sulphate of iron, 3 parts. For bituminous coal and gypsum quarries, and such like materials:—Saltpetre, 56 parts; sulphur, 14 parts; lampblack, 3 parts; tan or sawdust, 27 parts; and sulphate of iron, 5 parts.

For many purposes the compound may be profitably employed combined with nitro-glycerine, kerosene, or other similar explosive oils or substances; as, for example, for torpedoes and stone quarrying, and works under water. The combined product is not, however, inexplosive, but the mixture is only made at the ınt when it is to be used, thus reducing ınger to a minimum.

good proportion for a serviceable com- l is about 15 to 25 per cent. of nitro- rine or the other explosive employed, the nder being the improved powder; but the rtions must necessarily vary according to rength of explosion required. The mix- nay be effected either in the borehole or ously in a wooden vessel; but the tamping be carefully effected in the usual manner.

BEE MANAGEMENT.

(*Continued from p.* 592).

FORE going on to consider the management of "bar frames" it will be as well ive a few particulars to be observed ıstructing a bar-frame hive, as I have no ; several of our readers will, like myself, r to make a hive for themselves, as by so the pursuit will become more interesting remunerative, and the hive may be so ied as to suit the situation better than purchased article would. It must be at ame time understood that, where any ısion is definitely stated as being correct, quantity must be strictly adhered to, is only after repeated measurements that have been accepted. At the same time eason will be given, where possible, for adherence, and the consequence of devia- ɔinted out.

The size of frame is, of course, optional— fore the distance from front to back of and height are matters to be settled by piarian, but the width of the hive must multiple of 1 9-20in., as the distance from e to centre of the comb in a skep is 0in. For every five bars 7¼in. will, there- be required.

The distance between the side of hive and ame must be 5-16. If more the bees will comb between, and so fasten the bar to ive side. If less they will not be able to readily from comb to comb.

The distance from bottom bar to floor. when in position should be ¼in., which nable the bees to easily ascend the combs e they wish.

ving given these rules, to which strict rence is recommended, a few suggestions perhaps, not be out of place. In making den hive use no loose cover or case, but ruct it with a dead air space of at least wide. The protection against excessive and cold will then be thorough. If it is ded to help the bees with "impressed s" do not adopt a large frame, but in- e the number of frames, and keep to a bout Woodbury size. (As many makers adopted the Woodbury size, the inter- geability of bars is more probable if that adopted.) Let the hive contain at least oodbury bars, if such are adopted, and a e of dummies to contract the size of hive requisite. Let the flight-board be wider the full width of the door. Let the hive h or door be easily contractable, either by or runners, and well sheltered by a porch. the entrance cut out of the hive, not out e floor-board. If legs are attached to the have them screwed on outside the hive- so that they may be removed if desirable. tever sort of a support is used do not let light-board be more than a foot from the ıd.

Bar-frame Management.

d now, having the knowledge of what the iarities of the principal hives are, the ion naturally arises how to introduce them the apiary where skeps have been hitherto se. There are three different times at ı they may be introduced:—1. When first ns come off. 2. Three weeks after a first n. 3. At the end of the honey season. We reat the plans to be adopted in the above .

Having got the swarm safely hived in a place the "bar frame" on the ground if without legs; if with legs spread a sheet e ground, and stand the hive in the centre; ve the super cover and all the bars. If bees have just been "driven" (that is, ned artificially) they will require no pre- ion, but if they have been in the skep for an hour or two they will require a few puffs of smoke to be driven into the hive before they are disturbed. The hive is then inverted and bumped on the floor, not on the crown, but as shown in Fig. 1, which will gather the bees all to one side; without waiting a second to give the bees time to get foothold, the contents of the skep are poured quickly straight into the bar-frame, the skep then tilted higher, and a few good thumps given with the fist to the crown and the side where the bees had just rested. By this plan hardly a bee will fall outside the bar-frame. The sectional view at Fig. 2 shows how the hive must be held, the dotted line, A, showing its position when thumped, and the arrows showing where the blows must be given. Should any bees fall on to the sheet they should be brushed into a shovel with a feather, and then into the bar-frame. The whole of the bees being safely in the hive, the frames must be slowly and carefully placed in position, and the cover replaced. By adopting this plan there is less fear of the bees "boiling over" the sides, and on to the ground, than there is when shaken among the frames, as they fall in a mass, and are not divided as they are if shaken on top of the frames.

FIG. 1

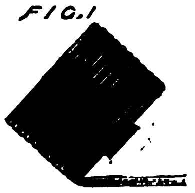
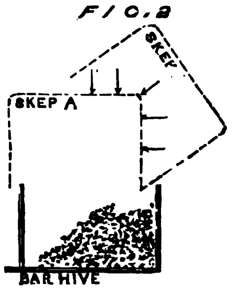


FIG. 2



In our next paper we shall consider the second method.

W. S. Travis.

A NEW WHITE PIGMENT.

UNDER this heading, in our number for Feb. 12, 1875, we said that "a white pigment, as cheap, as easily worked, and as good a coverer as white lead is a desideratum, and one that we are afraid will not readily be supplied." We are glad to find that, in less than four years from the date of that expression of opinion, the want has been supplied. We need not explain to our readers that hitherto no real substitute has been found for white-lead as the "body" of paints, but an oxide of zinc, known as zinc white, has long been used for special purposes. It is, however, more costly, and has less covering power than white lead. Some four years ago a patent was obtained for a white pigment compounded of zinc and barium, but whether it was too costly or was a failure as a pigment, we believe it has never come into use. It has been left to Mr. T. Griffiths, of Liverpool, to discover a really useful substitute for the poisonous carbonate of lead; and so complete is his discovery that the new pigment has a higher covering power than white-lead, while it is vastly superior in colour, and at the same time is not injurious to the workmen. At the International Congress of Hygiene the subject was introduced by Dr. Lutschaunig and Dr. T. L. Phipson, the latter of whom also read a paper on the subject at the meeting of the British Association. Apart from the fact that the new paint can be prepared and sold at about the same price as white-lead, while its covering power is 25 per cent. greater, we have the more important fact that it must ultimately drive that noxious pigment out of the market, as far as painters are concerned, and consequently save a number of human beings from a painful disease and a lingering death. The new pigment is being manufactured in Liverpool by the Silicate Paint Company, and a factory having been recently opened on the banks of the Thames a weekly output of about 50 tons can be insured; but if the demand increases, as it surely will, plans are already prepared for the erection of works capable of producing 200 tons per week. Some years ago Dr. Stenhouse made a white paint from oxide of antimony, and more recently Dr. Phipson himself has been experimenting with the artificial silicates. He has, though, invariably failed to impart to them the requisite "body." Mr. Griffiths, however, has devoted many years of research to the subject, and his triumph appears to be complete. Dr. Phipson says that, to his astonishment, he found, on examining the new pigment, that it not only surpassed the old zinc white, but was superior in every respect to carbonate of lead. It is obtained by precipitating zinc chloride or sulphate by means of a soluble sulphide. Sodic, baric, and calcic sulphides have all been used for the purpose, but special precautions are taken to prevent the precipitation with the white sulphide of any iron that may be present in the chloride of zinc. The precipitate of white sulphide is collected, dried, and transferred to a furnace, where it is calcined, being carefully stirred to bring all parts into contact with the air. Whilst still hot it is raked into vats of cold water, where it is levigated, and is then subsequently dried, the product being a white pigment of exquisite beauty, which is proof against the action of sulphuretted hydrogen. Dr. Phipson finds that its chemical composition is $5\,ZnS, ZnO$, but it varies slightly according to the duration of the calcination and the temperature, a larger proportion of oxide being occasionally present.

THE APPLICATION OF PHOTOGRAPHY TO THE PRODUCTION OF PRINTING SURFACES AND PICTURES IN PIGMENT.—VI.*

By Thomas Bolas, Esq., F.C.S.

(*Concluded from p.* 620.)

Other methods of producing Photographs in Pigment. Dusting-on process. Autotype printing.

YOU will remember that, last week, I spoke of the use of indiarubber rollers for the inking of collotype plates, and that I recommended a roller made with a thin surface of red indiarubber on a body of the glue and treacle composition used for typographic rollers. At the conclusion of the lecture, Mr. Dallas informed me that Messrs. Blades, East, and Blades, of Abchurch-lane, have recently introduced into commerce a roller consisting of a thick layer of red vulcanised indiarubber on a rigid stock. These rollers are made under a patent of Mr. Lanham, manager to the above-mentioned firm, and will, I am convinced, prove of very great value to lithographers as well as to collotypic printers. The manufacturers have kindly lent me some specimens of their rollers, which are now on the table.

Up to the present time we have been studying the means of producing, by the agency of photography, printing surfaces from which copies might be obtained without any further intervention of light; but in this, the last lecture of the series, I want to call your attention to some methods for the production of pictures in pigment, which necessitate a direct and separate action of light for the production of each picture.

Here is a glass plate, and I pour on it a mixture containing 25 parts of glucose, 4 of honey, and 4 of ammonium bichromate, dissolved in 120 of water. I lay the plate on the hot-water apparatus, and it will be dry in a few minutes. If the dried plate is exposed to the atmosphere, it will absorb moisture, and the whole surface will become sticky. Now that the plate is dry, and while it is warm, I will place it behind a transparency and allow a strong light to shine on it through the transparency. The joint action of light and ammonium bichromate tends to make the honey and glucose insoluble; or, at any rate, it prevents these materials from absorbing moisture from the air, as they tend to do naturally. Let us now take the plate out of the frame and examine it. A very faint image may be traced thereon, but only those of you who are near can see it. Now, what is happening to this plate? Those parts which were protected from the light are absorbing moisture from the air, the honey and glucose being here unaltered, while those parts which were exposed to the full action of the light refuse to absorb moisture, and those parts which have been protected from the action of a part of the light absorb an amount of moisture proportionate to the degree of shade afforded by the half tones of the transparency. Now note the effect of dusting powdered black-lead over the plate, and rubbing it on with a soft brush. Those parts which are dry refuse to take the black-lead, while those parts which are moist hold an amount of black-lead proportionate to the degree of moisture. Now look at our plate, and you will see that there is a picture showing all degrees of light and shade, the picture being formed of black-lead, held by the various degrees of moisture absorbed from the air. The next step is to coat the plate with collodion, and to immerse it in water, in order that the yellow ammonium bichromate may diffuse out. Other pigments than black-lead may be employed, and the pictures may be made on paper or other materials, but the dusting-on process, although interesting as a means of producing permanent photographs, is not worked commercially to any great extent.

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* Being the Cantor Lectures delivered before the Society of Arts.

We now pass on to the study of a process of much greater importance than the dusting-on method, namely, the so-called carbon process, or the autotype method. The first step in this process consists in coating one side of paper with a tolerably thick layer of gelatine, to which a little sugar has been added, together with sufficient pigment to strongly colour the mixture. Here is a piece of the "pigment tissue," as it occurs in commerce. To prepare it, about three parts of gelatine, and one part of sugar, are dissolved in water, and the pigment is added in sufficient quantity. A band of paper is then drawn over the surface of the mixture in such a way as to coat its surface with a uniform layer of the composition. The pigmented tissues are prepared on a large scale by the Autotype Company and others, and few will care to prepare their own tissue, excepting for experimental purposes.

To make the tissue sensitive to light, it is soaked in a solution of potassium bichromate, containing about three and a half per cent. of the salt. You see that this piece of tissue has now become quite flaccid from the absorption of the solution. So I scrape off the excess of solution by drawing the tissue over the edge of the dish, take it out, and hang it up to dry. When dry it will be ready for exposure under the negative. Here is some which has been previously dried, and I will put a piece under this negative and expose to the action of a bright light. In the ordinary process of silver printing, one can watch the progress of the operation, and can easily tell when sufficient exposure has been given. Not so in the case of the tissue, as it undergoes no visible change by exposure to light. Here is a little tin box having a small glass window in its lid, and a strip of sensitive silver paper can be drawn forward under this window. The lid having been shut down so as to press on the strip of silver paper, the tin box is exposed to light simultaneously with the printing frame containing negative and tissue, and as soon as the silver paper has acquired a certain standard tint or degree of darkness, it is considered that the tissue has had one unit of exposure. The silvered paper is then drawn forward, so as to expose another portion; and so on until as many units of exposure have been given as the tissue is known to require when exposed under the negative in hand. This is quite easy in practice, as a little experience will enable one to judge how many units of exposure, or "tints," will be required by each negative, and one guide-box, or "actinometer," serves for any number of printing frames. The tissue which I just placed under a negative has now had sufficient exposure to light; I take it out, soak it in water until it is soft, and then, while it is still in the water, I bring it in contact with a piece of paper which has been coated over with a thin layer of insoluble gelatine, so as to make it impervious to water. The tissue and the impervious paper are drawn out of the water together, and an application of the squeegee now removes the excess of water which remains between the two surfaces, and the exposed tissue adheres to the impervious paper. Let us allow them to remain in contact for a few minutes, in order that the tendency to adhere may become greater.

Bear in mind that the bichromatised and pigmented gelatine becomes insoluble by the action of light shining through the negative, and the depth to which this insolubility extends is dependent on the amount of light which has acted on it. On those parts of the tissue which have been exposed to much light, a thick layer of gelatine is made insoluble, while on those parts which have been exposed to only a little light, the insoluble layer is very thin.

Now, we want to wash away the soluble portions of the gelatine from the exposed tissue, and to leave the portion made insoluble by the action of light, just as in the Woodbury type process; but if the exposed tissue were put directly into hot water, the insoluble image would become undermined by the dissolving away of the gelatine from underneath it, and it would become destroyed for want of a support sufficiently strong to hold it together. You can now understand why the exposed tissue was mounted on a piece of impervious paper, this being intended to hold together the insoluble gelatine image during the treatment with warm water. Here is the tissue, which I mounted on a piece of the impervious paper, or single transfer paper. Notice the effect of putting it into a dish of warm water. You see that the soluble gelatine in which the insoluble image is imbedded melts and exudes from under the edges of the paper, while the application of a very little force will now enable us to separate the two papers, *viz., that on which the tissue* was originally made, and the impervious paper on which the tissue was mounted. Under these circumstances, the insoluble image naturally adheres to the impervious paper, or single transfer paper, but it is at present clogged up by some of the soluble gelatine, which must be removed by rinsing with warm water. You see that this soon dissolves away, leaving the image on the single transfer paper. Here it is. This image consists of varying thicknesses of gelatine made insoluble by the joint action of light and a bichromate, but as the gelatine contains a black pigment (carbon), it shows on the paper as a picture in black and white. This is the simplest form of the carbon or autotype process; it is known as the single transfer process, and, as a little consideration will show you, it requires a reversed negative, that is to say, a negative in which the sides of the picture are reversed, left-hand being where right-hand should be, and right where left. This disadvantage is obviated by the so-called double transfer process. According to this method, the picture is not developed on the support which is ultimately to hold it, but on a temporary support, from which it is removed by the application of a sheet of adhesive paper.

Yonder, at the other end of the table, stands Mr. Foxlee, surrounded by carbon printing materials of every kind, and he has kindly consented to demonstrate the principal phases of the carbon process with some materials and partly finished prints, for which I am indebted to the Autotype Company. I see that, while I have been talking, Mr. Foxlee has been busy; he has mounted some pieces of exposed tissue on waxed zinc plates, some on collodionised opal glass, some on single transfer paper, and others on a material known as Sawyer's flexible support, and which I shall describe to you directly. To all of these the wet tissue adheres perfectly well, and as the prints are now ready for development, Mr. Foxlee is putting them into trays of warm water. Notice how he strips the paper off as the soluble gelatine dissolves, and how the pictures will gradually unfold when he rinses them with warm water.

I want you now to take notice of the flexible support introduced by Mr. Sawyer the talented director of the Autotype Works. Its basis consists of hard paper coated with a layer of insoluble gelatine. This is floated on an alkaline solution of shellac, which softens the gelatine on the surface bonds with it, and forms a thin film of varnish over it. When dry, the flexible support is rubbed over with a weak solution of wax and resin in oil of turpentine, in order to prevent the possibility of permanent adhesion between the flexible support and the gelatine picture. The great advantage of this support consists in the fact that the fine details of the gelatine picture are not crushed against a rigid surface in the mounting and subsequent treatment. This will be illustrated further on.

Mr. Foxlee has now finished developing his pictures—those developed on single transfer paper are finished, as after development they only require rinsing in cold water, a dip in alum solution to harden the gelatine, and then a second rinse to remove the excess of alum. You see that among the single transfer prints which Mr. Foxlee has developed are some very fine large portraits, but Mr. Foxlee makes large prints as easily as others make small ones; he thinks nothing of making them three feet by four feet, or even larger. Now, here are the prints which Mr. Foxlee has developed for double transfer—some on zinc plates, some on Sawyer's flexible support, and others on opal glass. I see that he has a number of pieces of the so-called double transfer paper in a dish of warm water before him. This paper is coated on one side with gelatine, to which a little alum or chrome alum has been added, and when it is put into warm water the surface becomes sticky, but the gelatine does not dissolve. On each of these prints, which have been developed on the various supports, Mr. Foxlee is placing a sheet of the wet and sticky double transfer paper, and after having ensued contact by means of the squeegee, he puts them aside to dry, and when they are dry it will be found that the paper can be easily stripped from the temporary support, carrying the print with it. In order to illustrate this, Mr. Foxlee has provided himself with some transferred prints already dried, and ready to strip from the temporary support. You see that Mr. Foxlee is now stripping the prints from zinc plates; he just inserts his thumb-nail under one corner, and then a slight pull brings the print off. Now, he is similarly stripping prints which have been developed on collodionised opal glass. Notice what a fine enamel-like lustre they have. Next, he will separate the prints from Sawyer's flexible support. You see how easily they separate, and if you carefully examine the flexible support from which a print has been separated, you will be able to trace a faint intaglio image of the print, showing how the image sinks into, and is protected by, the flexible support. The single transfer process and tissue-making are now untrammelled by patent rights; but the double transfer method and the manufacture of Sawyer's flexible support are subject to patents held by the Autotype Company, and licenses for the working of double transfer are granted on almost nominal terms.

Mr. Foxlee will now illustrate to you the method of making carbon pictures on ivory and on artist's canvas. He has developed pictures on the flexible support, and while they are wet he lays them down on the ivory and on the canvas, which, by the bye, have been previously prepared with a thin film of partially insoluble gelatine, and makes contact by means of the squeegee. When dry the flexible support can be peeled off, leaving the print on the ivory or on the canvas. You see that Mr. Foxlee is now stripping the flexible support from some specimens which he has previously prepared. Very beautiful transparency pictures can be produced by the carbon process; it being merely necessary to squeegee the exposed and wet tissue on to a piece of collodionised glass, and after a few minutes, to develop in warm water. Mr. Foxlee is now developing some, and when they are finished I will exhibit them to you by means of the magic lantern. The process I have described to you is generally known as the carbon process, it having arisen out of an earnest desire to obtain non-fading photographs; and as carbon is the type of a non-fading pigment, it was naturally used at first, either in the form of lampblack or of Indian ink. As time went on, people wanted other tints, and it was considered especially desirable to imitate the purple tint of a gold-toned silver print. This was done to perfection by the use of a mixture of lampblack, indigo, and cochineal lake, but, unfortunately, the prints so coloured were found to change their tint owing to the fading of the cochineal lake. Attempts were soon made to replace the fugitive cochineal colour by permanent reds, and notably by madder red or alizarine, but until recently with only partial success, as ordinary madder lakes work mischief in the tissue. Mr. Sawyer has, however, recently overcome all difficulties with regard to the use of alizarine in tissue, and alizarine is now used in all the tissue of the Autotype Company, which imitates the "photographic tone," or series of tints shown by silver prints.

The kindness of many eminent carbon printers has enabled me to show you a splendid collection of prints to-night. The Autotype Company have lent me several hundred of their well-known and admirable productions, ranging in dimensions from four feet high to pin or brooch size. Messrs. Braun and Co., of Dornach, have kindly lent me specimens which are of the first order, and I want you to especially notice the excellence of two untouched portraits kindly lent me by the Woodburytype Company. Among the more recent carbon painters we have Mr. Witcombe, of Salisbury, who has sent a very fine collection of small prints, but as they arrived too late to be displayed, I have placed them on the table. You will see over younder a frame containing some prints made by a process due to Sir Thomas Parkyns. The carbon prints being covered with a film of coloured collodion, very striking effects are produced, imitating moonlight and other effects.

Mr. Le Neve Foster has lent me a carbon print made by Mr. Pouncy twenty years ago, and if you look at it you will see that in detail and delicacy of gradation it is quite equal to the productions of more recent times; and I have here some carbon prints which were made by Mr. Foxlee, nearly as long ago. I should like you to look at these, as they are an illustration of what was done during the infancy of carbon printing.

In these lectures I have not attempted to give anything like a history of photo-typography; I have not even mentioned many important processes. Had I referred to all, the six lectures would have been merely an index to the work which has been done. I wish I had been able to give you more details of the processes described, but you must bear in mind that days rather than hours are required for properly demonstrating the simplest photo-mechanical process, and real working and practical demonstrations can only be given in the quiet of the laboratory, and to a very small number of people at a time.

THE INTRA-MERCURIAL PLANET.

An able article in the *Times* of the 24th ult., after reviewing the history of "Vulcan," concludes as follows:—M. Gaillot, director of the "Bureau des Calculs," has compared the observed position of Watson's star with the position which Vulcan should have according to the four orbits determined by Leverrier. He has found that one of these orbits agrees fairly (*assez bien*) with the position of the body observed on July 29. He has even calculated the position of the planet for the beginning of August. We infer that the planet would be at its greatest distance on the eastern side of the sun (about 18 sunbreadths from him) on or about August 30, and that a transit might possibly occur on or about September 11.

If Vulcan has really been observed, and the orbit by which M. Gaillot has reconciled Lescarbault's observations with Watson's is really that of an intra-mercurial planet, then the planet travels round the sun in a period less than that in which the sun rotates on his axis. Its period is about 24 days, and its distance from the sun about 15 million miles, and if it has inhabitants they are exposed to a heat exceeding some 36-fold that which we receive from the sun. It would follow from Gaillot's theory of the new planet that, when Watson saw it, it was approaching superior conjunction—in other words, it was passing the part of its path furthest from the earth. This inference is an important one, because there would be a marked difference between the brightness of the planet at that part of its path and at a point on the nearer half of its path where it would seem to lie at the same distance from the sun. At the last-named point much less than half the planet's disc would be illuminated, whereas at the former much more than half would be illuminated; and since the planet's distance from the earth does not change considerably (the planet being so near the sun) it follows that the planet is much brighter when nearly at its greatest distance from us than when nearly at its least distance. Since the star seen by Watson was so faint, shining little more brightly than Theta Cancri, though thus favourably placed for observation, we must infer that Vulcan is a very small planet. If he were as large as Mercury, he would under similar conditions, shine at least five times as brightly, being so much more brilliantly illuminated by the sun. At a very moderate computation the disc of the body seen by Watson cannot have been greater than a hundredth part of the disc of Mercury at his mean distance. From this we should infer that the diameter of the stranger cannot be greater than about one-tenth of Mercury's, or say at the utmost about 350 miles. If so, such a planet in transit across the sun's face would not be very easily detected, and, indeed, one would scarcely have expected that Lescarbault would have seen Vulcan at all. There are other difficulties. It is quite certain that so small a body, unless its density enormously exceeds that of any known planet, would be quite unable to produce the perturbation detected by Leverrier. But if there were several such bodies, they should be seen frequently on the sun's face. It seems unlikely that there should be a flight of very small planets, and that only one among them would be large enough to be seen during total eclipse. We may, however, admit the possibility that Watson's planet is the only intra-mercurial planet, and that the rest of the pertubtion discovered by Leverrier is to be explained as Newcomb was disposed to explain the entire disturbance—as due, namely, to the action of the family of relatively minute bodies round the sun, whose lustre forms what is called the zodiacal light. In fact, the search made for bodies near the sun was so close upon this occasion, and the circumstances were so favourable for the detection of such bodies if they exist, that we are compelled to reject the belief that any other planets could have been in view than the one seen by Watson. For he and Professor Hall examined the whole neighbourhood of the sun—Hall taking, it would seem, the eastern side, and Watson the western.

We are thus led to the conclusion, as at least highly probable, that within the orbit of Mercury there is a planet far inferior to Mercury in volume and mass, travelling round the sun in about 24 days, at a distance of about 15 million miles. We find strong reason, also, for believing that the zodiacal light, which was seen during the late eclipse for the first time, not only occupies an enormous disc-shaped region around the sun, but is composed of matter, the aggregate mass of which probably exceeds three or four times that of Mercury. If we accept the latter inference, we may at the same time safely infer from theoretical considerations a relation which observations had hitherto left in doubt. The small bodies forming the zodiacal light must travel for the most part in planes nearly coincident with that of the path of Mercury, for if they did not, the position of the last-named plane would be affected by their disturbing action, and no such effect can be recognised. It will be manifest, we think, that astronomers will have abundant matter for observation during future total eclipses. The new planet must be seen several times before its orbit can be exactly determined, and doubtless Newcomb's success in observing the zodiacal light during total eclipse will encourage others to make similar observations with even greater care on future occasions.

THE COMPOSITION AND WORKING OF ALLOYS.—III.*

Fluxes for Alloys.

THE best flux for alloys of copper and tin is resin. It should be added when the metals are almost nelted. Another good flux is sal-ammonia. In ising this flux the copper is usually melted first and he flux added. When it is in the mushy state, after he flux has been put in, the zinc and tin are then dded. A good flux for old brass is common resin oap. It should be added in small lumps and stirred own into the metal when in the molten state. In orming alloys of different metals the molten metals hould always be kept under a covering of black glass r pulverised charcoal to prevent oxidation.

Black Flux.

Black flux, as it is commonly called, is composed of 7 parts of crude tartar, 6 parts of saltpetre, 2 parts of common bottle glass, and by some a small amount of calcined borax is added. These ingredients are first finely pounded and mixed together, and then gradually heated in an iron pot or ladle so as to burn them together. Care should be taken to not overheat the mixture, and as soon as it is thoroughly melted and mixed together it should be removed from the fire and allowed to cool. After it has cooled it is finely pulverised and sifted, and is then ready for use. It has a great affinity for moisture, and should be protected against it by being placed in glass bottles, and the bottles corked up until wanted for use. This is the most powerful flux that can be made. It is but little used in forming or fluxing alloys, but it is principally used by assayers in assaying of different kinds of metallic ores. In these assays the quantity of black flux used varies according to the quality of the ores, but the amount generally used is about an equal amount of ore and flux. The ore is first roasted and then finely broken up and mixed with the flux, and the whole is then rapidly heated in a crucible. If the flux does not make the slag sufficiently fluid to allow the metal to settle, a small amount of calcined borax is added, which makes the slag more liquid, and permits the metal to pass to the bottom of the crucible. The crucible is then removed from the fire and the mixture either poured from it or allowed to cool in it. After it has cooled the slag is knocked off with a hammer and a button of metal obtained. When using this flux the clay crucible, without either coal or plumbago, is preferred, for the flux is very hard on a crucible that contains either of these substances. Black flux is used by some foundry-men in melting the fine scrap sweepings from the floor, and dross and refuse from the crucible, by melting these in a crucible with black flux. They obtain considerable amounts of metal from them that would otherwise be lost. In melting this refuse with black flux the common clay crucible should always be used.

Nature and Character of Alloys.

Alloys of gold, silver and copper are generally superior in strength to any of the more fusible metals, and may be forged either when red-hot or cold. These three metals seem to unite in any proportions, and always form an alloy that is malleable when either hot or cold. Pure gold is but little used in the arts; it is then too soft. It is generally alloyed with silver and copper, both to harden it and depreciate its value. Alloyed with copper, it forms gold of a red tint: with silver, it forms gold of a green tint; and alloyed with both copper and silver, it gives intermediate tints. Pure silver is but little used alone; it is generally alloyed with a small amount of copper, which does not change its colour, and greatly improves its malleability and working qualities. When gold, silver, or copper are alloyed with the more fusible metals—lead, tin, and zinc—the alloy is less malleable and ductile than alloys of gold, silver, and copper. They are extreme red-short, and when heated to redness they will fly to pieces under the hammer; and alloys of brass, bell metal, &c., must be treated with precaution, and should never be taken out of the mould while red-hot. Alloys of 2 parts copper and 1 part zinc are very soft and malleable, and may be drawn by hammering or easily cut with a file, but an alloy of 1 part copper and 2 parts zinc is as hard and brittle as glass, and may be easily pulverised. An alloy of 2 parts copper and 1 part lead makes a soft, malleable metal, but is inferior to an alloy of copper and zinc. In alloys of 1 part copper and 1 part lead the lead will ooze out in cooling. In alloys of 1 part copper and 2 parts lead the lead will not unite, but will sink to the bottom when cooling. Alloys of 6 parts copper and 1 part tin make a very hard alloy, and the alloy gets harder and whiter the more tin is added. Alloys of tin and copper should not be too rapidly exposed to the air, for if a large percentage of tin is used it will strike to the surface and ooze out or make hard spots in the casting. Alloys of zinc and lead cannot be made without the addition of arsenic, unless the lead is alloyed in a very small quantity. Alloys of zinc and tin are very hard and brittle, and are but little used alone. By the addition of copper to alloys of these two metals, the alloy is rendered more malleable and soft. Arsenic makes all alloys hard and brittle, and is very dangerous to use. It is seldom used except to impart fluidity to the very infusible metals. Alloys of lead and tin are very malleable and ductile when cold, but at a temperature of about 200° Fah. they lose the power of cohesion and are exceedingly brittle. The alloys of tin and lead partake of the general nature of these two metals. They are soft and malleable when cold, even when a small amount of brittle antimony has been added. An alloy of 6 parts lead and 1 part antimony is very soft and malleable, but an alloy of 3 parts lead and 1 part antimony is very hard and brittle; and an alloy of 1 part lead and 1 part antimony is harder and more brittle than antimony.

Fusibility of Alloys.

In forming alloys of the different metals they do not combine with each other in their solid state (with the exception of mercury), owing to their chemical affinity being counteracted by the force of cohesion; and in order to form combinations of them it is necessary to liquefy at least one of them, in which case they will unite, provided they have a chemical affinity for each other; thus bell metal and brass is formed when pieces of tin or zinc are put into molten copper; and in the formation of alloys of this nature, where one of the metals is more fusible than the other, the less fusible metal should be fused first, and the more fusible metals added either in the molten or solid state. As the fusible metals are added the temperature of the alloy should be reduced to prevent oxidation or burning away of the fusible metals; for this reason it is better to add the more fusible metals in the solid state, as by so doing the temperature of the metals is decreased. Alloys are always more fusible than the less fusible metals of which they are composed, and in some cases are more fusible than the most fusible metal they contain, as is the case in alloys of tin, lead, and bismuth. Some founders, in order to have the metal thoroughly united, first fuse the metals together and cast them into ingots and remelt them for use; this practice is bad, for in the after fusion there is always more or less of the more fusible metal burnt away; and it is hard to determine the proportions of the alloy or to have any certainty as to the quality of the castings. In melting ingots or scrap alloys they should be fused as rapidly as possible, and at the lowest available temperature so as to avoid oxidation.

Some of the metals are almost infusible, and when heated to the highest heat in a crucible they refuse to melt and become fluid, but any of the metals can be melted by combination with the more fusible metals. Thus platinum, which is infusible with any ordinary heat, can be fused readily when combined with zinc, tin, or arsenic; this metal, by combination with arsenic, is rendered so fluid that it may be cast into any desired shape, and the arsenic may then be evaporated by a mild heat, and leave the platinum, in its pure state, cast into any desired shape. Nickel, which barely fuses alone, will enter into combination with copper, forming German silver—an alloy that is more fusible than nickel, and less fusible than copper; this alloy is rendered the whiter, harder, and less fusible the more nickel is added. The less fusible metals, when fused in contact with the more fusible metals, seem to dissolve in the fusible metals; rather than melt, the surface of the metal, is gradually washed down until the entire mass is dissolved or liquefied and reduced to the state of alloys. In forming alloys of brass, in furnaces where heat enough cannot be obtained to fuse the copper separately, the alloy may be formed by heating the copper to the highest heat, and then adding the zinc or tin in the molten state, so as not to reduce the temperature of the copper.

In forming alloys with new metals it is usual to melt the less fusible metals first, and then add the more fusible metals and mix them by stirring them well together; the rod used in stirring them should be heated to redness to prevent lowering the temperature or chilling the metal. In mixing alloys for bells the alloy should be well stirred with an iron rod, well heated, in which case part of the iron is dissolved and combines with the alloy and gives the bell a better tone; but alloys of brass that are to be turned or finished should never be stirred with an iron rod, for the iron dissolved from the rod will cause hard specks in the alloy if not thoroughly mixed. In forming fine alloys the alloy should be stirred with a rod of the least fusible metal contained in the alloy, or with a wood stick; the wood stick, in many cases, is better than a metallic rod, for it causes the metal to boil slightly and unite more thoroughly, but the wood stick cannot be used in a small crucible with only a small amount of metal. When alloys are made that contain only a very small quantity of a metal that is difficult to fuse, as in pewter, it is scarcely possible to throw into the melted tin the half per cent. of melted copper, with any certainty of the two metals being properly combined; and in forming this alloy it is customary to melt the copper in a crucible and then add to it two or three times its weight of melted tin; this dilutes the copper and makes an alloy, called temper or hardening. This alloy is very fusible, is melted in an iron ladle, and is added to molten tin or lead, to give it the desired hardness and form pewter.

SINGING TELEPHONE AT STEVENS INSTITUTE OF TECHNOLOGY.*

By Henry Morton, Ph.D., President.

A NUMBER of experiments have been made at the Stevens Institute of Technology with telephones for singing and for speaking, which, while not of a nature to form a systematic research, have nevertheless, developed facts of sufficient interest to merit some record. These experiments were chiefly conducted during the summer holidays, by several students and graduates connected with the institute, under the direction of the present writer, and were carried on, in the first place, mainly with the view of developing a loud-sounding instrument to transmit musical tones, and thus fitted for use in illustrating public lectures on the subject. The gentlemen concerned in these experiments were Messrs. Wm. E. Geyer, Henry A. Beckmeyer, and Brown Ayres. The point of departure was the oldest form of the singing telephone, described by Reiss in 1863, and consisting of a transmitting and a receiving instrument. This transmitter, used by Reiss, consisted of a mouthpiece like that of an ordinary speaking tube connected with a box or chamber, one surface of which was provided with a large round aperture covered with a parchment diaphragm. To the centre of this diaphragm was attached a small plate of platinum, with a metallic connection, to a binding-post. Opposite this central point of the diaphragm was supported a screw, with a platinum point, adjustable so as to touch the platinum plate on the diaphragm lightly when at rest. On singing into the mouthpiece the diaphragm was made to vibrate in unison with the note, and thus a corresponding intermittent current was transmitted to the receiving instrument.

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* From a series of articles by Mr. E. Kirk, published in ie *Iron Age*.

* From the Journal of the Franklin Institute.

The receiving instrument employed by Reiss consisted at first of a simple electro-magnet mounted on a resonant case, the sounds produced being simply due to the molecular changes in the soft iron bar of said magnet. Afterwards he used an electro-magnet, with a movable armature, whose vibrations then became the source of the sound.

The transmitting instrument employed by us (shown in Fig. 1) was made in the shops of Messrs. Geo. Wale and Co., located in our building, and consisted of a truncated hollow brass cone, provided with a ring slipping over its smaller end, by means of which a diaphragm of thin sheet rubber could be readily attached. To the centre of this diaphragm was attached a small circular piece of platinum foil, to which was soldered a very fine copper wire, which led to a binding screw upon the base-board of the instrument. Opposite the diaphragm was a screw, with a platinum point, supported on a brass column, so as to touch lightly the platinum foil in the centre of the diaphragm. The base of this column was also provided with a binding screw, to carry on the connection.

This apparatus being connected with a battery, it is evident that on singing into the cone vibrations corresponding to the note would occur in the diaphragm, and these would in turn cause ruptures and renewals of contact corresponding in frequency between the platinum foil on the diaphragm and the point of the opposing wire. This was, in effect, nothing more than the transmitter of Reiss made more compact and adjustable.

After numerous experiments with other plans, which operated with greater or less success, the following arrangement was made by Mr. Geyer, with much better results than any we had obtained before: An ordinary U-shaped electro-magnet, about three inches long, wound with coarse wire, so as to have only about two ohms resistance, was supported with its limbs vertical and the ends of its poles turned upwards. On each pole was laid a narrow thread of soft indiarubber. Upon these again rested an ordinary armature cemented to the resonant case of an Æolian harp.

The intermittent current here produced vibrations by fluctuations in the attraction between the magnet and armature, the necessary resilient force being supplied by the lines of rubber on the face of the magnet. With this instrument the sound produced *was loud enough to be* heard over a large room.

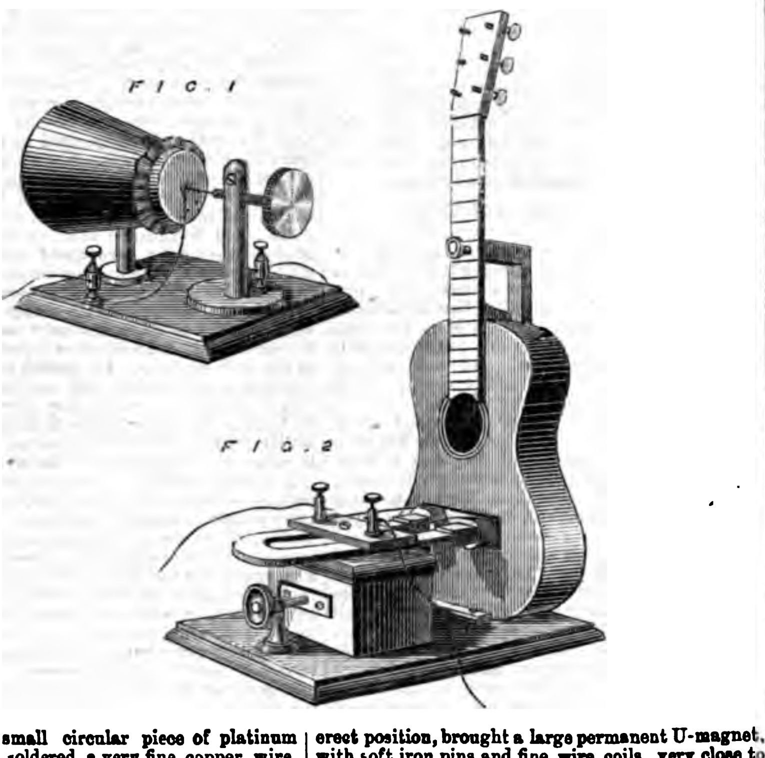
FIG. 1

FIG. 2

For greater convenience, however, the magnet was supported in a horizontal position, thin rubber bands, such as are used for filing papers, being stretched on it, so as to cross the face of each pole. The armature was attached to the bridge of a guitar, which in its turn was hung from an upright stand, so as to have the armature rest against the poles of the magnet.

This gave to the whole apparatus an elegant appearance, and produced a very striking effect in its use, as the guitar could be hung on its support without any special care or adjustment, and would then immediately begin to sound out the tune which was being transmitted from the other end of the line.

Such an instrument was fitted up for a concert troupe, who have been travelling over the country for some months past, and has given, we hear, entire satisfaction, exhibitions having been made with it in some of the largest concert-rooms and other public buildings.

In the course of some experiments which he made during the summer Mr. Ayres found that a telephone—made after the pattern of those used by Mr. Graham Bell at his lectures in New York last spring, and consisting of a permanent magnet with soft iron pins attached to its poles, these being surrounded with coils of fine wire, and having opposite to them a disc of sheet-iron about six inches in diameter—made an unexpectedly good receiver for a current transmitted by such a Reiss transmitter as we have described.

An application of this was soon made to what we may call the "guitar receiver" (see Fig. 2), by Mr. Beckmeyer, who, securing the guitar firmly in an erect position, brought a large permanent U-magnet, with soft iron pins and fine wire coils, very close to the armature which was attached to the guitar.

The instrument so arranged was found to give a louder sound, and to operate more easily than the previous one. The battery used in all these experiments consisted of six Léclanché cells of the usual kind supplied by the Léchlanché Battery Company, 40, West 18th-street, N. Y.

It struck the present writer as a very remarkable circumstance, that effects so nearly alike should be obtained under such different conditions as were here present. Thus, in what may be distinguished as Mr. Geyer's telephone, the resistance of the magnet was only about 3 ohms; while in what we may call Mr. Beckmeyer's arrangement it was about 200 ohms.

A series of experiments, carried on at his suggestion, also showed that the excellence of effect in loudness and range of tone did not depend upon the mere strength of the magnetic attraction, but might be greatest when that was least, and that the suppression of the extra current by the use of a condenser seriously impaired the effect of the apparatus.

This seemed to indicate that currents of high intensity, such as the extra current or an induced current, might be of special efficiency.

Such, indeed, proved to be the case. The battery current, interrupted by the transmitter, was passed through the primary of a small induction coil, and the secondary circuit of the same was then connected with the line in which the guitar receiver was placed.

Under these circumstances the results obtained were very excellent, the sounds produced being quite as loud as those from the battery current.

There was also another advantage in this arrangement—namely, that lines of very high resistance could be interposed, and thus the induced current could pass, for example, through the bodies of several persons, and yet produce loud music in the guitar. This makes a very striking lecture illustration or experiment.

Though reached independently by the course of reasoning and experiment here noted, no claim of originality is made in this connection, for one of Mr. E. Gray's patents covers the use of an induced current with an electro-magnet and armature attached to a sounding board. A further practical improvement was made in the transmitter at the suggestion of Mr. Ayres, by substituting thick letter paper for the sheet-rubber diaphragm. This greatly increased the range of action of this part of the apparatus, and thus facilitated its adjustment, and made the certainty of its action on all occasions much greater.

Another matter of practical importance was seen to be a convenient and portable battery, sufficiently constant to operate the apparatus for the time of ordinary experiments, without unnecessary bulk and weight. To meet this requirement the present writer designed the following arrangement:—Ten glass specimen tubes, 1¼in. by 4in.—in other words, large test tubes, flat at the bottom, and with heavy glass rings at the top, are set in holes bored in a strip of wood secured against a flat piece of thin board, 8in. by 12in. At the upper part of this board are attached two staples of brass, into which drop the ends of a bar of wood. On the bar are fastened, by a single screw each, seven rectangular pieces of sheet brass. Each one of these, except the terminal one, holds, by simple pressure, a wire connected with an element of carbon or zinc on either side. These elements dip appropriately in the tubes. The terminal plates of brass hold only one wire each, and close the end connections by contact with the staples, each of which has a binding-screw in its lower part.

A very cheap, compact, and yet efficient battery is thus produced. For exciting fluid a strong solution of Glauber salt will answer very well, so will one of sal-ammoniac; both of these are entirely non-corrosive and harmless if spilled. Dilute sulphuric acid produces more energetic effects, but even the neutral solutions will produce all the force necessary to fill the largest lecture-room with sound from the guitar.

A SIMPLE PHONOGRAPH.*

THE simple instrument shown in perspective in Fig. 1, in section in Fig. 2, and in plan in Fig. 3, consists of a mouthpiece, A, to which is attached a thin ferrotype plate diaphragm, B, by means of sealing wax or cement. Upon the outer face of the diaphragm and at opposite edges there are guides, C D, for receiving the wooden strip, F. These guides present only a slight bearing surface to the strip. The guide, D, is rounded to receive the spring, E, which is secured to it by two screws, by which also the spring is adjusted, so as to bear with more or less force on the small rubber block which rests upon the centre of the diaphragm. A needle, which is sharpened like a leather sewing-needle or awl, is soldered to the spring, and is located directly opposite the centre of the diaphragm. The guides, C D, are placed so that the median line of the strip, F, is at one side of the needle. The strip, F, has four slight longitudinal grooves, two on each side, which are made with an ordinary carpenter's gauge. These grooves are located so that when the strip is moved through the guides, one or the other of them will pass over the needle. A piece of beeswax is rubbed over the sides of the strip to give it an adhesive coating for receiving the foil used in recording the sounds.

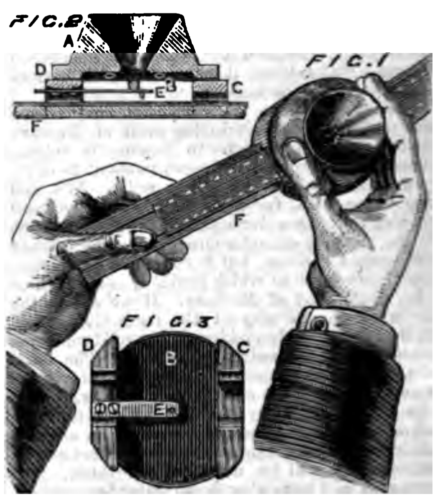
FIG. 2

FIG. 1

FIG. 3

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* From the *Scientific American*.

The foil, which should be rather heavy, must be ut into strips wide enough to extend beyond the rooves in the wooden strip. The foil is laid on the wooden strip and burnished down with the thumbail, so that it will adhere. The strip thus prepared placed in the guides, C D, and the needle is adusted so that it indents the foil slightly as the stick moved along.

By talking in the mouthpiece, and at the same me moving the strip along with a smooth steady otion, the sounds are recorded on the foil. By assing the strip again through the guides, so that he needle traverses the same groove, and applying o the mouthpiece a paper funnel or resonator, the ounds or words spoken into the instrument will be eproduced. It is even possible to record the sounds n a plain strip of wood so that they may be reroduced.

BRITISH ASSOCIATION.

ABSTRACTS OF PAPERS, &c.

Insect Fertilisation of Flowers.

Mr. Alex. Wilson, M.A., B.Sc., Glasgow, read a aper on the "association of an inconspicuous corolla ith proterogynous dichogamy in insect fertilised owers." There is a class of flowers represented by e common figwort (*Scrophularia nodosa*) which re shown, by their secreting nectar and emitting dours, to be dependent on the visits of insects for eir fertilisation and not on the wind, and yet they o not possess a conspicuous coloured or marked orolla for the guidance of insects to the flowers. oreover, the flowers are in them not massed togeer to gain additional conspicuousness as in highly oloured flowers like heaths, foxglove, gladiolus, &c. ighly coloured conspicuous flowers are usually proeranthous—*i e.*, the anthers are matured before the tigma, and as flowers are usually developed from elow upwards, it follows that in any given plant he lower flowers will have shed their pollen and ave their stigmas ready to receive it by the time he upper flowers are beginning to shed their pollen. n this inconspicuous class, on the other hand, the ower flowers will be in the second or male stage hen the upper flowers are as yet in the younger or emale stage. Now it is clear that an insect visiting uch flowers must adhere to the habit of the bees, hich invariably begins at the lowest flower on a talk and goes upwards, taking each flower in reguar succession. By this means itinvariably enters first female flower, and there deposits the pollen it brings ith it from another plant. Were the bee to reverse his order the whole elaborate arrangements of many lants for cross-fertilisation would be upset, for the ee would simply transfer pollen from the upper male lowers and deposit it on the lower female ones. This ould be fertilisation by flowers of the same plant, nd this Mr. Darwin has shown to be little or no etter than self-fertilisation. In the case of the inonspicuous flowers, where the opposite condition btains, a bee would frustrate fertilisation by dhering to its ordinary ascending habit. Mr. Wilson's observations of a wasp visiting these plants ndicate that the wasp begins at the top flower and roceeds downwards—so that they are adapted specilly to such insects, and as wasps are generally preatory in their habits, and not entirely vegetable eeders, as bees are, it is probable that, like other arnivorous creatures, their perceptions of vision nd scent are keener; hence wasps can probably find hese obscure flowers quite as easily as a bee can a ighly-coloured one. The plant, therefore, finds that he material can be more economically utilised than n the production of a coloured corolla just as in the ase of self-fertile cleistogamic flowers.

The Steering of Screw Steamers.

Professor Osborne Reynolds, F.R S., read the eport of the committee appointed to consider the ffect of propellers on the steering of vessels. The istance required by a screw steamer to bring herself to rest from full speed by the reverse of her crew was almost independent of the power of the ngines, but depended on the size and build of the hip, and generally lay between 4 and 6 times the hip's length. A screw steamer at full speed reuired five lengths in which to stop herself, but by sing the rudder she should be able to turn herself hrough a quadrant without having advanced five engths in her original direction. In the case of the Kurfürst and the König Wilhelm there were two essels in first-class condition, sailing on a clear ay, in the position prescribed by the whole wisdom f the German navy. One of them found it necesary to manœuvre a little, and in doing so found erself out of position. She reversed her screw, all ommand of her was lost, and she followed her own nguided way right into the ribs of her consort. amentable as the accident was, it would have been ome consolation had it been taken as a lesson; ut so far from this being done, we find what ppears as the cause of the accident—namely, the eversal of the screw—commended by the German avy.

Wind Power.

Mr. J. Price read a paper "On the Use of Wind-Power for Raising Water, and the Disposal of ewage and Drainage, with Special Reference to reland." The average force exerted by the wind all over Ireland equalled 360 million horse power. Wind-engines are now made which are self-acting, so as to provide against the effects of storms. Small towns and villages had not the means of bringing water from a distance, and might be supplied by deep wells and pumps worked by wind-engines at a very low cost. The same force might also be used for the removal of sewage from small towns by the infiltration process. A 1 horse-power wind-engine would suffice to keep 100 acres of land drained. The same power might with advantage be employed in the drainage of bogs and the manufacture of peat. He believed that if Ireland were fully drained and properly tilled the climate of that country would rank equal to that of England for the production of cereals. Mr. Bramwell said it would be advantageous for manufacturers and others using steam-power to provide windmills which could be used whenever the wind was strong enough in relief of the steam-power. The Margate Waterworks had both a steam-engine and a windmill. The President (Mr. Easton) did not think there would be any difficulty in connecting both the steam-engine and the windmill with the machinery.

The Adulteration Act and the Milk-Sellers.

Mr. E. H. Cook contributed a paper on "The Adulteration Act in so far as it Relates to the Prosecution of Milk-Sellers." More prosecutions of milk-sellers have occurred than of any other vendors, and, he feared they must add, more unsatisfactory decisions were given than in other prosecutions. Instances had occurred in which innocent milk-sellers had been fined for selling a pure article, and in very many cases they might be sure the fraudulent dealer had gone unpunished. Milk was a substance which varied greatly in quality. As a result of four years' experience it appeared to him that milk was subject to four kinds of adulteration—a variation owing to the food, a variation owing to the season, a variation owing to the animal, and a variation owing to the health. The best milk was given by those cows which were fed on grass, and the better the grass—other things equal—the richer the milk. Grains largely increased the quantity, but diminished the quality of the article. That the quantity of milk yielded by the same cow varied at different seasons of the year was well known, and the quality also varied considerably. Generally speaking milk was richer in summer, because the milk-producing articles were then available for food; but the variation with the season, he was inclined to think, was more due to the time of calving than to the alternation of summer and winter. Some cows gave better milk than others. If, then, milk was subject to these natural variations how were they to decide upon its sophistication? By adopting as their standard of pure milk the lowest percentage of solids not fat which it had ever been found to contain. This was the principle which was adopted by most analysts, but was open to objections—one being the fact that by the Adulteration Act the analyst was to fix the percentage himself, and it varied. In order that justice might be done, fraud detected, and the dignity of the chemist maintained, it was necessary to remedy that unsatisfactory state of things. Only one method appeared to offer a chance of success. Briefly, that was to buy and sell milk by quality, instead of by quantity. One method of introducing the practice would be to divide the milk into two qualities—first and second—the power to include all milks containing 12 per cent. of solids, and 9 per cent. of solids not fat, and to be sold at, say, 4d. per quart; and the latter end to include milks containing less than 12 per cent. of solids, or 9 per cent. of solids not fat. The vendor thus selling according to quality no unjust prosecution would arise; but a ready means of testing the quality.—Dr. Cameron, city analyst, said he had made a special study of milk, and had analysed since 1862 many thousands of samples. He had never known a case in which the result of the mixed milk of a herd of cows had fallen below 11·5 per cent. He had made analyses of milk in hundreds of cases in which successful prosecutions had followed, and in all of which it was in the power of the person charged with the offence to have the milk analysed by the Somerset House analyst; but in no case had they elected to do so, which he looked on as an admission of their guilt. The great difficulty an analyst had to contend against was when the milk was poor in fats, or the deficiency might be attributed either to the milk having been skimmed, or to the first milk of the cow being sold instead of the whole milk. The milk first drawn from the cow was very poor in fats, whilst the last portion was rich in fats, and it was a common practice to sell the first milk as the whole milk, and the strippings or the milk last drawn as cream, or to keep the strippings to make butter. It was a more serious offence to sell, or offer for sale, skim as whole milk, than to sell watered milk, for the former was relatively destitute of the most valuable ingredient of milk—namely, the fats.

Action of Chlorine on the Nitro-Prussides.

Dr. E. M. Davy, A.M., read a paper "On the Action of Chlorine on the Nitro-Prussides." It is stated in the different standard works on chemisty that chlorine excites or has no action on the nitro-prussides or nitroferri-cyanides, but he (Dr. Davy) had ascertained that such was not the case—at least, as regarded several of those compounds which he had made the subject of investigation, for he found that some were immediately, and others, after long exposure, more or less acted on by that substance even where they were excluded from the light. When, however, they were subject to the combined action of chlorine and the sun's rays they were soon decomposed. The following nitro-prussides—viz., those of potassium, sodium, barium, calcium, zinc, iron, and silver—were found to be thus decomposed when exposed to the conjoint action of chlorine and sunlight, and it was probable that other nitro-prussides would be similarly affected. The only one, however, which he (Dr. Davy) had observed resisting this action was that of copper, which had remained apparently unaffected after some weeks' exposure to its influence.

The Supposed Radiolarians and Diatomaceæ of the Coal Measures.

Prof. Williamson read a paper on this subject. He called attention to the Traquariæ of Mr. Carruthers, found in the lower coal measures of Lancashire and Yorkshire, which small spherical objects that observer believed to be Radiolarians like those still living in existing seas. The author showed that the radiating projections with which these spheres are surrounded were not silicious spines like those of the Radiolariæ, but extensions of a continuous membrane which inclosed the entire organism, and which, therefore, could not have the spicular nature attributed to them. He then demonstrated that within this external membrane is a second inner one, which latter is fitted with numerous small vegetable cells like those shown to exist in the interior of fossil spores and reproductive cryptogamous capsules found in the same beds as those which furnish the Traquariæ. These conditions are so different from those existing in any known recent species of Radiolariæ as to lead Prof. Williamson to reject the idea of their Radiolarian character. Their close organic resemblance to some obviously vegetable conceptacles found in the same coal measures suggest that the Traquariæ are also vegetable structures. The mountain limestone deposits of some British localities contain a vast multitude of minute calcareous organisms which some observers regarded as Radiolarians. These structures, however, seem to exhibit no satisfactory evidence of being so. In the first place, these organisms are now calcareous instead of silicious. It has been suggested that their silicious elements were removed and replaced by carbonate of lime, but this appears to be most improbable. Prof. Roscoe and Prof. Schorlemmer agree in stating that they would require overwhelming evidence before they would be prepared to accept such an explanation of the present condition of these objects, or of the fact of the substitution of carbonate of lime for silica, that such an explanation renders necessary. Count Castracane has published an account of a process by which he reduced numerous specimens of coals to very minute quantities of coal-ash, and has stated that he found in these ashes numerous marine and freshwater diatomaceæ. Prof. Roscoe kindly allowed one of his ablest assistants in his laboratory at Owen's College to prepare analyses of a number of coals according to Count Castracane's method. The residual ashes of these preparations have been tested microscopically by Prof. Williamson, and in no one of them can a trace of a diatom be found. Beyond stating the fact, he is wholly unable to account for the discrepancy between his results and those of the Italian observer. So far as his present observations go, he finds himself compelled to conclude that we have no proof of the existence of Radiolarians or of diatomaceæ in the British carboniferous rocks.

The Extinction of the Mammoth in Siberia.

Mr. H. H. Howarth, F.S.A., read a paper upon this subject, the principal object of which was to deal with the difficulties that surround the explanation as to the mode in which the animal became extinct. He said the theories hitherto propounded as to the extinction of the mammoth in Siberia were that it lived in the central parts of Central Asia, and that the carcases were floated down the large rivers in that territory to the sites where the remains were now found. This theory may now, however, be said to be extinct. The examination of the stomach showed that the mammoth lived on larch or birch trees growing at the verge of woods, near which the remains of the animals were found, and their position showed that they had not wandered far when they were entombed. After looking at the problem from every side, he had come to the conclusion that there had been a sudden and violent change of climate in Siberia which had frozen the previously soft ground, and had also preserved the mammoths as in a huge meat safe. Although the mammoth had even originally lived in the place where he was now found, it was impossible that he could live there now, owing to the absence in that part of the food which would be necessary to sustain him. Such trees as he used to live on were only now found about 500 miles from the spot where his remains were discovered. The natural corollary that followed from this theory was, that something similar must be postulated with regard to other regions. The conditions in which the elephant was found in Siberia were precisely similar to those in which it was found in the north-western part of Russian-America, and precisely the same as those in the Great Lakes, where the mammoth itself was found, and it could not, therefore, be doubted that the mammoth lived in Europe and America with the same food and surroundings as it did in Siberia.

Prof. Leith Adams gave it as his opinion that the extinction of the mammoth, like the extinction of many other animals, was not easily accounted for; but the interpolation of a cold period might very probably have been the cause. From the thickness of the coat of the mammoth it could have survived a climate such as Canada, but he could well imagine that in a climate like that of northern Siberia it could not survive. It was rather curious, however, that the whole of them should have been swept away, and that they should not be drifted further south, where the climate was more congenial. He instanced the case of the Irish elk, 200 skulls of which were found in the Wicklow mountains in a moss a quarter of a mile long and about 200 yards broad, and which animals must have been subject to frequent accidents, such as sudden inundations. Some such fate might have befallen the mammoths.

Electric Light.

Mr. J. W. Shoolbred read a paper "On Electric Lighting," in which he contended that electric lighting was in time destined to supersede the use of gas.—The President said that electric light was still in its infancy, and that any information with reference to it was exceedingly valuable.—Mr. J. R. Wigham said nothing had yet transpired to render them apprehensive that the present gas system would be superseded by electric light, and he thought they were a long way from bringing electric light into their private houses.—Mr. Briggs (Washington, U.S.) stated that electric light was used in the House of Representatives at Washington, and in the railway station at Philadelphia, and the cost was found to be much under that of gas. In fact, in the latter case, the cost was only 1-34 that of gas. In the course of time he believed the difficulties of electric lighting would be overcome.—Mr. Denny Lane said he was greatly interested in gas property. He had been informed that a number of gas managers had gone to Paris for the purpose of investigating the cost of electric light as compared with gas. The result of that investigation was that the cost of electric light would be enormous as compared with the gas—in fact, that it would cost about a thousand-fold more than gas. He had been able to obtain the opinion of Dr. Siemens on the subject, and that opinion was most valuable, as coming from so celebrated a practical scientist. Dr. Siemens observed to him that gas and electric light had two separate circles to move in, and these circles would rarely if ever coincide.

Official Paper.—Prof. Reuleaux recently gave a discourse before a commercial meeting at Leipsic, upon the character of the paper employed in the public offices, which he regarded as a striking evidence that the giving of contracts to the lowest bidder exerts an injurious influence. The paper which is now delivered consists almost entirely of wood, and in the course of ten or fifteen years we may reasonably anticipate that the official records, which are of the greatest importance to our families, will be destroyed through the natural processes of decay. Such a serious evil would seem almost incredible if it was not sustained by weighty evidence. But as long as our officials hold to their present course, and so long as they buy only what is cheapest, and what, as a necessary consequence, is also bad, we have no right to anticipate any improvement.

Formation of Whirlwinds.—In Hebert's recent communications to the French Academy he has laid special stress upon the influence of the land configurations, and especially of the mountains and valleys, upon the great movements of the atmosphere. He comes to the conclusion that all the cyclones which visit Europe from the Atlantic Ocean originate in the American mountains. Many years ago Professor Henry indicated the region of the Saskatchawan as a prominent cradle of storms. More recent communications to the American Philosophical Society, based partly upon the observations of the Signal Service Bureau, and partly upon special meteorological records at San Francisco and at Bar[illegible], have shown that there are two other important centres of extensive atmospheric disturbance—[illegible] the neighbourhood of Colorado, and another [illegible] West India islands.—*Journal of Franklin* [illegible].

[illegible] Punkahs.—The Hon. R. Charles Parsons [illegible] 7th Hussars, have, we are [illegible] difficulty of moving punkahs [illegible]. The motive power is compressed [illegible] into bedrooms and offices [illegible] is conveyed. By simply [illegible] air enters a little [illegible] which then pulls and [illegible]. The air is compressed by a [illegible] punkahs can be [illegible]. This system has [illegible] in England to [illegible] barracks and hospi[illegible] our soldiers [illegible]. It is [illegible] this work [illegible] addition to this [illegible] has con[illegible] compressed [illegible] when [illegible] hospital

SCIENTIFIC NEWS.

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THERE seems to be no doubt now that the unknown body discovered by Prof. Watson during the recent eclipse observations is an intra-mercurial planet. Mr. Swift, of Rochester, saw the "planet" at Denver about one minute after totality, when two stars caught his eye, which by estimation were about three degrees south-west of the sun. He saw them twice, and says that they were both of the fifth magnitude. The stars were about eight minutes apart, and one he recognised as theta Cancri. Mr. Swift has no doubt that the unknown star is an intra-mercurial planet, and is inclined to believe that there is more than one.

The recent secessions from the Royal Arsenal, Woolwich, appear to have had a beneficial result on the positions of the present workers. The Secretary of State for War has awarded very acceptable gratuities to two officials who have effected considerable improvements in torpedoes, but until the real workers receive both position and pay there is still a possibility that Herr Krupp or some other foreigner will discover ability and employ it for his advantage.

The past month of August must be noted as a memorable one in a long term of years. The returns are not yet completed, but it is certain that it was the rainiest August we have had for a long time, and Mr. Plant, writing from the neighbourhood of Birmingham, tells us that he registered more rain last month than in any month of any year since 1852. The average annual fall at his station is 30in., or 2½in. per month, but in August he registered 7¾in., or rather more than a quarter of the yearly quantity in one month.

The zoological collections made by Signor d'Albertis in his expeditions to New Guinea, having been declined by the British Museum, were sold to the Marquis G. Doria, of Genoa, and will probably be deposited in the museum founded by the marquis in that city.

Mr. Swinhoe's collection of Chinese birds was also declined by the British Museum. The refusal of these offers is probably due to the fact that the natural history collections are about to be moved to South Kensington.

Referring to our note on p. 626, "The Microphone," Mr. Wiesendanger informs us that he devised several forms of telephonic receivers without magnets many months ago, and he claims whatever merit there may be in priority of discovery.

Messrs. Leffel, the well-known turbine-makers, referring to our note on p. 520, announcing an improvement of the type-writer by a Russian inventor, forward a letter from their New York house, written with a type-writer employing both capitals and small letters. They have had it in use for some time, so that the Russian was anticipated.

At a spot a few miles from Barnsley the thick or Barnsley seam has been reached on the estate of Mr. Allott at a depth of 635 yards. The find is taken as evidence that a well-known and valuable bed of coal exists in the largest unworked coal-field of the West Riding. The shaft is the deepest in South Yorkshire, and the thickness of the bed is about 8ft.

The Museum of Comparative Zoology at Cambridge, Mass., familiarly known as Agassiz's Museum, is adding to its already large building another section. The interior dimensions are about 40ft. × 60ft. The basement is intended to be used for spirit vaults and working rooms. Both rooms on the ground floor, with their galleries, will probably be devoted to general palæontology. In the second story one room and its gallery will contain collections illustrating the existing faunæ of Europe, and the other faunal collections from Asia and Africa. The attic will, as usual, be set apart for the storage of skeletons and other dry specimens. It is intended, if possible, to get the addition under cover this year, and to finish it next.

Prof. Agassiz has also finished the erection of an establishment, near his house at Newport, Rhode Island, for the purpose of biological research. It is replete with every appliance and convenience that can be suggested for the benefit of the investigators.

The accident at Sittingbourne last Saturday is the latest of a now long series due entirely to the crass stupidity of a system which permits of shunting operations while signals are actually set for trains to pass at high speed. It is not intended to foul the main line, of course, but somehow trucks get in the way. As a matter of £ s. d., what do the companies save by a system that almost invites disaster? Five minutes' delay in shunting the goods and the accident would not have happened; five minutes' interval between the shunting and the approach of the fast train and there would have been time to signal the latter and stop it.

On one of the principal railroads in Prussia the embankments have been planted with the white willows used for basket-making (Salix viminalis and S. triandra). If the ground is dry the cuttings should be deeply inserted; they will then put out roots in all directions, and bind the embankment together. Besides the improvement in appearance, the withies thus produced would fetch a good price in any town where basket-making is carried on.

Prof. Zeller has succeeded Helmholtz in the rectorship of the Berlin University.

Before leaving Europe, to attempt the North-East Passage, Prof. Nordenskjöld sent to the Paris Academy of Sciences an account of a new mineral recently found in Sweden, named Thaumasite. It has been met with in (1) specimens brought by Prof. Nordenskjöld from the Gustav and Carlsberg mines, or the Bjelke mine at Areskustan, in 1859; (2) specimens of an old Swedish collection from the same mines 100 years ago, by M. Polheimer, mining engineer; (3) other specimens brought from the same mines this year, at Prof. Nordenskjöld's request, after the analysis of Nos. 1 and 2 had shown the strange composition of the substance, which contains at once silicic acid, carbonic acid, and sulphuric acid. The microscopical analysis shows that the mineral is a genuine new species, and not a mixture.

Cremation becomes optional in Gotha on the 1st of October, and a building has been erected for the purpose.

The electric light is about to be tried on the Copenhagen forts, and will light up a large expanse of the Sound.

In his speech at a dinner given to him at Paris Prof. Haeckel expressed gratification at the progress of evolutionist ideas among French men of science, and remarked that professors and preachers who ridiculed man's descent from the ape unwittingly furnished the proof of it, their pride and childish vanity being foibles which might have been bequeathed by the ape.

The Norwegian scientific Arctic expedition returned with the steamer Vöringen to Tromsöe on the 26th of August. The expedition left Hammerfest on the 28th of July for the last time. Rich tusk fisheries were discovered on the coast. On the 5th of August the expedition reached the south cape of Spitzbergen, and the polar stream and the ice boundary to the north-west on the 8th of August. On the 14th of August the expedition was in the 80th degree northern latitude, and anchored next day off the so-called Norwegian island of northern Spitzbergen. On the 17th and 18th it proceeded by way of Smeerenberg to Magdalene Bay, thence to Advent Bay, where charts were taken. Professor Mohn, one of the leaders of the expedition, telegraphs that the plan of the expedition has been completely carried out in the time fixed, and that the scientific results are exceedingly rich.

The Month's Rainfall.—Mr. J. H. Steward writes:—The past month having been somewhat remarkable for storms and heavy rains, an account of the rainfall registered by me during the month may be interesting to some of your readers. Rain fell on 19 days out of the 31, and the total amount from the 1st to the 31st inclusive was 5·62in. The average rainfall per month for the preceding twelve months was 2·10in.

LETTERS TO THE EDITOR.

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[We do not hold ourselves responsible for the opinions of our correspondents. The Editor respectfully requests that all communications should be drawn up as briefly as possible.]

All communications should be addressed to the Editor of the ENGLISH MECHANIC, 31, *Tavistock-street, Covent-garden,* W.C.

All Cheques and Post-office Orders to be made Payable to J. PASSMORE EDWARDS.

*** *In order to facilitate reference, Correspondents, when speaking of any Letter previously inserted, will oblige by mentioning the number of the Letter, as well as the page on which it appears.*

"I would have everyone write what he knows, and as much as he knows, but no more; and that not in this only, but in all other subjects: For such a person may have some particular knowledge and experience of the nature of such a person or such a fountain, that as to other things, knows no more than what everybody does, and yet, to keep a clutter with this little pittance of his, will undertake to write the whole body of physicks: a vice from whence great inconveniences derive their original." —*Montaigne's Essays.*

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SEPARATION OF THE PLANETS FROM THE SUN.

[14778.]—IN the ENGLISH MECHANIC for July 26, 1878, "W. G. P." takes exception, in letter 14644, p. 501, to the hypothesis that the planets have been "separated from the solar mass." In reply permit me to say—

1. The fact that all the planets move in the same direction with the sun's rotation, and nearly in the same plane, cannot be the result of chance.

2. There is now no material connection between the bodies of the solar system which could have caused the common direction of their motions.

3. Either, therefore, the sun and the 197 known planets which revolve around him were each started in the same direction by a separate impulse from the Creator, or an original connection between them undoubtedly existed. With those who adopt the former alternative I shall undertake no discussion. If the latter be true, then the planets have been "separated from the solar mass," either in the mode suggested by Laplace, or in some other not yet understood.

4. The mathematical objection to the nebular hypothesis is doubtless familiar to all who have carefully considered the subject. If the variation of density from centre to surface was the same at the assumed epoch of the earth's separation as at present, then indeed "it may fairly be said that the hypothesis breaks down." But this has not only never been proved, but it is in itself altogether improbable.

I have elsewhere stated that the facts of observation "seem to demand a modification of the nebular hypothesis, as generally held. No reason has ever been assigned why the solar nebula should not have abandoned rings at distances intermediate between the present orbits of the planets. On the contrary, it seems highly probable that, after reaching the point at which gravity was counterbalanced by the centrifugal force arising from the rotation of the contracting spheroid, a continuous succession of narrow rings would be thrown off in close proximity to each other, and revolving in different periods according to Kepler's third law. It would seem, moreover, as shown by Mr. Trowbridge,* that the solar nebula during the process of ring formation was very oblate, and also much condensed at the centre.".

Daniel Kirkwood.

Bloomington, Indiana, U.S.A., Aug. 13.

METEOR.

[14779.]—AUG. 28d. 9h. 22m. G.M.T. (uncertain to two or three minutes), my right eye being engaged at the telescope, I caught with the left a very oblique view of a meteor, which had almost disappeared before I could turn so as to face it. It seemed to increase from my first sight of it, till, as it approached Jupiter, it nearly equalled him, and presented the beautiful though illusive spectacle of a stationary and a moving planet. Their colours were quite similar. A good deal of irregularly-distributed haze in the sky might have affected the earlier magnitude, even had I been in a better position. From comparison with the map its course, which was nearly vertical, may be set down in a very rough way, from the neighbourhood of the equator to somewhere about R.A. XIXh. 50m., D.S. 15°.

T. W. Webb.

ASCENDING LIGHTNING.

[14780.]—"THE spark appears distinctly to issue from the ball to which the attention of the observer is directed." So says an able correspondent, who signs himself "J. T. M." (letter 14738, p. 601). This is the solution of the mystery. I really think this is why the flash appears to strike upwards, if I chance to be looking at the earth and not at the clouds.

It occurred to me that the delusion might be thus explained. We are often told by popular lecturers that the propagation of a sensation along a wave is comparatively slow—some 90ft. a second. Now, when the eye is directed to an object the image is depicted near the centre of the retina, while all other objects fall obliquely around, and farther from the entrance of the optic nerve—in fact these oblique rays excite sensations which have farther to travel than the direct ones, and consequently reach the brain after the others have arrived. This is my solution, but whether, as a matter of fact, the interval occupied by the sensation in travelling a few hundredths of an inch of nerve would be perceptible I do not know.

Accinctus.

[14781.]—NOT being an artist, and having neither colours nor brushes used by artists to work with, I send a very rough sketch [too rough to engrave—ED.] of a flash, or rather, number of flashes, as seen by me some years ago while in one of the Yorkshire dales during a very severe thunderstorm. The flashes appeared to rise from one spot on the top of a heath-covered moor, and to spread out like a fan, vividly forked, to a great black cloud above. The electricity appeared to flow continuously for about two seconds, giving me ample time to see that the fan or brush-like form was real, and not an ocular deception. Now, leaving out of the question altogether the apparent upward motion, I would like to ask some one better acquainted with electricity than myself whether it would be most likely that a number of flashes should come from various parts of a cloud, and converge to one spot on the earth, or whether it would be more likely that the electricity would rise from one spot, and diverge to the cloud?

A. P.

THE RAINBOW QUESTION.

[14782.]—Is the following observation of value? It was mentioned in your columns two or three weeks ago, but I now give full particulars. Boating one evening with some friends on the Derwent (Derbyshire) we were overtaken by a shower, and took shelter under some trees at a point where the river was about 20 yards wide. Noticing in the water, near the opposite side, say 15 yards from the boat, the (apparent) reflection of a rainbow, I looked up and saw the original, the ends appearing to rest on the earth a mile away. Distinctly the image in the water was not more than 15 yards distant, and in a straight line between the boat and the bank opposite.

Arcanum.

NEWTONIAN AND GREGORIAN REFLECTORS.

[14783.]—I HAVE made a 5in. Newtonian equatorial on the merits of which I may possibly write at a future date, for, though not A1, considering that the entire thing, including speculum and stand—everything in fact—didn't cost above 7s. 6d., I believe it is very good. But thinking of a few matters and difficulties in connection with the same which don't appear to trouble the Gregorian style of construction, and not being well acquainted with the latter instruments, I could not decide for myself as to whether my conclusions were correct and practicable or not; but, if they are, they are, I think, worth the notice of amateurs. My premises were these when reduced to a kind of order:—

1. Newtonian and other similar reflectors are always constructed of very long foci because curves of very short radii are very difficult to work to correct figure. But in the Gregorian form the specula are invariably ground to foci of about half the length of the Newtonian of the same aperture.

2. In a telescope of very short focus the image formed at the focus is smaller by a certain proportion than that formed by a long focus instrument, and the proportionate ratio of those images will be the same as the ratio of the foci. But in the Gregorian and such there does not appear to be a very small image resulting from the very short focus, for in Vol. XIV., p. 209, the power of a 1½in. eyepiece to a 4in. Gregorian is stated to be probably about 150.

My conclusions were these: That in that form of instrument having a small concave or convex speculum near the focus of the larger speculum there must be (1) an elimination, to a great extent at least, of those errors in the large speculum which would in a Newtonian be unbearably glaring on account of the very short radius of curvature; (2) as the image in the Gregorian is formed at the end of tube most remote from the secondary speculum, instead of an inch or two outside the side of the tube, as in the other kind, it may be equivalent to doubling the focus of the large speculum as regards the size of the resulting image.

Now, if these deductions are correct, would it not be well for novices who wish to construct their own star-gazers to combine the advantages of both principles, and so get a much more perfect issue to their labours. To put this in perfectly practicable form I would ask these questions: If I converted my present Newtonian into a Gregorian would not the result be—(1) the correction of my somewhat imperfect mirror (which is of 50in. focus) by the second mirror; (2) the doubling of the focus length (in effect), giving twice the power with the same eyepieces, they having to work on an image of such size as an instrument of 100in. focus would give? Thus, by uniting the long (but not very unwieldy) focus, with few errors of one telescope, with the supposed correcting and improving small mirror of the other, we have a great chance of complete success. If some of those who know more than I do on the subject will give their opinions, aid, and instruction to us amateurs struggling with difficulty, the one now writing would be very thankful.

Robinson Crusoe.

LETTERS FROM THE PARIS EXHIBITION.

A New Street—The Electric Light in the Streets of Paris and at the Exhibition, &c.—The Working Gallery—Glass and Diamond Cutters, Enamel Workers, Clockmakers, Bells, Stained Glass, &c.

[14784.]—THE large and magnificent new street, leading from the New Opera House in a straight line down to the Louvre, presents, at the present moment, a singular aspect, with its fine houses—unfinished as yet—most of them seven stories high, built of white stone.

The shops are not yet finished, and ready for occupation; but about fifty toy and novelty sellers have taken temporary possession of them, and offer for sale those tastefully got-up articles for which the Parisians are famous. There are letter-weights consisting of a slab of black marble, and an egg of iridescent glass fixed on to it; huge butterflies, illustrating the flight of birds and insects, card-cases of papier mâché, ornamented as Japanese goods, brooches consisting of a bundle of keys, very neat looking watch-cases of iron, oxidised by superheated steam, &c. The two rows of ornamental lamp-posts look rather curious. Each post carries 4 gas lamps, and about a yard higher up a huge globe of milk-glass, over a foot in diameter. When passing there again by night, we are struck by the mass of light streaming from the milk globes (the gas lamps are not lighted). It is like daylight up to the Opera as far as you can see, and the shops look simply wretched, with their feeble yellow gas flames. The Opera itself, the street just mentioned, the Châtelet Theatre, the Corps Législatif, the orangery in the Jardin des Tuileries, and some other places are already illuminated with the new light of the future. Its cost is at present 5d. per hour per burner, and undoubtedly will be reduced when large orders are given. The new light is all that could be desired—very intense, remarkably steady, mild, and pleasant to the eye. Whosoever sees it feels that gas has passed its time. In the Champ de Mars, outside the main structure of the Palace of the Exhibition, we find a separate building, where the Electric Light Company exhibit their apparatus at work—steam-engine, Gramme magneto-electric machine, huge condenser, lamps, and candles. There all experiments are done daily between two and three o'clock p.m. Our attention is drawn more especially to the candle and condenser, these being the only new accessories, so valuable in their capability of dividing the current and feeding many lamps with the current produced by one machine. The condenser occupies a space of 64 cubic feet; the sheets of tinfoil are separated with oiled taffeta silk. The candles are very thin blades of composition, with two carbon pencils running from end to end on each side. This composition, whose chief compound is plaster of Paris, is a very bad conductor when cold, but it acquires conductivity when subjected to its temperature of fusion. The heat produced at the end where the current passes is sufficiently intense to fuse the composition there, and as the carbons decrease in length so the composition between melts away. The ordinary regulating apparatus used for the electric lamp, so costly and troublesome when numbers of lamps are used, is thus altogether dispensed with.

In the same building we find a small kiosque, with glass painting, to illustrate that this artificial light is strong enough to let us distinguish colours in their true shades. The effect produced by the apparatus is so striking that it can only be appreciated when seen, and we should recommend all who can do so to go and see the exhibition. Our scientific readers will be glad to hear that M. Baudry has just published two books, one on the new apparatus for producing the light and dividing the current, by Fontaine, price 6f., and the other on "Telephones and Phonographs," by Niaudet, price 4f.

Mr. Edison's newest form of his phonograph, offered at the Exhibition at 200f., or £8, is in some respects simpler than the instruments sold in London, and we believe amateurs would have reason to prefer making the former kind. The stand or base is made of cast iron, 9in. by 9in., and ½in. thick; into that base are screwed two uprights, one with a threaded bearing, the other with a smooth hole to admit of the spindle. The cylinder is 6in. diameter and 3in. thick, made of a solid cast, with its great weight it acts as a fly-wheel, and will in some degree insure uniformity of rotation. The spindle or axle is fixed into a central hole of the cylinder; it is 9in. long by 1in. diameter, and one end has a square or V-thread cut on it, corresponding with the interior thread of the one bearing, and also with the exterior thread of the cylinder; the pitch of the thread is 12 turns to the inch, 36 altogether. The mouthpiece is fixed on a support, as illustrated in Fig. 1, p. 30, of the English Mechanic for March 22, 1878, with a horizontal set-screw behind to make the adjustment. If once set, the instrument, unlike telephones, does not give any further trouble. The mouthpiece and iron disc are in size, shape, and construction identical with that of a Bell's telephone; the diameter of the disc is 2½in.; the orifice in the lid is ⅛in. A steel needle is soldered into the centre of the disc from behind, it passes also through a piece of watch mainspring, ¼in. broad and 2in. long. For the reproduction of speech a paper trumpet, 8in. long, ¼in. diameter at one extremity, and ⅛in. at the other, is held over the mouthpiece. The tinfoil is simply fixed on with a little gum. We experimented on several occasions with this instrument, and obtained very good results. The great advantage of this instrument is its compactness and great strength. It only takes up a space of 9in. by 9in., can easily be packed and carried about, and will stand very rough usage.

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* *American Journal of Science*, Nov., 1864, and Jan., 1865.

The English Mechanic and other scientific papers have of late repeatedly pointed out the injurious effects the working of sewing machines has on women. The body of necessity is bent forward, the lungs are subjected to undue pressure, and consequently the respiration is hindered and retarded, and the blood is pressed to the head, not by this position alone, but also by the motion of the legs in driving the machine. A convenient motor for the sewing machine has been for some time a thing wished for by the friends of those humble hard-working sempstresses who strive to earn their scanty living by efforts of their own.

We have seen the water motors exhibited by the Western Company in Queen Victoria-street, and found them very good. But water motors can not be fixed anywhere, and removed again with ease.

M. Gunzberger, route d'Epinay, St. Denis, France, exhibits a very efficient spring motor, which takes up little space, can be placed anywhere, and removed without difficulty, and requires no fixtures (as water motors will do). See illustration, Fig. 1.

The motor is wound up like any clockwork; to wind it fully 2½ minutes are required—the machine will then go on for 20 minutes. The motor can be rewound while still at work, so that no awkward delay need occur; and a break-block and lever, to be governed with one foot, enable the worker to obtain any degree of speed, and to stop the machine in a second.

The price of the motor alone is £14, or 350 francs; motor and sewing machine, complete, £55, or 550 francs. The apparatus is fitted up with a governor to insure uniformity of speed, and the exhibitor affirms that the regularity of motion thus obtained allows better work to be produced, and saves the sewing machine from being used out in a short time.

We trust some enterprising firm of sewing-machine sellers will introduce the motor to public notice in London.

One of the most instructive departments of the Exhibition is the long avenue of workshops and stalls along the far end of the main building, on the side of the Ecole Militaire. Visitors find there huge glass cases serving as workshops to clockmakers, jewellers, artists in enamel, glass engravers, manufacturers of ornamental buttons and studs, and diamond-cutters. We noticed especially the graceful objects in enamel produced by fair hands under our eyes, and diamonds cut—or partly cut—by steam while we were watching the work. Ladies do a great deal of ornamental work in Paris, and in France in general, and the objects produced by them at the Exhibition speak well for their skill and taste. We saw five of them seated in one of those work-stalls; each had a miniature blast gas-furnace in front of her on the table, and a quantity of thin rods of enamel of different colours by her side. They take the rough stick; melt its point in the blowpipe, take a stick of another colour, treat it in the same way, then they twist the points together; melt and twist them again and again, and in a few minutes' time you see an artificial flower formed in their hands, serving either as a brooch, or a pin for a necktie, or a stud, or earring. Some beautiful specimens of work are exhibited there—pins worth from 10d. and bouquets up to £150 sterling. Ladies are forcibly drawn to the diamond-cutter's place. He has four machines driven by steam, and workers of both sexes cut and polish the precious carbon pebbles until they glitter and make your eyes covetous. You see there a dish containing a few thousand pounds' worth of the cut stones, and by the side of it some rare specimens in the rough, black and unsightly, nearly as large as an egg. The same gallery contains a number of very fine organs, and a magnificent collection of work done by the famous metal factories at Rouen. Close by, but outside the main building, you find the exhibits of church bell-makers. One set of over 50 large and small bells are played by hand on an instrument looking like a piano. The next pavilion contains the electric-light apparatus, described above. On the other side you find two churches for exhibiting stained glass, and every one should go, and see the beautiful paintings; and in the corner is Duval's restaurant—a place of rest and refreshment for those who, after the fatigues of sight-seeing, wish to dine at a reduced price.

Fig. 1.

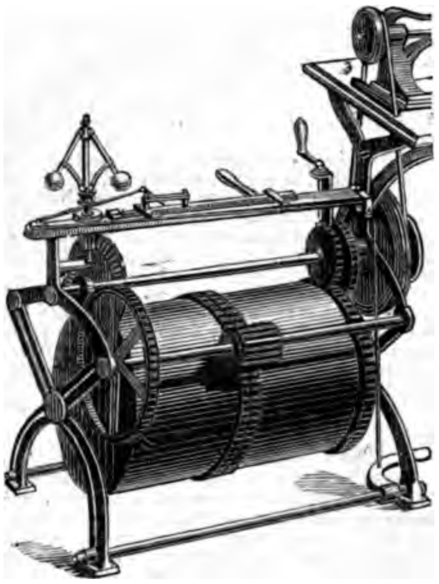


Fig. 2.

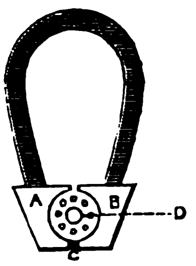
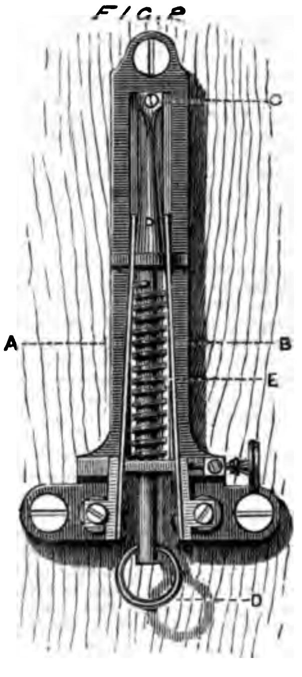


FIG. 3



We should recommend all those who go to see the Exhibition not to forget this gallery. It is at the far end, but the exhibits there are the most interesting objects to be seen among the wonders of the Champ de Mars.

M. Breguet exhibits some very well made and powerful Jamin magnets, both in the French section and in the exhibition of telegraph apparatus, Porte Rapp. We find there also two magneto-electric machines for use in the laboratory instead of batteries. These machines have only one magnet on Jamin's principle. It has the shape of a horse-shoe, 16in. in height. Instead of being made of a solid bar of square steel, it consists of twelve steel ribbons, 1¼in. broad, firmly held together by two ribbons of brass, one inside and one out. See Fig. 2. The poles (*a*, *b*) are pieces of solid steel, separated from each other by means of a brass block, *c*. The armature and coils are identical with those of an ordinary Gramme machine. A large cog-wheel, to be worked by hand, and multiplying motion, enable us to make the bobbin revolve with great speed. The machine is very neat and powerful, and cannot easily be deranged.

The Société Parisienne d'Eclairage also exhibits a hand magneto-electric machine on Gramme's principle, but different in construction from the one they use to produce their light. The permanent magnets are 24 in number, arranged as 2 × (4 × 3) in a strong frame of wood. There is a fly-wheel with handle as well as a pulley, so that either steam or hand-power may be applied. There are light revolving bobbins, with cores to correspond with the four triple magnets on each side. One commutator is at the top and another at the axle, and we are enabled to produce either a continued current or a series of alternate currents.

A great many efforts have been made of late to construct automatic fire-alarms. We notice a good many such instruments in the "Appareils Télégraphiques," near the Porte Rapp. Most of them are constructed on this principle—the elements of a bichromate battery, connected with a bell, are suspended by means of a thread over the cells and solution. When the string burns away the elements drop into the cells, and the current sets the bell ringing. In another apparatus the string holds a valve—when burnt away the liquid rushes into the cell. Messrs. Charles Mildé and Co., 3, Rue de Monceau, Paris, exhibit what we think to be the best of all fire-alarms. It serves at the same time instead of a press-button of a bell. See Fig. 3. The handle, *d*, is connected with the street knob, *c*, and held in its place by the steel spring, *e*. *a* and *b* are two blades of steel, ending in steel knobs at the top, and adjustable by means of a set screw. Each of these blades is connected with one pole of the battery and an electric bell, so that when they touch the bell rings. When the apparatus is set the top ends of the blades very nearly touch, but not quite. The heat produced by the fire will, however, expand the blades, and then they touch, and the bell accordingly rings. The apparatus is separately sold for 8 francs, or 6s. 6d. If a complete set—battery, bell, wire, and alarm—are ordered the charge for the latter is only 4s., the same price as their press-buttons. As the apparatus is used daily as a call-bell it is certain always to be tested and re-set when deranged, a thing which is not always the case with other alarms. By way of experiment we heated the apparatus with our breath, and it began to ring after we had done so for 30 seconds only. Wiesendanger.

THE LAWS AND PRINCIPLES OF ACOUSTICS IN REFERENCE TO THE TELEPHONE, MICROPHONE, &c.

[14785.]—I fail to perceive any object in your correspondent (J. W. Schucht's) letter (14744, p. 603). It is evident, from the carelessness of his communication, that he is not a very close observer, and it may therefore be easy in his case to be "astounded to a degree which he cannot express," at very rudimentary facts of science. If he be in any doubt as to the fact that heat and light pass through space where there is no vibratory matter, he must be little acquainted with, or have observed in vain, some of the commonest phenomena of pneumatics and acoustics. Let him take the trouble to look at the sun through the exhausted receiver of an air-pump, and he will be made conscious of the fact that both solar light and solar heat pass through it; and let him further interpose a burning-glass to the solar rays, after they have passed through the exhausted receiver, and he will find that the solar heat and light can be made very appreciable realities. Yet in just such an exhausted receiver he will also find that a bell, in consequence of the absence of vibratory matter within the receiver, will not be heard outside, even though visibly struck by the tongue or clapper. Lest, however, your correspondent should not consider this experiment crucial, in consequence of the residuum of air which is left in the receivers of even our best air-pumps, let him try the same experiment on a sufficiently extended scale with the vacuum in the top of a barometer tube, in which there is absolutely no air or rarefied gas, and he will find the same results.

As to the "Structure of Primary Matter," your correspondent might have noticed in my letter (14659, p. 524), had he looked at it with the ordinary care necessary to justify him in writing you on the subject, that I say, "In 1856 I announced, as the result of a careful correlation of all the scientific facts then known and relevant to the subject, that the primary structure of elementary matter did not consist of either infinitesimally divisible particles or the one hand, or round solid atoms on the other, but of hollow elastic shells or globules, spherical when taken singly, and, like the soap bubble, polyhedral over all their surfaces of contact, and without interstices between them when in clusters or masses," &c. Your correspondent quotes the last part of this sentence only, without noticing the words and date with which it begins. Why is this? I am quite prepared to give absolute evidence of this announcement and its date, if that be what is required; but I do not find that your correspondent calls me in question on that point. I am at a loss, therefore, to see his object in asking me if I have read the book he refers to as published in 1862, six years after the date of my own announcement, or what it would signify if I had. To relieve his mind, however, I will answer his question: I certainly have not read nor seen the book of his friend, and never knew of its existence till I yesterday saw his own mention of it in your columns.

Your correspondent persistently suppresses my first initial in his letter, and as *A.* Smith reduces so popular a name as mine to the lowest conditions of identity, courtesy as well as accuracy require from him a little more attention to particulars.

J. Alexander Smith.

98, Gower-street, London, W.C.,
August 24th.

AN ACOUSTICAL CONSTANT.

[14786.]—It is well known that the number of transverse vibrations executed in a given period by a stretched string depends upon the length, diameter, and specific gravity of the string, and also upon the tension to which it is subjected. A closer consideration of the laws bearing on the matter leads to the formula—

$$n = \frac{1}{dl} \times \sqrt{\frac{T}{S}} \times k,$$

where n = number of vibrations per second, l = length of the string, d = its diameter, S = its specific gravity, T = the stretching weight, and k = some constant, which it is evident must be the same for all strings, since n depends only on the four elements taken into account in the expression. No text-book with which I am acquainted gives the value of k directly, but in Ganot occurs the formula—

$$n = \frac{9\,8257 \times \sqrt{c}}{l},$$

where c = length of string, whose weight is equal to the tension. From this formula k may be calculated; and, taking a metre as unit of length, a millimetre as unit of diameter, a kilogramme as unit of tension, and sp. gr. as customary, I find k = 56 nearly. I hope to attack the question experimentally in the autumn, and meanwhile will be glad if any mathematical correspondent will check the above result.

Newcastle-upon-Tyne. **Wm. John Grey.**

A NEW FORM OF TELEPHONE TRANSMITTER.

[14787.]—In this instrument the object aimed at is the amplification of the sound-wave by mechanical means, in order to produce a greater fluctuation in the electrical current. This is accomplished by means of a lever, which is arranged to magnify the vibrations of the diaphragm, just as the small bones of the ear, acting in an opposite way, diminish those of the tympanum. Indeed it was the study of the latter which suggested the idea, and in a form of carbon telephone which I have constructed the lever has its fulcrum so placed that it diminishes the swing of the diaphragm, whilst it increases its power precisely as the auditory ossicles do.

In the earlier forms of the instrument a single lever was used, and the current sent along the line was always in the same direction, but in the one figured here a beam is employed, and the current is alternately positive and negative, according to the phase of the diaphragm—thus producing with a battery what Mr. Bell does with a magnet in his beautiful instrument. The battery current is sent into an induction coil, from which a current of high tension is transmitted to the line.

In the figure D is the diaphragm which is connected with the small arm of the lever, L. This lever may be compared to the beam of a pair of scales, of which the pointer would be the small arm, and each half of the beam the long arm. To the extremities of the latter, where the pans would be suspended in the scales, the resistances are attached. These may be either conical pieces of carbon, fine platinum wire, &c., dipping into mercury, &c., contained in cups, C C. It will be observed that the beam is not loose on its fulcrum, but that direct metallic communication is preserved by a piece of delicate spring inserted in the knife edges. This is done to avoid microphone effects. In the position shown in the diagram the instrument is in equilibrium, and no current passes through the primary coil of the inductorium; but when the diaphragm is driven in or out, corresponding arms of the beam are depressed, and a negative or positive current sent through the primary coil which induces a relative current in the secondary. In principle the instrument somewhat resembles Wheatstone's bridge. The resistance coils, &c., required for adjustment have been omitted for simplicity, as also certain precautions to avoid vibration. The drawing is not to scale in practice—the moving parts are made as small as possible to insure vibration en masse.

FIG. 1

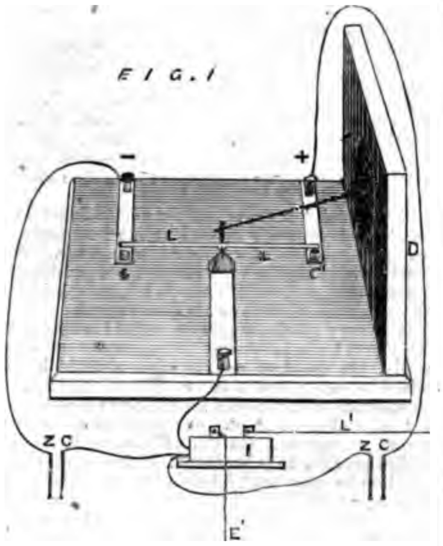


FIG. 2

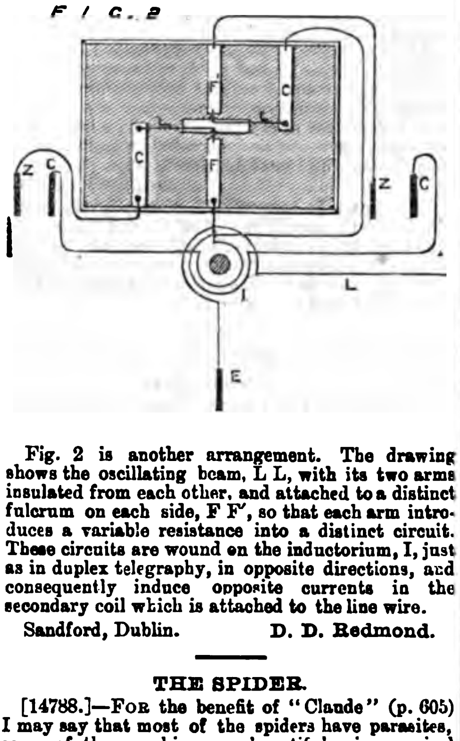


Fig. 2 is another arrangement. The drawing shows the oscillating beam, L L, with its two arms insulated from each other, and attached to a distinct fulcrum on each side, F F', so that each arm introduces a variable resistance into a distinct circuit. These circuits are wound on the inductorium, I, just as in duplex telegraphy, in opposite directions, and consequently induce opposite currents in the secondary coil which is attached to the line wire.

Sandford, Dublin. **D. D. Redmond.**

THE SPIDER.

[14788.]—For the benefit of "Claude" (p. 605) I may say that most of the spiders have parasites, some of them making very beautiful microscopical slides. With regard to the sight of spiders, it is, of course, well known that spiders have eyes, or ocelli, and that the number of such ocelli is constant in the same species, but different in different species. Thus, Dysdera erythrina, Segestria perfida, and others have six ocelli, while Mygale aviadaria, Lycosa vorax, Epeira diadema, and others have eight ocelli, but all differently arranged, so that one would expect spiders to be among the sharpest of insects on account of their having so many eyes. These eyes are all placed on the top and front of the thorax, for the spider possesses no head separate from the thorax, the body of a spider only having a thorax and an abdomen. Now, I cannot think, from long observation of their habits, that the eyes of the spiders are of any practical value, and to endeavour to prove this I am about making some experiments in blacking the eyes (painting) of several spiders I have, and when I obtain the results I will communicate them. I have frequently hung a piece of brown paper, coiled up into about the size of a fly, by means of a piece of cotton, on a spider's web, and by continually jerking the cotton have not only brought the spider down to the paper, but have had for some seconds a sharp fight, until on loosing the cotton the spider has commenced to cut away the web all round the roll of paper, and then let it fall. Now, this has taken place with scores, I may say hundreds, of spiders, and it fairly proved to me that spiders do not either see or hear their victim. Only within the last few hours a spider commenced battle with a piece of wood, and I have held a fly within half an inch of a spider when he has been holding the central fibre, and have never noticed the slightest motion on the part of the spider. These remarks of course would only apply to the web-making spiders. The Phalangioidæ or harvest spiders have only two ocelli, but have long legs, and these legs receive many nerve filaments from the central ganglia, and are thus very sensitive, and are used for the purpose of tasting their food. Now, this peculiar and delicate sense of touch is possessed by all the spiders, and I believe the making of the web and the capture of insects is accomplished entirely by feeling. The web is of course spun from the spinnarets at the back of the spider, and generally one of the hind legs directs the course of the thread. In this process the eyes cannot be of any service, and I might also mention that the greater part of the web-spinning takes place in the dark, thus rendering the eyes apparently useless. The cleaning of the web again seems to be effected entirely by touch. I have noticed a spider when going over his web passing over an obstacle in its path, and then going backwards, and eventually removing the obstruction. One of the most curious circumstances I have noticed was, on cutting the central fibre leading from centre of web to nest, when the spider was coiling some fibres round its victim before carrying him up to the nest. The moment the spider has reached the middle of the web he has at once stretched out his front feet to take hold of the thread, and he has done this much, evidently not knowing it to have been broken. Several spiders seem to have been bewildered, and have left their prey, and not returned; others, having secured the fly, have gone up the nearest thread, and spinning another thread, have eventually found their nest, attached the thread, and then gone down for the fly. This, however, has been invariably a clumsy performance on the part of the spider. There is one thing, however, that I have not mentioned before, and that is, I have sometimes thought that the spider could probably see in the dark, and that in daylight it is almost or quite blind. Spiders take food both during the night and in the daytime. I have, however, been unable to gain any knowledge about the habits of spiders in the dark. There are so many difficulties in the way, and I should be pleased to read other letters from any reader who has made a point of watching spiders in the dark, or at any rate with a feeble light.

W. J. Lancaster.

THE IDENTIFICATION OF VARIOUS ORGANIC COMPOUNDS FROM ALCOHOL TO HIPPURIC ACID.

[14789.]—Chloroform has its physical characters, the results produced by the action of heat, its solubility, and the reactions with reagents given at page 317, of June 7th last. It may be stated in addition that it should give no turbidity with $AgNO_3$, and that it should leave no residue on evaporation. It is neither acid nor alkaline.

Cholesterine ($C_{25}H_{44}O + OH_2$) is a crystalline transparent, fatty scales, having an iridescent lustre consisting of very thin rhombic plates, having acute and obtuse angles of 79½° and 100½°, and by these angles it is characterised.

It fuses when heated to 145°C, and the vapour produced burns with a smoky luminous flame. No change is produced on boiling with KHO. On the evaporation of an etherial solution with half the quantity of alcohol the crystals are deposited. The water of crystallisation is dissipated by a heat of 100°C, when the crystals become opaque. It is not decomposed when distilled at a temperature of 349°. When boiled with HNO_3 cholesteric acid is produced. It is almost insoluble in water, and it is infusible in boiling water.

It dissolves in boiling alcohol, and crystallises characteristically on boiling. It is easily soluble in ether.

There is a yellow residue when moistened with HNO_3, and evaporated—that is changed to red—by ammonia. It gives a blue violet colour when moistened with strong HCl and a little Fe_2Cl_6 added, and evaporated to dryness. The alkalies have no action on it. Sulphuric acid decomposes it, forming cholesteriline.

Cinchonine ($C_{20}H_{24}H_2O$) consists of white brilliant striated, rhomboidal prisms, having a slightly bitter taste. Its salts are exceedingly bitter.

The solid fuses, give off an odour like coal tar. It fuses at 165°C. to a colourless fluid, which becomes a crystalline mass on cooling. When heated in a small tube it gives the odour of ammonia, and crystals are formed on the cool part of the tube. On heating after moistening with H_2SO_4 (dilute), it gives a red colouring residue.

It is insoluble in ether, nearly insoluble in water, soluble in alcohol and alkaline solutions. It is not dissolved when ammonia is added in excess, and shaken with ether. It does not dissolve when KHO is added to water, but when HCl is added it is soluble.

When chlorine water and afterwards ammonia are added it does not give a green colour like quinine.

When dissolved in as little HCl as possible and potassic ferrocyanide added a yellow precipitate is produced, which dissolves on warming with slight excess of the latter, and, cooling, crystals are formed.

A brown precipitate is formed when a solution of iodine in iodide of potassium is added to its aqueous solution. The sulphate is its most important salt. When the solution in H_2SO_4 is heated with PbO_2 a red substance is formed. The solution in water is acid, and not astringent

Citric acid ($C_3H_5O(COHO)_3 + 2H_2O$) consists of transparent rhombic colourless prisms having a pleasant acid taste.

When heated it loses water, then fuses, and is decomposed, blackening, and giving an odour like tartaric acid, but more pungent. When heated with strong H_2SO_4 there is a gradual blackening with evolution of CO. On ignition the alkaline citrates leave carbonates. The crystals melt when heated to 100° C., losing half their water. When heated with KHO it forms water, potassic oxalate, and acetate. When heated to 177° C. aconitic acid is one of the products obtained.

Citric acid is soluble in alcohol, very soluble in water, but insoluble in ether.

When ammonia is added in slight excess to the acid or neutral solution, filtered if necessary, and calcic chloride added, a precipitate is produced on boiling. When KHO is added $CaCl_2$ gives a precipitate, which does not redissolve in excess of KHO.

Lime-water will give no precipitate until the solution is boiled.

By adding excess of KHO and potassic permanganate on boiling the colour becomes green. It forms three classes of salts, being tribasic. When AmHO is added to argentic citrate there is no mirror formed on heating. Ferric chloride gives no precipitate. Plumbic acetate gives a white precipitate. Strong HNO_3 turns citric acid into CO_2 $(COHO)_2$, and CH_3COHO.

This acid and the soluble citrates, when present in solutions of ferric, aluminic, or some other metallic oxides, prevents ammonia from precipitating the metal.

By acting on this acid with hydrobromic acid, aconitic acid is produced, and when heated with hydriodic acid tricarballylic acid is obtained.

Formic acid has its physical characters. The results produced by heat, its solubility and its reactions with reagents given at p. 576, Feb. 22, last.

Gallic acid ($C_6H_2H_3O_3COHO + H_2O$) is a yellowish white powder consisting of spinning silky needles. Its solutions have a sour astringent taste, and an acid reaction.

When heated it blackens, and when exposed to a temperature of about 212° C. it is entirely converted into CO_2 and pyrogallin, and when the temperature is raised about 36 degrees the pyrogallin is decomposed into metagallic acid.

This acid is much more soluble in boiling than cold water. It is sparingly soluble in alcohol, but freely soluble in alcohol.

Ammonic or potassic hydrate gives a real brown colour that becomes darker on shaking. A little Fe_2Cl_6 gives a black colour when added to the acid or neutral solutions. It reduces the salts of silver and gold. A crimson solution is formed when this acid is mixed with about five times its weight of H_2SO_4, which, when dropped into water, deposits crystals of rufigallic acid. The alkaline gallates absorb oxygen from the air, becoming brown. With Fe_2Cl_6 it gives a dark blue colour. Gelatine has no action on this acid.

Gelatine ($C_{16}H_{25}N_5O_6$) is a translucent, tough, and almost colourless or brownish-yellow mass, having neither taste nor odour.

When heated it blackens and gives off an offensive odour.

It is insoluble in ether and alcohol, and swells up in cold water, becoming dissolved when boiled.

It dissolves calcic phosphate to a considerable extent. It forms a viscid fluid in boiling water, and on cooling it forms a jelly.

Tannic acid gives a buff or yellow precipitate even with very dilute solutions. Mercuric or platinic chloride also precipitates it largely. An excess of alcohol gives a flocculent precipitate in aqueous solutions.

Potassic ferrocyanide, added to its solution in acetic acid, does not produce turbidity, as is the case with albumen. Strong H_2SO_4 converts it into leucine, glycocoll, &c., after remaining for some time in solution, and HNO_3 produces from it oxalic acid. By frequent boiling in water it loses the power of gelatinising or cooling.

Glycerine, $C_3H_5(HO)_3$, is a neutral, uncrystallisable, syrupy, colourless liquid, without odour, and having a very sweet taste. Its specific gravity is about 1·25.

If distilled alone it becomes decomposed, but it can be distilled without alteration in a current of superheated steam. At about 4° C. it becomes gummy and nearly solid. It burns with a luminous flame when heated on platinum foil, and no residue is left. On evaporation no residue is left. It does not perceptibly alter when heated in a water bath, thus differing from ordinary syrup. When heated with strong H_2SO_4 it becomes black, and gives off acroleine vapour that irritates the eyes.

It is sparingly soluble in ether, but very soluble in water and alcohol.

The oxide of barium, calcium, lead, and strontium are soluble in glycerine.

Nitric acid converts glycerine into glyceric acid. Sulphuric acid or phosphoric anhydride convert it into acrolein, and the latter, on taking up oxygen, becomes acrylic acid.

Potassic hydrate, when heated with glycerine, produces potassic formiate and acetate.

Under the influence of yeast, and a temperature of about 25° C. continued for a few weeks, glycerine is converted into propionic acid.

Hippuric acid ($C_8H_8NO_1COHO$) forms milk-white or colourless shining prismatic crystals, having a slight bitter acid taste and no odour. Plumbic hippurate crystallises in shining four-sided tablets, and calcic hippurate crystallises in fine rhombic prisms.

When heated it melts readily, and is decomposed, emitting an agreeable odour like bitter almonds, and leaving a residue of carbonaceous matter. When treated with H_2SO_4 it blackens more readily than benzoic acid, and emits more sulphurous acid. On boiling at 240° C. it becomes decomposed.

It is very sparingly soluble in cold water and in ether, but hot alcohol and boiling water dissolve it easily. It dissolves readily when a little KHO is added to water, and it is precipitated by HCl. Its compounds with the alkalies are very soluble.

Fe_2Cl_6 added to an acid or neutral solution gives a brown precipitate. On the addition of HCl a crystalline precipitate is produced. If the sulphuric-acid solution be cooled and diluted with water, and boiled with excess of KHO, it gives off NH_3, differing from benzoic acid. Benzo-glycolic acid is produced by the action of nitrous acid on this acid. When this acid is boiled with nitric, oxalic, dilute sulphuric, or strong HCl, it is converted into glycocoll and benzoic acid. On boiling with KHO it is turned into glycocoll and potassic benzoate. When dissolved in strong HNO_3, and an equal bulk of H_2SO_4 added without increasing temperature, nitro-hippuric acid is formed, and is deposited in crystals on adding a large excess of water. Argentic and mercurous nitrate give with hippurates white insoluble precipitates.

Hugh Clements.

Errata.—In letter 14773, p. 631, in the twelfth line, 110° C., should be — 110° C., and "burns," in the tenth line from foot of p. 632, should be "turns." In the fifty-fifth line from top of p. 551, let. 14692, after the word strychnine insert the words "to which H_2SO_4 has been added."—H. C.

BLOOMER ENGINES—L. AND N.W. ENGINES.

[14790.]—I beg to thank "Itzaex," p. 504, for his confirmation of the anticipated idea I had of the Bloomer class of engines. Also "Egeria," p. 499, for his remarks on the same. But I would call "Egeria's" attention to an apparent contradiction in the second and third sentences. He says, "L. and N.W.R. Bloomer engines have *inside* cylinders, single framing, and are not coupled. Miranda, 1,897, No. 2 Rocket, 1.810, are the *same* class; they have *outside* cylinders, 7ft. wheels, and are similar to Edith, 1.427, &c., only smaller." The italics are mine. "Egeria" will see that in the first place he quotes an engine with inside framing only; next, one with inside frames to the drivers, and outside to the leading and trailing wheels; and secondly, the first mentioned have inside cylinders, while the latter have outside cylinders, and yet the two "are the same class." If I had not known the distinction in the engines mentioned I should have had an erroneous impression.

To the Centaur class of engines "Egeria" can add Eagle, Kestrel, Amphion, and Jason. Can "Egeria" say if No. 2 Rocket, 1,810, is the same that was No. 290, stationed at Liverpool some time since, and at the same time give a description of the No. 1 Rocket?

I am surprised that query 32608, "Bloomer Engines" (April 12), should have been so long unanswered, considering the fame of those engines. Thanks for "Egeria's" list of Bloomers. I see several of the names have been taken from old outside cylinders, and wing tank engines—as Wyre, Lune, Bull Dog, Swift, Wasp, and Councillor. What has become of the 1,115 class of engines (four-coupled outside cylinders), that formerly worked the Manchester and Buxton trains?

"W. E. H.," p. 526, says as regards cabs and weatherboards the L. and N.W. seem to rush into opposite extremes. If "W. E. H." will take notice, I believe he will find that all L. and N.W. *new* engines have cabs, and many that have been rebuilt have had cabs put on.

"W. E. H." is evidently confusing the small weatherboards (which are only to be seen on the *old* outside cylinder engines), with those in use prior to the introduction of the "cab." Then as to the identification of a L. and N.W. engine by the cab or weatherboard, it may be done by those who know the difference between the L. and N.W. and other companies, but for one unaccustomed to the various designs he would very soon get wrong. The cab or board alone would hardly be a safe guide; for instance, the Midland, Furness, L. and Y., L. and S.W., and G.E., have all a similar cab to the L. and N.W., but each company has its own colour and style of painting, not to mention the boiler fittings, chimney, &c.

August 21st. **R. N. H.**

L. & N.W.R. ENGINES—7ft. 6in.

[14791.]—I beg to hand list of above class of engines (61 in number). They have outside cylinders 17 × 24, driving wheels 7ft. 6in. (except No. 173, "Cornwall," which is 8ft.), 192 tubes, 1⅞ external diameter, total heating surface 1013·1648 square feet. This class of engines has been used for a good deal of the express traffic on the L. & N.W.R.; 7 of them are now working the Irish mails, 2 are running alternate days from Manchester to London and back, and, till Webb's new coupled came out, 11 were running the express traffic between Crewe and London.

1	Saracen
7	Scorpion
28	Prometheus
33	Erebus
44	Harlequin
60	Tantalus
61	Phosphorus
77	Mersey
97	Atalanta
111	Russell
117	Tiger
127	Peel
134	Owl
139	Cygnet
165	Star
173	Cornwall
184	Problem
196	Leander
218	Wellington
222	Lily
229	Watt
230	Monarch
234	Mazeppa
279	Stephenson
291	Prince of Wales
531	Lady of the Lake
561	Prince Oscar
562	Palmerston
563	Combermere
564	Majestic
565	Napoleon
610	Princess Royal
612	Princess Alice
618	Princess Alexandra
622	Prince Alfred
665	Lord of the Isles
667	Marmion
675	Ivanhoe
719	Outram
723	Clive
754	Ethelred
762	Locke
802	Red Gauntlet
803	Tornado
804	Soult
806	Waverley
818	Havelock
827	Victoria
833	Clyde
834	Elgin
837	Fairie Queene
1427	Edith
1428	Eleanor
1429	Alfred Paget
1430	Pandora
1431	Psyche
1432	Panopea
1433	Daphne
1434	Ennomia
1435	Fortuna
1436	Egeria

Leander (196) and Peel (127) are running as follows—

Manchester L Road	London
a.m. 7.45	noon. 12.30
	4.0
8.45	

The first-named runs this on Monday, Wednesday, and Friday, and Peel on Tuesday, Thursday, and Saturday. Peel has been running this for two years; she has not missed except about about a fortnight and one or two days during that time. Nos. 234, 97, 44, 7, 222, 111, 612 are working the Irish mails as follows—

Holyhead	Crewe	Stafford	Rugby	London
		a.m. 3 23		a.m. 6.45
			noon 12.30	a m. 9.15
		p.m. 2.58	1.15	
		p.m. 3.8		p.m. 6.25
				p.m. 8.25
		p.m. 11.40		
a.m. 3.5		p.m. 11.43		
a.m. 11.40		p.m. 3.5		
	Chester 12.15			
p.m. 5.0	2.28	10.0		
p.m. 11.55		a.m. 3.20		

Nos. 562, 1434, 564, 60 are running the 45 minutes' expresses between Liverpool and Manchester. Nos. 1435, 1436, 754 and 1 are running local trains between Stafford, Rugby, and Birmingham. **Egeria.**

COUPLED ENGINES.

[14792.]—"C. E. S." is certainly a most able advocate for coupled-express engines, but apparently loses sight of a very important part of the question, which is not so much whether a coupled engine could run the Flying Dutchman or Scotch-at a pinch—we all know it could; and as a er of experience, when an express engine breaks ı, the goods engine taking the train on seldom much time in the hands of an energetic driver. broad question is, whether coupled-express ıes can run fast trains over maximum gradients 100 with the same speed and economy of coal repairs as single engines? It is a question not of ı the thing be done?" but "can it be done lly well?" Now, first, as regards consumption ol or water, which, as there is no reason why oilers should differ, may be regarded as bear- constant proportion to one another. The Mid- tenders hold from 2,750 to 2,950 gallons of water, cannot run from London to Leicester (a little r 100 miles) without stopping for water. The t Northern tenders hold from 2,500 to 2,700 ns of water, and run from London to Grantham miles) without stopping, maximum gradients 1-105, and ruling gradient 1·176.

lowing the five miles to balance the heavier ients (a very ample equivalent) we have the fact the single-wheel engines can do work the led cannot, although the latter carry about 8 cent. more water—that is to say, the single ıes work with about 10 per cent. less fuel—a important item. Next, as regards repairs: it ll known that one reason why coupled engines abandoned on the G.N.R. was the frequent kage of coupling rods, crank axles, crank pins, often carrying away splashers and part of cab e fell swoop, and endangering the lives of the

All this meant excessive strains somewhere, rently caused by coupling four wheels—conical, egin with—and their diameters, &c., further d by wear. What the relative figures may be e G.N.R. and Midland I know not, but I think ıst be plain that coupling involves much extra and tear when used for very fast speeds. Cer- r, that is the idea given one by the jerky snatch- ıction of a coupled compared with a single ıe. Let "C. E. S." ride on the foot-plates of and he will notice this.

m told that on a line where single and coupled es of similar build are running and doing the work, the single engines run 50 per cent. more before requiring repair. A fact like this re- s no comment. The one objection to single es—slipping—seldom occurs at a high speed, hiefly at starting—so cannot much effect the on a 100 mile run.

regards weight on driving wheels, steel rails tand a great deal, and the permanent way ex- s of the Metropolitan and North London are larly low, though their engines have 15 and 16 on every driving wheel. The G.N.R. perma- way is far smoother than that of the Midland, believe does not cost more to keep up.

Helios.

SPEED OF LOCOMOTIVES.

793.]—PERHAPS it may interest some of our rs to see a late performance of a single engine a Scotch express train, which will show, I , that they can do something yet.

& N.W.R. ENGINE 887—LOAD, 14 LARGE COACHES—WEATHER DULL.

	p.m.		Speed.
Iuneaton ...... (leave)	5.48		
Bulkington ...... (pass)	5.54$^{3}/_{4}$	...	31·11111
hilton	5.57$^{5}/_{12}$	...	50·625
Brinklow	6.1$^{1}/_{6}$	...	52
ugby	6.8$^{1}/_{12}$	...	*45·54217
rick	6.19$^{1}/_{3}$	...	40
Veedon	6.25$^{7}/_{12}$	...	55·2
Blisworth	6 33$^{1}/_{6}$	...	51·42857
oade	6.37$^{1}/_{6}$	...	45
Volverton	6.45$^{5}/_{12}$	...	56.36363
Bletchley	6.52$^{1}/_{6}$	...	48·88888
eighton	7.0$^{1}/_{6}$	...	48·75
heddington	7.5$^{5}/_{12}$	...	45·71428
ring	7.12$^{5}/_{12}$	...	38·57142
erkhampstead	7.17$^{1}/_{2}$	...	44·26229
oxmoor	7.21$^{1}/_{4}$	...	56
ing's Langley	7.24$^{11}/_{12}$	...	57·27272
Vatford	7.28$^{3}/_{4}$	...	54.78260
ushey	7.30$^{5}/_{12}$	...	54
inner	7.33$^{11}/_{12}$	...	†47·14285
arrow	7.36$^{1}/_{6}$	...	53 33333
ndbury	7·39$^{5}/_{6}$	...	53 18181
Villesden .... (arr.)	7.43$^{1}/_{4}$	...	43·90244
			22)1073·07310
Average		...	48·77605

acked through station. † Picked up water.

ned this train past all the mile-posts from the the 27. The quickest mile was 1 min. 1 sec.; owest, 1 min. 43 sec. The Kilsby tunnel was d in 2 min. 5 sec.; the Stove Hill, 19 sec.; ide, 11 secs.; North Church, 14 secs.; and ord tunnel, 1 min. 8 secs.

Itzaex.

794.]—LAST night (August 27) I came from ester by the train starting at 8.5 p.m., and . to arrive at Paddington at 11.15 p.m. We were detained at Swindon to await the arrival of the Weymouth train, and started late. The distance between Swindon and Westbourne Park was run in 88 minutes, and from Reading to Westbourne Park in 36 minutes. Speed was slackened through Didcot Junction to not much more than 12 or 15 miles per hour. Number of engine 1,126, single driving wheel, apparently about 7ft. diameter. I believe the above distances to be approximately 75 miles and 34 miles respectively, but have not the exact distance by me.

J. H. W.

CONTINUOUS BRAKES—THE EXPERIMENTAL VAN ON THE BRIGHTON RAILWAY.

[14795.]—THE length of my last letter (page 605) compelled me to defer giving the following most interesting tables, which have been deduced by Captain Galton from the very large number of experiments which have been made with the experimental van on the Brighton Railway, and which has formed the subject of his paper on "the coefficient of friction," which was read before Section G of the British Association at Dublin.

Table No. 1 gives the coefficient of friction between cast-iron brake blocks and steel tires.

Table No. 2 gives the co-efficient of friction when wrought-iron brake blocks had been fitted to one pair of wheels on the 25th of July, as explained in my last letter.

Table No. 3 shows the coefficient of friction between the steel tires and the steel rails.

TABLE No. 1.

Speed.		Coefficient of friction between cast-iron brake blocks, and wheels having steel tires.			
Miles per hour.	Feet per second.	At commencement of experiment to 3 seconds.	At from 5 to 7 seconds.	At from 12 to 16 seconds.	At from 24 to 26 seconds.
60	88	·062	·054	·048	·043
50	73·3	·100	·070	·056	—
40	58·7	·134	·100	·080	—
30	44	·184	·111	·098	—
20	29·3	·205	·175	·128	·070
10	14·7	·320	·200	...	—
5	7·3	·360	...	...	—

TABLE No. 2.

—	Coefficient of friction between wrought-iron brake blocks and wheels having steel tires.		
Speed in miles per hour.	At commencement of experiment to 3 secs.	At from 5 to 7 seconds.	At from 12 to 16 seconds.
48	·110	...	...
31	·129	11	·099
18	·170	...	...

TABLE No. 3.

—	Coefficient of friction between steel tires and steel rails.		
Speed in miles per hour.	At commencement of experiment to 3 secs.	At from 5 to 7 seconds.	At from 12 to 16 seconds.
50	·04	...	...
45	·041	...	...
38	·057	·044	·044
25	·080	·074	...
15	·087	...	...
10	·110	...	...

The result of these tables shows that the coefficient of friction varies inversely in a ratio dependent upon the velocity at which the surfaces are moving past each other; and also that the longer the surfaces are in contact, the smaller the coefficient of friction becomes. The following is the theoretical reason which is believed to give the true solution of this problem.

When a brake is applied with sufficient force to "skid" the wheels, the friction between the rails and the tires develops heat, and the consequent expansion tends to close up the pores in the metal, and to make the heated surface of the tire a more united surface than the colder surface of a tire which is pressed upon by the brakes, but "*not skidded.*"

The coefficient of friction between the brake blocks and the wheel is found to be thus—

$$\frac{\text{the tangential force}}{\text{the pressure applied}} =$$

and between the wheels and the rails it is—

$$\frac{\text{the friction of the brake blocks}}{\text{the weight upon the wheels}} =.$$

The opinion of Mr. Fleeming Jenkin, given in the paper which he read before the Royal Society in April, 1877, "that in all cases where a difference is observed in the coefficient of friction, between the static and kinetic friction, the static exceeds the kinetic," is receiving great attention; but all the experiments made by Mr. Jenkin were with bodies moving at very low velocities, and, therefore, cannot so easily be compared with those made by Captain Galton.

The second paper upon "Continuous Brakes" will be read by Captain Galton at the autumn meeting of the Institution of Mechanical Engineers, when the whole of the results of the present series of experiments will be communicated.

August 28th. **C. E. S.**

(To be continued.)

L. & N.W. LOCOMOTIVE ENGINE SHEDS.

[14796.]—IN let. 14632, p. 499, "R. N. H." gives a list of locomotive engine sheds of L. & N.W.R. The following list is rather more complete:—

Euston.
Willesden.
Bletchley.
Rugby.
Birmingham.
Wolverhampton.
Stafford.
Crewe.
Manchester.
Leeds.
Birkenhead.
Chester.
Bangor.
Holyhead.
Warrington.
St. Helens.
Wigan.
Liverpool.
Preston.
Carnforth.
Carlisle.
Shrewsbury.
Abergavenny.
Cockermouth.

Can any one tell me if 20 is at Sutton, or anywhere else? Also, where Precedent and Patience are stationed, and if Precedent is a 5ft. 6in. four-coupled engine?

Wildfire.

UNFERMENTED BREAD.

[14797.]—As some of your correspondents appear to have failed in making unfermented bread perhaps the following may be of use:—Mix 12 fluid drachms of pure hydrochloric acid and 300 grains of common salt in 10 fluid ounces of water. Keep this mixture in a bottle. When you wish to bake—1. Heat your oven; 2. When the oven is quite ready mix 60 grains of bi-carbonate of soda with 1lb. of flour. Do this well, and let the mixture be intimate. 3. Measure out 1 fluid oz. of the mixture from the bottle, and add 9 fluid ounces of water to this 1 ounce of mixture. With the 10 fluid ounces thus obtained make the 1lb. of flour with the soda in it, into dough as rapidly as possible. It is best done in a large bowl. Make the dough into the shape of a loaf, and as soon as it is made, in with it into the oven, and bake for an hour. This ought to teach any one. The amount of salt may be too much for some folks. It is not for

J. F. E.

BATH HEATING.

[14798.]—SOME time ago there were inquiries in "ours" about this, and I had hoped, as I also was just then in want of some simple and easily manageable plan, that some practical system would have been described. Such, however, was not forthcoming, and as I found it impossible to rely upon the servant for preparing the fire to time, with which my bath was hitherto occasionally heated, I set to, and devised a simple boiler, actuated by a gas jet. The boiler is of zinc, about 9in. high by 6in. diameter, with an internal "fire-box" 7in. high by 4in. diameter. It is connected from the outside to the large end of the bath by two horizontal tubes, one of 1in. diameter, starting from lowest point of boiler, and one of 1¼in. diameter, starting from near the top, and when the bath is filled the boiler and tubes are also full of water, being about a couple of inches under the level of the water in bath. A gas jet plays directly from below into the fire-box, and the heated air is carried off by a small tube from top of fire-box, passing through the water space above. No disagreeable smell is found to arise from this, and the bath-room is very nicely attemperated from this by the morning.

As I take my bath every morning on rising I light the gas the evening before, allowing it to burn all night with cock at from one-half to two-thirds open.

The bath contains 560lb. of water at an initial temperature of 59° F. The result of an experiment was as follows:—Gas jet lit at 11.30 p.m. At 8 a.m., or in 8½ hours, the water was raised in temperature to 81½°—*i.e.*, had accumulated 22½° of heat, at which temperature I usually take the bath. The amount of gas consumed in this time was 28·7 cubic feet, and at 4s. 6d. per 1,000 cubic feet, had thus cost me 1·55d. It will appear from this that each cubic foot of gas had given a useful effect in heating the water of 439 pound-degrees in 8½ hours.

The apparatus cost me about 12s. to have made and applied, and being able in this way to control temperature, and to have my bath ready at the moment required, I can but recommend it to others in like circumstances.

The addition of heat to the bath was at the rate of 2·647° per hour, so that an estimate can be made for any other temperature of commencement and ending, as also for other times of taking the bath.

As I cannot stand a bath at the same temperature as the surrounding atmosphere, and find at this season of the year an excess of temperature of about 10° most suiting, I should be glad if some of our medical friends would kindly give their advice if this proportion will also apply during the winter and spring season. Subject to catching cold very easily, I am desirous of "hardening" myself by gradually reducing, if possible, this ratio of excess temperature of water over atmosphere, but do not know if it may safely be done, or if the proportion is proper, also for lower and higher atmospheric temperatures. Information upon this will oblige

E. W. A.

THE HYPHARMONIC THESIS CONSIDERED.

[14799.]—It is not necessary, I think, in response to letters 14672 and 14725, to extend observations at very great length in the consideration of the thesis that the structure of the diatonic scale is not perfect unless it is supplemented by the note rah as the product of hypharmonic evolution. It would appear that, according to the correlative hypharmonic theory, certain notes of the diatonic scale correspond with an harmonic ascending series of concords, and that certain others similarly correspond with a hypharmonic descending one. In the ascending series are obtained doh, me, soh, and in the descending me, la, doh, with their replicates. Placing a harmonic concord on soh there are obtained te and ray, and an hypharmonic concord under la, fa, and rah. There are now in the harmonic series the two triads of doh, me, soh, and soh, te, ray; and in the hypharmonic those of la, doh, me, and rah, fa, la. These series complete the diatonic scale, the notes of which are thus: Doh, rah, ray, me, fa, soh, la, te, doh¹. The relation which they bear to each other is expressed by the following series of ratios:—

As doh : rah : ray : me : fa : soh : la : te : doh.
So 1 : $\frac{10}{9}$: $\frac{9}{8}$: $\frac{5}{4}$: $\frac{4}{3}$: $\frac{3}{2}$: $\frac{5}{3}$: $\frac{15}{8}$: $\frac{2}{1}$.

A converse order is as follows:—

As me¹ : ray¹ : rah¹ : doh¹ : te : la : soh : fa : me.
So 1 : $\frac{9}{10}$: $\frac{8}{9}$: $\frac{4}{5}$: $\frac{3}{4}$: $\frac{2}{3}$: $\frac{3}{5}$: $\frac{8}{15}$: $\frac{1}{2}$.

Then, it is argued, since the concords of la, doh, me, and rah, fa, la are produced in hypharmonic evolution as those of doh, me, soh, and soh, te, ray, are in harmonic; since they are necessary to the perfection of the symmetry of the scale, and since rah is an essential note in the concord rah, fa, la, it is a note necessarily belonging to the diatonic scale.

This is also sought to be established by the aid of the monopolytone, which is an imaginary generator of musical sounds, commencing with the subdominant fa in the pitch of the third octave below the counter tones, and progressing in musical ratio according to the indices 1 to 48, and arriving at the musical scale of the small octave in the ratio and progression of

As 24 : 27 : 30 : 32 : 36 : 40 : 45 : 48.
So doh : ray : me : fa : soh : la : te : doh¹.

From this a hypharmonic monopolytone is constructed, in which the note te is made the highest in the pitch of the 5th line octave, whence descending in similar ratio correlatively the order above is found to correspond with the notes me¹, rah¹, doh¹, te, la, soh, fa, me. Hence, again, it is contended that the note rah pertains to the diatonic scale.

On the contrary, it is asserted that between such descending series and the ascending one there is in reality no coincidence, and that they really have no connection the one with the other. Hence the occurrence of a ratio in the descending series, which is indicated by the denominative note rah, cannot be a proof that it has a legitimate place in the diatonic scale.

Considering that all the notes of the diatonic scale may be obtained in an ascending order of ratio; that the subdominant of the scale generates in thirds every note of it in the progression fa, la, doh, me, soh, te, ray; that these notes in the two modes of major and minor are amply sufficient for all theoretical purposes of melody and harmony; that the diatonic scale of the seven notes, understood by the terms do, ray, me, fa, soh, la, te, is, as Mr. Curwen expressly says in his "Lessons on Music" in the *Popular Educator*, 1st edition, the scale of all nations and all time, immutable in its very nature; and, considering that it cannot admit any other note in its structure than these fundamental seven notes, without vitiating and destroying its diatonic character, the conclusion would seem to be inevitable that, whatever position may be assigned to it in enharmonic scales, the note rah, in the scale termed diatonic, has not, and cannot have, position or power. **Isaac Fowler Ballard.**

AUTOMATIC REED ORGANS.

[14800.]—I was very much interested in the communication from George Tommy (letter 14735, p. 691) concerning automatic organs. Can he kindly give any further information about the construction of the same—is it patented, and, if so, what year is the specification dated? In searching the "Post-office Directory" I find the name of Dawson, the inventor, is no longer at 395, Strand. Can George Tommy say where the instrument can be seen? I am extremely interested in the question of mechanical musical instruments, and have been experimenting thereon for some time. I know they are looked upon by musical professors with a very small amount of veneration, but to people fond of music it is no small matter to be able to sit and play continuously overtures, symphonies, &c., with perfect precision. Even with an ordinary barrel instrument I have, with the aid of lever and stop, obtained, in addition to perfect mechanical execution, great expression, obtaining forte, piano, sforzando, diminuendo, crescendo, &c., &c., but all barrel instruments are defective in being limited to the circumference of the barrel for the length of tune; any system, therefore, like that described by George Tommy I should like particulars of. Can any reader describe the principle of the piano mécanique, invented by Debain, where the music is arranged on small continuous boards, or another instrument I have heard of upon the principle of the Jacquard loom?

R. Smith.

AUTOMATIC REED ORGAN—COTTON BLIGHT OR MEALY BUG—ANOTHER QUESTION—OBLIGATIONS OF WRITERS—THE FLY'S TRAMP.

[14801.]—Is Mr. G. Tommy quite sure there is "no novelty in the principle" of the automatic organ, illustrated on p. 514? I ask, because for all the information he gives, no one can possibly say what the "instrument similar in principle" was like. I fail to see any "principle" in the question; but Mr. G. Tommy has now to show that the perforated sheets of millboard were made to act as the pallets of the organ, before he will establish an identity in the means employed. Is he sure that the perforations in the millboard did not actuate levers? Because, if so, there would be a difference in the "principle," which, after all, is not the test of the validity of a patent.

Is there not some misunderstanding as to the question headed Aphides, p. 607? I think there is some confusion between American blight and mealy bug, often called "scale insect"—a species of coccus, quite different from Aphis lanigerus.

In his letter, p. 575, "F. R. A. S." quotes a sentence from a letter by "Pioneer," and says, "the naïveté of this would be amusing if it were not pitiable." I should like to ask in what way it is either naïf or pitiable? It is a good instance of how one sentence strikes two readers. I understood "Pioneer" to mean that, although the wages of the working classes may have been raised 40 per cent., they are no better off, because necessaries have also gone up 40 per cent., and, as I understand him, he makes that statement, because, as he says (p. 470), the British workman has been referred to as the most favoured in regard to wages. We have been told so frequently lately that the working man is a vampire, fattening on the juices of society, that people begin to believe it. "Looker-on," p. 576, can "prove it, too" (about the extra cost of houses), but I observe that he, too, omits the proof. If he had to pay so much for the work being done, why, in the name of common sense, did he not do it himself? I am heartily sick of this instructing of the working man, who perhaps understands the principles of political economy as well as those who appear to think they have a monopoly of such knowledge.

I am obliged to "H. G." (p. 629) for his attempt to answer my question; but I would point out that it is scarcely what is wanted. Surely a "builder, or other person of experience," can give the actual items of cost for materials and labour of a house of any known size now, and 30 years ago. The actual daily wages paid and number of hours worked scarcely meet the question, because I have known such a thing as high-priced workmen doing vastly more and better work than low-priced men, and not work so many hours. I mentioned the experience of Mr. Lascelles on this point recently. "Penance Point" (p. 630) may attribute as many cranky notions as he likes to me. I hope he will not lose his temper if I touch him with my rasp. At present I have not time. The passage in his letter winding up with "pigs," is eminently suggestive.

I was much amused when reading the "lecture" of "Aliquando" (p. 602), and thought "surely the reader also is bound to take care that he understands the meaning of the writer—or suffer in default." I do not know how many of your readers failed to understand Mr. Dewsbury's description of his pulley block, and it is always difficult to explain a new thing, but I venture to think that the word "till" is quite as clear as the word "will" in the connection cited. It is not advisable to look gift horses in the mouth too critically. The effort to understand anything is often of great value in impressing the knowledge gained upon the memory, and I for one protest against this "lecturing."

Do we hear the tramp of the fly, or merely the vibrations set up in the microphone? "Brickwall" (p. 529) speaks of "feeling" the movements. I take it he felt the undulations or vibrations caused by the movements of the fly, and I doubt whether one really hears the actual sound of the fly's tramp in the telephone. It may be heard easily enough on a summer afternoon by covering one's head with a newspaper. It will be odd if some flies do not settle on it, and you can hear their steps distinctly. The microphone, it should be remembered, magnifies the sounds, and transmits them to the telephone or receiving instrument, in the shape of electrical vibrations, and the movements of the diaphragm would, to a certain extent, be communicated to the wooden covering-piece. I must acknowledge, however, that the tick of a watch is reproduced exactly as regards the quality of the sounds. **S. Mayer.**

FLY-WHEELS.

[14802.]—"Norfolk's" proposal in letter 14746, p. 603, of weighting fly-wheels with mercury would not, I think, be of much more service than having extra metal cast on the wheel at the same places as his cylinders. It is hardly likely there would be 24in., or even any vacuum at *a b* (position 1), considering the friction of the piston, which must fit tight, or the silver would be liable to escape; there would certainly be none when the wheel was turning rapidly, as centrifugal force would keep the mercury at the farthest point possible from the centre of the wheel. Even supposing the vacuum to be formed, would the extra leverage caused by the part, *a b*, being filled when descending, be sufficient where a heavy fly-wheel was before needed to carry the crank over its dead points?

The only satisfactory way of preventing more mischief being done by the accumulated force, in case of break-downs in the machinery connected, would be to fix a brake, so that it could be easily applied to the rim of the fly-wheel to stop it quickly; or some of the heavy fly-wheels in use might be replaced with advantage by lighter ones.

A. M. H.

BOAT-BUILDING.

[14803.]—I find one or two slight mistakes in the letter on boat-building; p. 445, near top of first column, I state the model is drawn ½in. to the foot, should have been 1in. to the foot: middle column, tenth line below engraving, read Fig. 7 instead of Fig. 5; bottom line, middle column, read Fig. 8 instead of Fig. 7; same column, eighteenth line from the engravings fit the front end to the stern, should be fit the front end to the stem; the second line below again, instead of stern rabbit, should be stem rabbit; third column, eleventh line from bottom, a narrow iron strut, should be a narrow iron strap. I find that amateur boat-builders often get the boat wider than is intended from not bevelling the top of each strake at and near midship sufficiently. I would suggest to the novice to take a number of pieces of wood, say 3in. or 4in. long, and as wide as the strakes are intended to be, and bevel the top outside edge 1in. wide from top until they fit the outer edge of midship template when placed one upon another in the positions the strakes will occupy. This will give him a good idea how much to bevel each strake. **R. Cooper.**

OBTAINING NITROGEN FROM THE ATMOSPHERE.

[14804.]—I am very much obliged to you for your article on my invention of a new process for obtaining nitrogen. There is, however, one erroneous statement in it which I beg leave to correct. According to the method described by me all the oxygen is removed from the atmospheric air. When I stated that there might remain a residuum of oxygen amounting to 2½ per cent., I meant by that not the minimum, but the maximum of oxygen remaining in consequence of an imperfect way of using the apparatus, and I mentioned this only for the purpose of preventing a refusal of the patent in case of an insufficient examination of my method.

As you yourself express the opinion that an entire disoxygenisation of the air would be of considerable value, I hope that the above communication will be of some interest to your readers both in England and America. Should any of them feel sufficiently interested in the invention, commercially or otherwise, I should be glad to correspond with them.

Dr. Treutler.

Blasewitz, Saxony, August 26.

SIEMENS' FURNACE.

[14805.]—In your issue of the 16th August (let. 14721), I am pleased to see that "P. F. McC." gives a description of the Siemens furnace, which, I think, might be applied to many other industrial processes requiring comparatively low temperature as compare water heat—necessary for the manufacture of steel or glass.

In my case I require to heat an oven or kiln to a temperature of between 250° and 300° Fahr., and I should feel obliged if "P. F. McC.," or any correspondent, would kindly inform me if this could be done with the Siemens furnace. As I understand this apparatus, it consists of three distinct parts—viz.:

1st. The gas-producer.
2nd. The regenerator.
3rd. The oven or kiln to be heated.

In the first the fuel undergoes an incomplete combustion—that is to say, it is converted into carbonic oxide gas, which is conveyed to the "regenerator," which consists of a simple chamber filled with firebricks heated to redness by the water or escape heat from the oven. Here the complete combustion of the gases liberated in the producer is effected by the introduction of atmospheric air, which affords a sufficient quantity of oxygen to convert the carbonic oxide into carbonic acid gas, which, together with the other heated products of combustion, pass away to the kiln or oven, where the process requiring the heat so obtained is carried on.

It appears to me that, if the supply of air and gas admitted into the regenerator be completely under control by means of suitable valves or dampers, so that their flow can be checked or accelerated at will, the heat in the oven will be regulated in the same way that heat in a common gas-cooking stove is kept at the required temperature by simply turning the taps, and so reducing or increasing the power of the flame. I should be much obliged if "P. F. McC." would kindly inform me if this could be done, and, also, if I am correct in supposing that the quantity of fuel consumed for the production of gas will be in proportion to the quantity of air burnt in the regenerator. The quantity of gas produced, I presume, could be further controlled by a damper placed so as to regulate the admission of cold air below the firebars.

I should be glad to know what is the use of the cooling tubes shown at Fig. 1, and if it is necessary for the gases to be cooled before entering the regenerators. Also, how one of these furnaces is started, as in the first place the regenerator would be cold. It is important also to know if all the oxygen is consumed in the regenerator before the heated gases enter the oven or chamber. This is an important matter in my case, as the substances requiring to be treated take fire at a comparatively low temperature in contact with the air.

Could not some self-acting contrivance be adopted for regulating the admission of the gas and air, and, so to speak, turn off or on the supply?

Some arrangement, based upon the unequal expansion of two metals, acting upon suitable levers in connection with the valves, might answer, and perhaps some correspondent would give some idea of a simple form of heat regulator. **Etna.**

THE MANUFACTURE OF STEEL BY SIEMENS' PROCESS.—II.

Working of the Gas Producers.

[14806.]—The most inferior descriptions of fuel, such as slack, sawdust, peat, &c., which will hardly burn at all in an ordinary grate, may be converted into highly combustible gas by means of the producers; and on the Continent, where good coal is not so abundant as in this highly-favoured land, modifications of the gas producer are used even for steam boilers. Gas producers are employed to a large extent in potteries and glass manufactories, as well as in almost all metallurgic operations; and it may be safely said that they present the cheapest and cleanliest method of burning fuel wherever a large and constant amount of heat is required.

A stack of four producers of the size shown in Fig. 1, when all the fires are clean and in good repair, is capable of converting about six tons of round coal into gas in a "shift" of twelve hours; but, as the fires soon become partially choked with clinkers, &c., the average amount of coal, which in ordinary working can be properly burnt in twelve hours, may be taken at about 5¼ tons. The fuel is gradually introduced in successive increments, at intervals usually of about 1¼ hour; but longer or shorter according to the rate at which the gas is being drawn away to the furnaces. The workman by frequently inspecting the fires through the sight holes is enabled to perceive when stirring or fresh fuel is required, and he must always maintain a slight outward pressure within the producer, otherwise air would enter, and serious danger of an explosion be incurred. It may be asked, is there no danger from the air drawn in at the fire-bars? but this air is always converted into carbonic oxide or carbonic acid before ascending to the upper portion of the fire.

When additional fuel is required the hopper (see Fig. 1), which holds about one hundred weight, is filled. The hand lever is then raised, allowing the contents to descend, the operation being repeated till the desired amount has been introduced. The cover is then replaced, and sanded down to prevent escape. On referring to Fig. 1 it will be seen that the fuel falling from the hoppers will have a tendency to accumulate on the inclined plane directly beneath them. To remedy this the fireman introduces a bar through the sight-holes, and spreads the coal evenly over the surface of the fire, which is usually preserved at a level of not more than 1ft. below the flue (A, Fig. 1), which leads up to the stack. The fire-bars require to be freed from ashes, &c., at intervals, the length of which depends upon the nature of the coal used—generally twice in twelve hours. If desired the fires may be worked in such a manner as to leave a considerable residuum of coke. When slack is used some mechanical means of stoking may be employed with advantage and economy both in fuel and labour. It may be as well to state here that, though a more regular quality of gas is obtained by working the producers continuously, the production may be, if desired, stopped for many hours without detriment to subsequent working.

The gas resulting from the partial combustion of the fuel in the producers consists of a complex mixture in variable proportions of carbonic oxide, hydrogen, various hydrocarbons, nitrogen, carbonic acid, &c. The specific gravity of the mixture averages about 0·79, so that it is considerably lighter than the atmosphere. The following analysis will give a good idea of the proportions of the various constituents:—

Carbonic oxide	24·7	volumes
Hydrocarbons	1·3	„
Marsh gas	1·8	„
Hydrogen	7·5	„
Carbonic acid	4·5	„
Nitrogen, &c.	60·2	„
	100·0	„

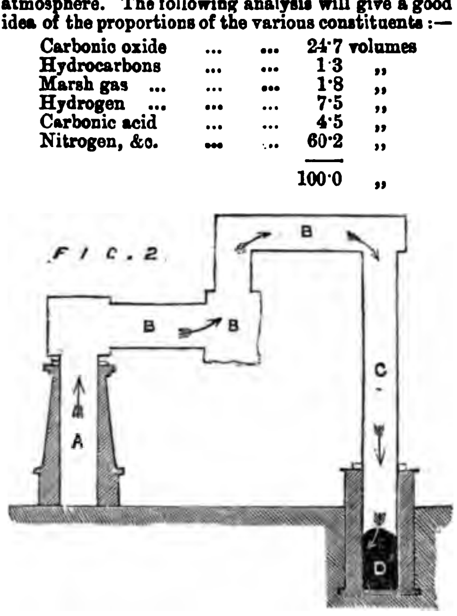


FIG. 2

The most important of these gases is the carbonic oxide, and its formation is thus explained:—The air passing through the incandescent fuel at the fire-bars is converted into carbonic acid, and passing upwards through the heated coke above, combines with an additional atom of carbon, the result being the production of two volumes of carbonic oxide. The hydrocarbons, generally present only in small volume, and the hydrogen, partly the result of the decomposition of the steam arising from the water in the ash pits, are also valuable heat producers. The nitrogen acts as a diluent, and the carbonic acid, resulting from a too free admission of air, exerts a prejudicial action in the furnaces by hindering combustion.

When coal containing sulphur is used various compounds of sulphur with carbon and hydrogen will of course present themselves in the gas; but they do not appear to exert any appreciably injurious action on the metal in the Siemens' furnace.

One ton of coal produces from 50,000 to 55,000 cubic feet of gas at a temperature of 60° F.

The gas being lighter than the atmosphere, it is evident that, except in cases where the producers are placed at a considerably lower level than the melting furnaces—an arrangement seldom practicable—some special expedient must be used to cause the gas to descend to the furnaces. In Fig. 2, A is a section of the producer stack; B B B, the cooling tubes; C, the downtake; and D, the underground flue leading to the furnaces. The gases which ascend from the producer at a high temperature become cooled in passing through the tubes, consequently the descending column of gas in the downtake, C, is heavier than the ascending column in A. The result being a constant pressure in the direction of the furnaces. The arrows indicate the course of the gas.

The temperature of the gases leaving the producers is between 800° and 900° F., and it is reduced down to between 200° and 300° F. in traversing the tubes, the gases undergoing an increase in density of about 50 per cent.

In building producers the lowest part of the fire-grates should not be placed at a higher level than the bottoms of the regenerators of the furnaces they are intended to supply, if it can be avoided.

The underground flues, which conduct the gas from the downtake to the furnaces, may be about 5ft. high by 2½ft. wide, with a semicircular roof, and brick walls 9in. in thickness. A smaller area would suffice for the passage of the gas; but the large size is convenient for cleaning, and also admits of a large accumulation of tar, without any interference to the flow of gas. Manholes for giving access are provided at short distances. Directly beneath these flues, and of the same width, and about 3ft. in height generally, are built the flues, which conduct the waste gases or smoke from the furnaces to the chimneys. By thus placing the gas and smoke flues considerable economy is effected both in excavation and brickwork.

As a large amount of soot, tar, &c., is continually being deposited in the cooling tubes and flues, they must be cleaned out at intervals, the length of which will depend upon their size and on the nature of the coal used; but generally not longer than six months. The tar which collects in the main tubes is solid in the immediate vicinity of the producers, becoming gradually liquid at a greater distance; and, where the tubes are of considerable length, it is advisable to have some means of drawing off the mixture of tar and water as fast as it is condensed from the gas.

P. F. M'C.

(*To be continued.*)

MICROSCOPICAL—THE HOUSE FLY.

[14807.]—I do not think I have ever read any letter to the E. M. with more amusement than No. 14753. Is Mr. E. B. Fennessy really so ignorant of the subject he writes upon as not to know that his so-called spider skeletons, which he imagines to be remnants of cannibalism, are really the cast-off skins of living spiders. To guide his steps in the study of spiders let me tell him distinctly that spiders cast their skins regularly, and the skin includes claws, jaws, eyes, &c. These he can find wherever he can find spiders' webs.

Another correspondent (query 33796) asks for information about the house fly. The house fly, although a small insect, is a member of a very numerous race. It is probable that the majority of people see the countless swarms of flies every summer produces and every autumn destroys without ever giving a single instant's serious attention to them. When their numbers become so great as to be a nuisance we knock them from the walls, or buy a fly-paper and poison right and left, without pity or remorse, and when we have swept our dead out of our sight we congratulate ourselves on our achievement, and there is an end of the matter. Whence do they come, what purposes do they serve, what is their organisation and life history, we do not ask, and yet I know no more wonderful creation, no one more wondrously made or more beautifully constructed, no one with plainer adaptation of means to an end than this little insignificant house fly, which so often only obtains notice to be anathematised. At some seasons their countless legions become a veritable torment, and we can form some faint idea of the weight of the Egyptian plague. If it were possible to take a census of them, figures would fail to represent the vast total. Even the host in a single house is as numerous as a large army. A grocer in Cathcart-street, Glasgow, who was much annoyed by them, invested in a halfpenny fly-paper, which he placed in the window on a plate with a little water. "After it had lain there a week, on the usual turn over of the window, on Wednesday afternoon, an immense number of dead flies were collected from it. Curiosity led the man to put them in the scale, when he found their combined weight to be 2¼oz. He thereupon weighed 600, and upon calculation it appeared the 2¼oz. would contain 10,800 dead flies. Besides this it is considered that nearly half as many more would be dusted out of the window during the week, making a grand total of 15,000 slaughtered in a week by this housewife's benefactor," as the *Glasgow Morning Herald* calls it, but certainly it is not much of a benefactor from a fly's point of view.

Small as the fly is, if we were to range in order the whole animal creation, from the minutest animalculum to the huge whale, we should find the fly more than half way up the scale—*i.e.*, there are more animals smaller than the fly than there are larger, but we are so accustomed to look on the larger animals as the whole of life, and to estimate at nothing at all the myriads of insects and animalcula, that it really requires a little consideration before we can accept this statement as an unimpeachable fact. But, after all, we could catalogue the large animals in a very short time, and when we descend, and especially when we reach the regions where the unaided eye fails to supply our requirements, we find exhaustless variety, and only then begin to realise the vastness and abundance of the universe.

I have called the fly an insect. What is an insect? Unless one has paid some attention to this they would hardly like to answer the question promptly. Spiders are commonly called insects, as by Mr. Fennessy in his letter before alluded to; so are mites, yet they are not so. An insect may be defined as a small animal, having no bones, no veins, and no branched arteries, whose body is cut into three more or less distinct segments, which breathes through air-pipes in the sides instead of by the mouth, which generally undergoes three transformations, and has exactly six feet when in the perfectly developed state. This last is a decisive mark—without it none are genuine. The common fly belongs to the division of two-winged insects, or diptera. The house fly is produced from an egg which is hatched within a few days of deposition. Some persons assert they have known the eggs to hatch during the act of deposition, leading to the statement that the insect brings forth its young alive. They are deposited by preference in the dung of the horse, although refuse and rubbish of all kinds may be made use of, and a fly has even been known to mistake snuff for dung, and deposit its eggs therein. Still the presence of the horse appears to be necessary to their prosperity, for they certainly are more numerous in the vicinity of stables than elsewhere, and I have read that in the city of Venice, where there are no horses, there are no house flies. The female fly may commence to lay at seven or eight days old, and one coming into existence in early summer probably lays five times, each time depositing from 70 to 90 eggs. Most insects deposit a large number of eggs once and then die, but the fly continues to live during the season if it escapes accidents. It has been calculated that a member of the advanced guard of each year's multitude is probably the parent of two millions of descendants before the frosts of winter terminate its career. This, then, is where their immense numbers originate. I will continue this subject through the whole history and organism of the fly in a future number. **Essex.**

THE MONOPOLY OF LAND AND SCARCITY OF HOUSES FOR THE WORKING CLASSES.

[14808.]—Cannot "Pioneer" see the difference between the daily sales of land and the sales of patents he quotes? No two patents are for precisely the same article or process, and, even when "licenses" only are sold, those for one patent are only to be had from the proprietor of that particular patent, so that patents are a monopoly indeed, but cannot, by any such argument as "Pioneer" uses, be fairly compared with the land question. It is, or was, proposed to compel the owner of a patent to grant licenses, and fairly so, I think, on account of the monopoly given him. Does "Pioneer" suggest that the owner of land should be compelled to let his land for "granite quarries," &c., &c.? Is such owner not to have the privilege of judging for himself whether the projectors of such quarries are sound in their speculations and financially, or must he risk the destruction or disfigurement of his property at the bidding of any one who, rashly or otherwise, imagines a granite quarry will pay? Can "Pioneer" not see that the "argument" in this question would apply in others? For instance I have a nice little lathe, and a goodly lot of tools; why should I not be compelled, "in the interests of trade" and the "development of legitimate and valuable industry," to let them to him because he thinks he could start a business that would pay? And if I will not, and say it pays me better to keep them by me in good order to use for the amusement of myself, must I at once be quoted as inhuman to the "intelligent workman," who, by his "combinations," has raised our prices till capitalists prefer 3 per cent. from land to the precarious profits said workmen think proper to allow them.

Finem Respice.

ANTIQUITY OF MAN.

[14809.]—As desired by Capt. Steel (letter 14774) I have checked his calculation from the data he gives, and find the ratio per year to be 1·00348. On referring to his letter (14567) I see that he gives it as 1·0034; his answer is therefore correct to four places of decimals.

Manchester, August 31. **B. Riley.**

New Telephone Diaphragm.—Louis Ollivier, of Elbœuf, believes that the flat form of the receiving diaphragm interferes with the proper reproduction of the vocal *timbre*. This timbre is produced by the more or less complete blending of different harmonics. Helmholtz, by the aid of his resonators, has been able to isolate, successively, the fundamental tone and the different harmonics. After having thus analysed the sounds, he has recombined them by synthesis. In order to have a diaphragm which may vibrate in unison with various harmonics, Ollivier uses a concave plate of varying thickness, imitating, in some respects, the tympanum of the *ear*.

REPLIES TO QUERIES.

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⁂ In their answers, Correspondents are respectfully requested to mention, in each instance, the title and number of the query asked.

[32461.]—**Tasmania.**—The mineral resources of this country seem to be unlimited, and at present only partly discovered. Gold, silver, copper, tin, bismuth, all seem to be plentiful. Two iron mines also were started a few years ago; one of them had a very short life, but the other carried on until a few months ago, when it was sold to some one in Melbourne, and will probably be opened again in a few months; the iron is in great abundance, and, I believe, of first-rate quality. The only difficulty in the matter was finding a market for enough of it to make it pay. Unless a man is a really good practical farmer, and up to any amount of hard work, he had better not try his hand at farming here. The markets are ruled by the prices current all over the world, and what can't be disposed of in the island is sent away. A good deal of wheat finds its way to England, and most of the wool grown in the country also. There is any amount of water power in the island. Coal is abundant, at about £1 per ton, and several mines are worked, but I believe most of it is much impregnated with sulphur, rendering it almost useless for steam purposes. I might have written a much longer reply to this query, but imagine the subject is not of much importance to the general readers of the English Mechanic. If Mr. R. J. Johnson will publish his address, and wishes it, I will send him newspapers, which will give him an idea of the minerals produced in the country, and the number of mines at work. I mention that it is probable an exhibition of Tasmanian products under the name of the "Tasmanian Courier Exhibition" will shortly visit England. The idea originated with a Mr. E. R. Richardson, a very noble-minded fellow, who lost his life a short time ago by the capsizing of a boat at the conclusion of an exploring expedition. It is hoped his brother, Mr. James Richardson, will go home with the exhibition, which, I may say, is subsidised by no one, and under no one's special patronage, and will trust for support entirely to its own merits.—Antipodes, July 3rd, 1878.

[33156.]—**Cupola.**—To J. C——y.—In Box's "Treatise on Heat," page 32, you will find, according to Dulong, carbon burning to carbonic acid develops 12,906 heat units. Despretz gives 14,040, and Favre and Silbermann say carbonic acid from wood gives 14,544 (page 7). The latent heat of liquefaction of cast iron is 233·0 (Clement), page 2. The specific heat of cast iron is ·12983 (Regnault), and (page 24) its melting point is 2,190° Fahr. (M. Pouillet). Now if we take the ordinary temperature of cast iron at 50°, we will require (2,190 − 50) × ·123 = 263·22 units of heat to raise 1lb. to its melting point, and 263·22 + 233·0 = 496·22 the total amount of heat to melt 1lb. This result is higher than that given in my letter (No. 695), in consequence of a very stupid error in my last calculation. One ton of iron requires $\frac{2{,}240 \times 496{\cdot}22}{12{,}906 \times {\cdot}85} = 101{\cdot}3$lb. of coke. This brings the theoretical consumption nearer to the actual, or 10·7 instead of 14. I am doubtful that this is quite the truth for the following reasons: In the first place, I have selected the lowest heating power of carbon, 12,906, against 14,040. I am also quite sure the coke I use contains, by analysis, 90 per cent. of carbon. With these data we have—$\frac{2{,}240 \times 496{\cdot}22}{14{,}040 \times {\cdot}90} = 88$ nearly, or a margin of 24lb. But if, as is quite possible, all the carbon is not burnt to CO_2 then some of it may pass off as CO. In that case we would have a very prodigal source of loss. According to Dulong, 1lb. of carbon burning to CO will only give out 2,495 heat units. It will thus be seen that every care should be taken to prevent the formation of CO, by not putting on too much coke at each charge. It is also quite possible that you may be using too much coke at each charge, although I am aware that you cannot do so well with a small cupola, yet you may easily be wasting fuel and losing time by burning it to no purpose. You do not say what proportion of coke and metal you charge your cupola with. I think if you were to try the following you would reduce your coke consumption:—Begin by filling up to about 18in. above the tuyeres; then put on 12cwt. of metal, after which put on 68lb. of coke. Continue the proportions alternately till you get on the whole of the metal you want. You will then be melting metal at the rate of 1cwt. of coke per ton plus the amount required for filling up, which, of course, is the same for one ton or a hundred. There is one feature I do not like to see in your cupola: you have two tuyeres, each being 6in. in diameter. Your cupola would work very much better by having an air belt passing round the cupola, and two rows of tuyeres, 4 in each row, one above the other, placed zig-zag fashion, similar to Ireland's cupola. Of course you would not need them more than 3in. square. I used to have my cupolas lined similarly to yours, but gave it up long ago, and now line them quite cylindrical. I used to be bothered with the charge hanging or scaffolding in the furnace. If you were to enlarge your cupola and make it parallel and 42in. diameter, then with 12oz. blast you would be able to melt about 6 tons an hour. I do this frequently, the saving in wages being considerable.—Cupola.

[33174.]—**Olive Oil (U.Q.).**—I read in Fownes that the oil deposits a solid, chiefly consisting of palmitine at 4° C.; the liquid remaining being nearly pure olive. An interesting paper—I think in *Nature*, a few weeks ago—described experiments proving that when the earth was cooling, the solidified stone would float on the molten mass, like ice on water.—Ploni Almoni.

[33174.]—**Olive Oil.**—"Gallium" is not likely to get any better account of olive oil than that contained in the work he mentions. As to the expansion of substances when solidifying he will find this matter very fully gone into in Vol. XXV., pages 318, 368, 393, 416, 442, 466, and 492, under the heading "Curious Property of Cold Cast Iron."—R. P. G.

[33406.]—**Belemnites.**—The cone of the belemnite is composed of crystalline carbonate of lime, disposed in fibres that radiate from an eccentric axis to the circumference of the belemnite. The odour—resembling burnt horn—produced on burning it arises from the remains of horny membranes interposed between each successive fibro-calcareous cone. —F. C. Hawks.

[33433.]—**Battery Carbon Blocks (U.Q.).**—I I am not aware of any way of joining them when broken. Good carbon should not black the hands, unless very slightly, after wiping with an old cloth. I drill holes in my carbon to cut it, using the same drill, as it takes the sharpness out of them. This is the best way that I have yet tried. I wonder how saws made out of old scythe-blades—such as country blacksmiths use—would do?—Ploni Almoni.

[33504.]—**Aphides—Honey Dew.**—The difference between "G. J. H." (p. 607) and myself appears to amount only to a verbal misunderstanding. Chas. Robinson (p. 483) asks the cause of the "specks of white." In my answer (p. 506) I say, "They are caused by a species of aphis." Perhaps I was not quite explicit enough; but if I erred it was in good company, for I find that the Rev. J. G. Wood, in his charming "Natural History" (Vol. III., p. 548) writes as follows:—"The white cottony substance that is found upon trunks of apple trees, and is popularly called the apple blight, is produced by one of the aphides called popularly the American blight, and known to naturalists under the title of Lachnus lanigerus." This insect appears to rejoice in several names. Some naturalists call it Myzoxyle mali, others Schizoneura lanuginosa, and on p. 577 "G. J. H." calls it by yet another—viz., Suchus lanigerus. With regard to honey dew, Chas. Robinson (p. 582) may rest assured that it is caused by aphides, who drop the honey on to leaves, &c. Perhaps there is a tree near the window some leaves of which touch it, or the insect might deposit the dew and fly away. There is a very interesting account of the aphides and their relations to ants in Louis Figuier's "Insect World," but it is too long to quote here. However, it is quite true that the ants not only keep the aphides in confinement for the sake of their dew, but actually milk them when they require a supply.—R. P. G.

[33548.]—**Multiplication.**—The original query on this too trivial subject has, in my opinion, already been satisfactorily answered by "Ploni Almoni;" but I cannot pass over the statement of "Idem," who, because the symbol × is not clear enough, chooses the word "of" to supply its meaning, and very correctly says that 4 hands of 5 fingers = 20 fingers (but in this case the of signifies "each containing"), and from this he deduces that "S. D. K." can speak of 2 apples × 3 oranges, which must, according to "Idem's" demonstration, mean 2 apples of 3 oranges, and what that means I am sure I cannot understand. The act of multiplication is the making of anything greater in quantity or extent, and, therefore, you cannot multiply 2 apples by 3 oranges, or 3 oranges by 2 apples, for neither the number nor the size of either apples or oranges can be altered by such treatment.—Chat.

[33566.]—**Telegraph Engineering.**—Is a very good profession for a man with brains, and the ability to use them; but it is useless for a man knowing classics and nothing of science to enter.—Nemo.

[33573.]—**Gasholder.**—Water is the best seal for the two holders; but perhaps you mean what is best to join the material of which holders are made; if so, perhaps you will get an answer when you say what you do mean.—T. J. M.

[33587.]—**Steel.**—Firth's, of Sheffield; but there is no correct answer to the question, as there are several makers of the very best stuff. I saw a reply recently about "shutting" cast steel.—Eros.

[33623.]—**Dido.**—I am afraid I cannot help your correspondent much. A careful search in several reference Bibles and a number of other books has given me nothing but dates. Ahab commenced to reign, according to Ussher, B.C. 918; according to Creswell, B.C. 917; according to Hales, B.C. 931. Ethbaal's father I have not found, nor indeed any of his relations. Dido was the daughter of Belus, the son of Phœnix, the son of Agenor, the son of Neptune. Dido left Phœnicia in about B.C. 953—that is, 36 to 22 years before Ahab's accession.—Ram Chand Biswas.

[33626.]—**Boat Building.**—"W. A. R." need not fear the weight of white lead in his boat if constructed on the "bread and butter" plan, and he can use tar or pitch if the extra expense is objectionable. It is, of course, possible to build a tight boat in many ways, but these require an excellence of workmanship not often possessed by amateurs. A standing lug-sail—that is, a lug with the tack made fast to the foot of the mast—is the simplest and handiest form of sail for a small boat, and if the single halyard be rove through a block at the foot of the mast and led aft, the safest for a boat managed by a single person, as in a squall the sail can be let go with one hand while the helm is put down with the other. Also a standing lug, if the fore and after leaches are parallel, has more cloth in the head than any other sail, and for sailing in a canal, where if the banks are never so low, they skreen off a great deal of wind. A foot of area of sail aloft is worth two or three low down. Two frames or templates give a large unobstructed central compartment, and more are not wanted for strength. Centre-boards are unusually pivoted at the lower forward corner, but where the centre-board is likely to be fouled with weeds and mud it would be better to pivot it on a pin or bolt passing through the top edge of casing and top fore corner of centre-board, so that this last can be lifted out and examined while afloat. A flat-bottomed boat must have a large rudder, the lower edge of which should come three or four inches below the stern-post, so as to be acted upon by the solid water, and not the eddy which follows in the boat's wake. If the rudder is fitted with eyes as well as the stern-post, and a long rod is passed through both sets of eyes, the rudder if touching the ground will rise without becoming unshipped.—Gimcrack.

[33681.]—Object-glass of Telescope.—From "Wallaby's" question the double convex glass is missing from object glass of his telescope. I am afraid he can only put it right by a new object-glass.—Astronomer.

[33691.]—Cider.—The best time to buy cider is about November, after it has fermented and been properly racked; you will then have it sweet, and in a fit state for either drinking or bottling. Should a portion of the cask be bottled the remainder should not be allowed to stand long, or it may become tart from the air getting to it. In bottling a small piece of sugar candy should be put in each bottle. The corks should be tied down, and it should stand for a month; you will then have it sparkle, and be almost equal to champagne. The price is sixpence to tenpence per gallon in buyer's cask.—Cider Maker, Tenbury.

[33713.]—Mechanical Stoker.—The best mechanical stoker that I know of is one patented not long ago. It is very simple in construction, and can be fitted to any boiler without holes having to be drilled in the face, which I believe has to be done in putting up all other "stokers." Slack can be used in it with equally good results as round coal, and will produce more steam when the stoker is used than round coal will with hand stoking. The feed can be regulated with great accuracy, and the coal is distributed evenly over the furnace bed. This stoker requires very little repair, and the prime cost of it is moderate.—W. A. C.

[33729.]—Naviget Anticyram.—I never like to answer a question unless I can do so completely, and want of time has prevented my sending this until now. I was in hopes when I saw the current number of the English Mechanic that my trouble and postage stamp would have been saved; but not one of the three answers is "good enough" for the readers of "ours." Therefore, I will try and let in a little more light. "Naviget Anticyram" is a taunt frequently used in argument by some classic Latinists to an opponent, the English equivalent being "Go to Bedlam and get your head shaved." It is far worse than either "Go to Bath," or "Go to Putney," and it arose in this way. There were, as has been stated, two Anticyras, both celebrated for the growth of hellebore, but one much more than the other. This plant, hellebore (ἐλλέβορος), is divided into several kinds, but more distinctly into two. That known as the "Black Hellebore" is the most remarkable, being an acrid poison of a most dangerous character. It grows in broken mountainous ground in Greece and the Levant, and is now called *scarphe*. The ancient Greek physicians used it as a cure for mania, epilepsy, and dropsy; and it was also a great favourite with the secret poisoners in the days when analysing the contents of stomachs was not so well understood as at present. Some think that it is the same agent as that which made a ghost of Hamlet's father:—

> "Sleeping within mine orchard,
> My custom always in the afternoon,
> Upon my secure hour thy uncle stole,
> With juice of cursed hebenon, in a phial,
> And in the porches of mine ears did pour
> The leperous distilment; whose effect
> Holds such an enmity with blood of man
> That, swift as quicksilver, it courses through
> The natural gates and alleys of the body;
> And, with a sudden vigour, it doth posset
> And curd, like aigre droppings into milk,
> The thin and wholesome blood."

The Anticyra of the proverb was situated at the mouth of the river Sperchius, not far from the defiles of the classic Thermopylæ, where the immortal Leonidas and his three hundred heroes nobly died in defending the passage against Xerxes and his enormous army, in B.C. 480. This is the Anticyra where the genuine hellebore was said to be grown. And now about the proverb, "Naviget Anticyram," as recommended to people who were going mad. It is first met with in the second book of Horace's "Satires." This satire is the report of a conversation between Horace and one Damasippus. The latter worthy had been in his day a "merchant-prince" in the shipowning interest; but, not content with being rich, he tried to be richer. Like many hundreds of his greedy kind he fell in with sharp "promoters"—for there were such beings even in those remote days—and lost his all. Damasippus then became a Stoic philosopher and a disciple of Zeno. In this system of ethics virtue and temperance were looked upon as the sole bases of the happiness of man. It will now be understood why the poet and the philosopher should have a conversation that was thought by the former worth reporting. A conversation they accordingly had; and Damasippus proved the paradox of the Stoic philosophy that most men are actually mad!

> "Insanit veteres statuas Damasippus emendo:
> Integer est mentis Damasippi creditor?"

"Damasippus is a madman for buying all these statues; but is Damasippus a creditor to his senses?" Again:

> "Danda est hellebori multo pars maxima avaris:
> Nescio an Anticyram ratio illis destinat omnem."

"By far the largest portion of hellebore is to be given to the covetous. I know not whether reason does consign all Anticyra for their use." The denunciation of greed is one of the objects of the "Satire," which is a very lengthy one, containing no fewer than three hundred and twenty-five Latin verses or lines, as we would call them in English. The covetous man is put down both as a fool and a madman. He is called a patient, and the physician is dealing with him, and it is there where the text of the proverb is first found. Even a man who is not covetous is not immediately to be deemed sound. He may want to get out of bed, but Craterus, the doctor, will not let him, because disease exists within him.

> "Non est perjurus, neque sordidus; immolet æquis
> Hic porcum Laribus: verum ambitiosus et audax,
> Naviget Anticyram. Quid enim differt, barathrono
> Dones quicquid habes, an nunquam utare paratis?"

"Such a man is not perjured, nor sordid; let him sacrifice a porker to his propitious household gods; but he is ambitious and daring. Let him make a voyage to Anticyra. For what is the difference whether you squander whatever you have upon an abyss, or make no use of your property?" So much for "Naviget Anticyram." The household gods were the sons of the goddess of madness, whose animal in sacrifice was a pig.—Stylus.

[33754.]—Map of English Canals.—Before "Faber" adopts "Gimcrack's" recommendation, on p. 610, to make his way to the south coast, viâ Wey and Arun canal, he had better ascertain that it is still navigable. It was not so some time since, and I do not think that it is so now. There is, as far as I know, no inland navigation connecting either Portsmouth or Southampton with the Thames.—Remex.

[33757.]—Driving Lathe by Wind.—Impossible; if such a motive power could be obtained from the wind every lathe worker would be glad of it. Now, if you feel inclined to erect an anemometer with cups, about 12in. diameter, on arms 2ft. long, connected by an endless screw to a train of wheels, with a weight some 2cwt., then you may drive your lathe at any time, and at any speed. But the cost of plant to do this would be sufficient to purchase two or three steam engines and boilers.—W. J. Lancaster.

[33750.]—Leclanche Cells.—Take out the carbons and manganese, and well clean the carbons, then re-pack, and put new connecting wire or plate, and re-charge, when the cells will go right again. Don't waste them; they ought to wear until there is nothing hardly left.—W. J. Lancaster.

[33760.]—Dull Black Bronze on Opera Glass.—About the best bronze to stand without lacquering is the platinum bronze. Full directions how to use this bronze have been given over and over again. Nitrate of silver, strong solution, makes a good bronze when applied to the metal in a warm state.—W. J. Lancaster.

[33760.]—Dull Black Bronze on Opera Glasses.—I have got a good bronze by dipping repeatedly in sulphate of potash. Take 1 part of crude sulphur or stick brimstone by weight to 3 parts of American potash in powder, and well mix; put into an iron ladle, and place upon the fire, and well roast it, keeping it well stirred. It will become a reddish-grey coke-like substance. This is what the old chemists called liver of sulphur. Put ½lb. of this in one quart of boiling water, and when dissolved pour off and bottle for use. This you may use as it is, or take 1 part to 2 parts of boiled water. The articles must be well cleaned after pickling, and dipped in and hung up until the desired colour is got, then well brushed, and lacquered with thin lacquer.—Jack of All Trades.

[33765.]—Photographing Instruments.—To Mr. Lancaster.—From the fact that such work as you wish to do is done every day it would be a pity for you not to continue your efforts. In the first place the ¼ plate lens is useless for the purpose; you cannot get any depth of focus with it, and although you may make shift with it by using a centre lens and a small diaphragm, still it will be preferable to at once obtain a good triplet. One of Ross's may be obtained second-hand, and with this and a bellows camera you can copy from a large or small object, in all cases obtaining well-defined lines from front to back. The exposure is rather long, but the results are perfect.—W. J. Lancaster.

[33766.]—Spectacles.—Spectacles of the kind you mention have never become a trade article, neither are they likely to, the objection to their use being far greater than the points in their favour. I have made spectacles with a mirror in one eye to see sideways, but have never made them like De la Court's.—W. J. Lancaster.

[33768.]—Chemistry.—Specific Gravity.—I suppose you know what is meant by the molecule of a gas occupying two volumes. If then you divide the molecular weight of the gas by the number of volumes it occupies, you get the sp. gr. referred to hydrogen. Divide this by 14·4, and you have the sp. gr. referred to air. Your own formula gives the same result. All chemical works show you the sp. gr. of a gas when H = 1, and by dividing by 14·4 you get the sp. gr. when air = 1.—Ploni Almoni.

[33768.]—Chemistry—Specific Gravity.—To J. H. Rowney.—You are right—and yet not right, as I will explain. It is quite correct to say that $\frac{l}{14{\cdot}47}$ = s.g., but you must, of course, understand that l = weight in criths of given gas *per litre*—and this you omit to state. To prove the result, reason as follows:—∴ 1 litre of hydrogen = 1 crith; ∴ 1 litre of air = (1 × 14·47) = 14·47 criths. Now, the known s.g. of oxygen (by actual experiment) = 1·10563; then, by adopting your proposed method, we get this result:—∴ 1 litre of air = 14·47 criths, and ∴ 1 litre of oxygen = 16 criths; ∴ $\frac{16}{14{\cdot}47}$ $\left(= \frac{l}{14{\cdot}47}\right)$ = 1·10573 (the s.g. of oxygen), and this accords closely with the known s.g. of that gas. You should, however, assume that "1 litre of air = 14·47," in lieu of "14·4 criths." We always compare *equal bulks* in the determination of specific gravities.—Douglas Scoffern, St. John's Wood.

[33768.]—Chemistry—Specific Gravity.—The method is correct, but it is much better to multiply weight of hydrogen by weight of gas—thus, 1 litre of hydrogen = 1 crith, and 1 crith = 0·0896 grammes. Hence, the weight of litre of oxygen may be found by multiplying the weight of 1 litre of H. by 16, for the atomic weight of O. is 16, therefore 1 litre of O. = 16 × 0·0896, or 1·4336 grammes. The same rule holds good with the other gases.—W. J. Lancaster.

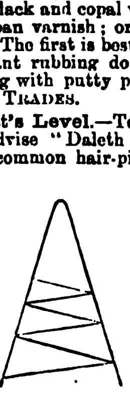
[33769.]—Sore Skin from Shaving.—What soap do you use? Get a tablet of white curd and scrape it, or cut it up into very fine shavings, and rub it up with just enough water to wet it. Now take ¼oz. honey and a tablespoonful of best olive oil, and well mix, letting it stand a day or two, stirring it now and then. Take some of this, and press into your box for shaving, and I think you will find that you will get over your unpleasantness, and say for once you have had a pleasant shave. You can perfume this with camphor, roses, lavender, lemon, bergamot, or anything you like.—Jack of All Trades.

[33771.]—Black Dye for Leather.—This will depend a great deal upon what tannage, which leather, &c. Some use first, a weak wash of soda, some potash, followed up by one of urine. In chamois and buckskin a decoction of elder bark is used, but not for ordinary leathers; after with gall and copperas or sulphate of iron or acetate of iron, and sometimes logwood. The latter I have found best made of good clean urine ½lb. good gall (well-broken), ¼lb. logwood, 3oz. sulphate of iron, will make about 2 gallons. This is for all grain goods, but for kips, calf's, &c., size and lampblack.—Jack of All Trades.

[33771.]—Black Dye for Leather.—Take half a gallon of vinegar, ½lb. of dry lampblack, and 3lb. of iron rust, sifted. Mix, and let stand for a week. Lay three coats of this on hot, and then rub with linseed oil, and you will have a fine deep black.—F. C. Hawks.

[33772.]—Letters on Tombstone.—You can paint it with black sealing-wax dissolved in spirits of wine; or ivory black and copal varnish; or ivory black and black japan varnish; or ivory black and Brunswick black. The first is best for marble. To polish it, it will want rubbing down with York or Dover, and polishing with putty powder or oxide of tin.—Jack of All Trades.

[33773.]—Gravatt's Level.—To restore "spider lines" I should advise "Daleth" to proceed as follows:—Take a common hair-pin, bend it until the ends are about 1½in. apart, then select a clean and fine spider's web; fasten the web to the pin, and wind openly around (as in sketch), slightly stretching the web at the same time; then pass it freely



through clean water to remove dust, and examine it with the eyepiece of level to see that it is perfectly clean and free from blotches. Over the cuts for the reception of the web place some glutinous substance, then hold the hair-pin containing the spider's web across these marks, and press the web into them. After having made good the three lines, carefully adjust your level for collimation by the ordinary system.—W. W. E.

[33773.]—**Gravatt's Level.**—If "Daleth" will take out the eyepiece of his level he will see four scratches on the sides of the tube, to which he must fit the hairs exactly, and he will find the adjustment to be correct.—Adye Douglas.

[33777.]—**Ball Taps.**—The only thing contained in the ball of an ordinary ball-cock is air, and the spitting which "Ignoramus" notices is most likely the effect of the heat acting on the flux used in making the joint.—Adye Douglas.

[33777.]—**Ball-Tap.**—The spitting and spluttering which troubles "Ignoramus" is the expansion of air upon the application of heat—*i.e.*, the copper bit.—Jack of All Trades.

[33779.]—**Miniature Coil.**—Don't use a condenser with the coil—it will render the coil rather a dangerous weapon. As cells nothing will beat the chloride of silver cells; you should have a couple of them in ebonite cases, and have them in a small box, so that the coil may be carried with them in a small compass.—W. J. Lancaster.

[33788.]—**Level Tubes.**—You cannot mend the tube; it will save much trouble and annoyance to get a new one, and fit into the frame. The ordinary tubes are drawn at the end to a long thin piece, then the spirit put in, and the bottom of the tube fused, the spirits will not take fire then.—W. J. Lancaster.

[33790.]—**Wooden v. Iron Teeth in Cog-Wheels.**—The advantage is that they last longer, and so pay first cost, which is greater than that of iron teeth.—Ploni Almoni.

[33790.]—**Wooden v. Iron Teeth in Cog-wheels.**—Some of the advantages of cog-wheels are, that when the wood cogs wear down they can be replaced again, and the wheel will be as good as new, and they make scarcely any noise when in motion. They should be used for quick motions only, and geared into metal-teethed pinions. Iron teeth have the advantage of wooden ones in slow motion, but should not be used for quick motions, as the teeth would soon wear out, and the wheel become useless. —W. M.

[33793.]—**Explanation Wanted.**—Friction produces heat, and just as when two stones are struck together, so does the action of the grinding stone upon the piece of Arkansas, or, in fact, upon any hard mineral, produce a line of light. To give a pretty effect grind a piece of transparent rock crystal.—W. J. Lancaster.

[33800.]—**Pure White Flexible Hard Enamel.**—You had better obtain some white enamel varnish, but I know only one house where you can get it pale enough. I don't mean French oil, but a much paler article. Mix your flake white with some of this, and some paper varnish. Try various proportions till you obtain the nearest approach to what you require. Don't try what you suggest; you won't succeed. This matter troubles the brains of many varnish makers. The most likely thing I know of to scent with is oil of lavender, but it is very expensive.—Dandie Dinmont.

[33801.]—**Electrical.**—As no doubt you have found, a momentary deflection takes place when the pieces of wire are dipped into any acidulated solution, one of them being more deeply immersed than the other, but no deflection when both are put in level, this seems to me to be produced in the following manner:—The two copper terminals are in a static condition electrically before being plunged into liquid, but the moment one enters the liquid a current is set up which would travel through to other wire when the circuit was closed, thus causing deflection, say, to right. But the same thing takes place whichever wire be placed in first, so that by alternately immersing (*a*) and (*b*) the current will deflect the needle right and left. The deflection, however, is only a momentary one, and the terminals seem to resume at once their static condition. —W. J. Lancaster.

[33804.]—**Society's Thread.**—The thread is 14 to the inch, and the outside diameter of top of thread 1¼in. If you get a piece of tube 1¼in. inside diameter, and cut a thread with 14 screw tool until the thread just goes into tube, you will have it as nearly correct as possible without having a gauge.—W. J. Lancaster.

[33805.]—**Nicol Prism in Field Glass.**—The prisms work fairly well, except when the water is rough. On smooth water the effect is very fine. The surface of the sea being usually in ripples prevents the use of the Nicol's with any gain.—W. J. Lancaster.

[33810.]—**Electric Pen.**—This instrument acts by making small holes in dry paper. An ink a little thinner than ordinary printing ink is used, and a rather hard gelatine roller. The article is not satisfactory; it only gives a skeleton of the writing. Such things as the crotchets of music it cannot touch, besides the trouble of the tottering, &c. — A. *Pumphrey.*

[33811.]—**Charging and Drawing Gas Retorts.**—There are several methods of drawing and charging retorts by machinery, but none of them are suitable for small works; they require power to drive them, and take up a large space in front of the benches for working. A description would take up more space than our good-natured Editor can spare; but if you refer to King's "Treatise on the Manufacture and Distribution of Coal Gas" you will find drawings and description of every machine that has made its appearance. There is no substance, that I know of, for destroying the carbon in gas retorts. It can be prevented in a great measure from forming by using an exhauster to relieve the retorts of internal pressure. If your works are small, and an exhauster cannot be used economically, you can reduce the pressure in your retorts by reducing the dips in the hydraulic main, washer, and wherever dips exist, charging purifiers lightly, and weighting gasholder to give only sufficient pressure to supply your district. There are a great many methods in existence for removing the carbon, but a good one for a small works, where single retorts are used, is as follows:—Introduce a 3in. pipe into the retort of sufficient length to reach within a few inches of the back end, and to project a few inches beyond the mouthpiece. A lid is cut at the bottom with a hole to fit the pipe, then luted, and screwed up to the mouthpiece in the usual manner. The cap on the top of the ascension pipe is then removed, and a current of air will be established through the pipe, striking the carbon in its passage through the retort, and escapes by the ascension pipe, which acts as a chimney. After a few hours the carbon will be burnt away, or so loosened by contraction as to be easily removed by the usual scurfing bar.—J. R. Warren.

[33812.]—**Manufacture of Sulphuric Acid.**—I am sorry that my knowledge of the construction of a Glover tower is not of any practical moment; in fact, I feel that I cannot recommend you to adopt the course you suggest, but no doubt there are some of our readers practically engaged in the manufacture of sulphuric acid from copper pyrites who will be pleased to give you the information you require. —W. J. Lancaster.

[33814.]—**Steel Stoves.**—"Housewife" will find either of the following recipes a good one for keeping the fender bright:—1. After it has been thoroughly cleaned dust it over well with unslacked lime, and leave it till wanted. 2. Dissolve ¼oz. camphor in 1lb. of hog's lard, take off the scum, and mix as much blacklead as will give the mixture an iron colour. Rub over with this mixture, and leave on for 24 hours, then dry with a linen cloth, and it will keep clean for months. 3. Warm the fender, and then rub it over with paraffin oil, which will form, when dry, a coating on it.—Adye Douglas.

[33814.]—**Steel Stoves.**—1. Dissolve ¼oz. of camphor in 1lb. of hog's lard; take off the scum, and mix with as much black lead as will give the mixture an iron colour. Iron and steel goods rubbed over with this mixture and left with it on 24 hours, and then dried with a linen cloth, will keep clean for months. Or, 2, after having brightened them, dust over with unslacked lime, and leave till wanted.—F. C. Hawks.

[33820.]—**Damp Inner Walls.**—"Mechanical Stoker" recommends "laminated lead." How is it applied to the wall?—T. P. W.

[33822.]—**Black Dyeing.**—Impregnate the material with acetate of iron mordant, and then boil in a decoction of madder and logwood. I have never tried this recipe, but perhaps, if no one else can give a better, it will do, without injuring the tissue.—F. C. Hawks.

[33823.]—**Bird Catching.**—The idea is absurd, cruel, and vicious. Why not shoot them at once instead of getting some 200 to 300 cells, and spending a lot of money in laying duplicate wires, &c.? Why not get a boy with clappers to drive the birds away? Build such a tree in the best possible manner (electrically), you would not kill one bird out of 500. They would never be in the position you would want them for the discharge to pass through them.—W. J. Lancaster.

[33823.]—**Bird Catching.**—If "Cinocephalus" will forward his address to the Society for the Prevention of Cruelty to Animals, or to the local official whose duty it is to carry out the Small Birds Preservation Act, he will obtain valuable information, or it might suit his turn of mind to bide outside the ring whilst "gentlemen" are pigeon-shooting; or a small "pour boire" might give him an hour's recreation in the yard of a wholesale poulterer. Our friends the Italians are great adepts in the capture and cooking of small birds. A visit to Italy would help "Cinocephalus." He says: "But I want instruction." That is quite plain. Let him seek it in the pages of Gilbert White, Wood, Johns, Darwin. He may be taught in those pages to preserve not to kill small birds.—N. Sirch.

[33829.]—**May Examination.**—I found the following salts:—Bases: bismuth, copper, magnesium, potassium, and sodium. Acids: phosphoric, sulphuric, hydrochloric, chloric (and trace silica and bismuth). I am acquainted with another "First Honours," and his salts were quite different to mine. —First Honours.

[33830.]—**Black Stains on Silver Articles.**—Stains may be eradicated by making a little chloride of lime into a paste with water, and rubbing it upon the stains. Great care, however, should be taken, as it is very likely that it will slightly injure the metallic surface.—F. C. Hawks.

[33834.]—**Bucket Lift.**—In all probability the capstan chain was not of sufficient strength for the weight required to be lifted. So long as the rods and bucket remained immersed in the water the strain would not be perceived, and the chain would remain intact. When they were withdrawn there would be nothing but the chain to receive the additional weight thrown upon it, and as a consequence of its incapacity to sustain the weight the chain would break.—T. E. J.

[33835.]—**Sizes of Books.**—No exact measurement can be given of sizes of books when bound, owing to the trimming in binding, &c.; but, generally speaking, a 12mo. may be distinguished from an 8vo. by being longer in proportion to width, and a 4to. is mostly wider in proportion to length than an 8vo., as well as being much larger. However, a good plan would be to take a sheet of paper—newspaper if nothing else can be got—and cut to sizes given below, and then fold into 8vo. (8 leaves, or 16 pages). Mark on each the size and name of sheet —as royal 8vo., &c.—and then they can be kept at hand for reference, always remembering to allow a little for trimming. Quarto is, of course, twice the size of 8vo.; so you have only to open one fold of your paper and there you have it. But if you wish for one specially for 12mo. take another sheet and fold into 12 leaves, or 24 pages—into three the long way of the paper and four the narrow way. The sizes of printing sheets commonly in use are: royal, 25in. by 20in.; demy, 22½in. by 17¾in.; crown, 20in. by 15in.; post, 18¾in. by 15¼in.: foolscap, 16½in. by 13¼in. The size of sheet which a work has been printed on is mostly stated—as cro. 8vo. (crown), fcp. 4to. (foolscap), &c.—though in practice sheets double the size are mostly used. A person used to books or printing soon gets accustomed to the various sizes.—C. Lark.

[33835.]—**Sizes of Books.**—The size of a book cannot be told from its apparent size; but, to show how you may tell, I take the first book that comes to hand—Sprague's "Electricity"—and at foot of p. 1 is letter B. This is called the signature. On p. 17 occurs the letter C. This shows that pp. 1 to 16 inclusive form one sheet, and as there are 8 leaves, or 16 pages, we call it 8vo. (octavo). The pages of this book are 7¼in. by 4¾in., but three other octavo volumes which I have at hand are 8¾in. by 5½in., 6¾in. by 4¼in., and 5¾in. by 4in.; so that there is no guide in the size. Another book nearly the same size as one of these, and larger than the smallest, has C and D on pp. 24 and 49; this is a 12mo. The English Mechanic is a 16mo., if the term be applicable to newspapers. You will see that the size depends on the size of the paper before folding and binding.—Ploni Almoni.

[33836.]—**Painting Greenhouse.**—Zinc white is the best if you use the improved kind manufactured by the Liverpool Silicate Paint Co., and is, or has been, advertised in these pages. Ordinary zinc white is dearer, and less satisfactory than white lead; but this new kind is cheap, and gives a splendid colour. My attention was drawn to it at Dublin, during the recent meeting of the B. A., when a paper was read on its manufacture, &c.—Peg.

[33836.]—**Painting Greenhouse.**—If you want a good job use white-lead with oil by all means.—Lathey.

[33837.]—**Absorbing the Heat Rays.**—Nothing will be better for you than a pair of spectacles with plain glasses in. The glass need not be thick. You will be able to bear the heat with your eyes then quite as long as your face will bear it. A solution of alum in a glass case would obscure more heat, but the difficulties are too many to admit of its use in your case.—W. J. Lancaster.

[33837.]—**Absorbing Heat Rays.**—You need no solution: a sheet of window glass fitted loosely in a frame like a slate, and with a handle, will enable you to examine the most intense fire for some time. I have often used it to look into gas retorts and blast furnaces.—Sigma.

[33842.]—**Fastening Brass Union into Solid Lead Cistern**—Should not be attempted if the acid is to run through it or touch it. Use lead piping, burn it thoroughly in, and if you want stopcocks use antimony ones, or you will have no end of bother.—Ploni Almoni.

[33846.]—**Cutting Ferrotype Plate.**—"Vercingetorix" will have but little difficulty in cutting the above without "buckling" if he has a lathe. To fix a disc without any holes through it in the lathe, so that the edge can be turned, is a job beyond the scope of the ordinary methods of chucking metal work, and may naturally present a little difficulty to a novice. There are several ways of cementing, soldering, and such like, with their special advantages for individual cases, but I think the following a simple, expeditious, and general method of cutting and turning the edges of discs:—Turn a wooden chuck with a true flat face, next prepare a wooden disc turned flat or slightly hollow on one side (this must be a trifle smaller than the required metal one), now place the ferrotype plate between this chuck and the smaller wooden disc. To the right of this place a piece of brass (a penny will do), now fix the loose head and screw the steel centre against the brass plate, when the ferrotype will be pinched firmly between the two wooden surfaces, and as the lathe turns the friction sufficient to revolve all three loose pieces as if rts of one chuck, turning on the metal bearing ainst point of right-hand centre, where the friction least, which of course must be oiled. Should the ght centre of lathe not be coincident with the axis revolution this may be in some measure compen-ted for by bringing the centre to project well out om the loose head, so as in some degree to spring it, or in a still further degree by fixing a lathe ntre in the end of a short length of gas-barrel, and ing this as a connecting piece, to communicate the essure from the right centre. Now by taking a ght cut upon face of ferrotype with the point of a raver you may cut through the plate, removing the ur corners with narrow connecting strips in one ece, and then turn the edge of the disc square to ce, and to size before uncramping it. It is evident is method in no way strains or distorts the plane the original plate like shearing would. I have und the friction ample for cutting thicker metal an ferrotype. Use the point of the graver, and do ot hold it too rigid.—A. E. Dancaster.

[33846.]—**Extemporising.**—This art is not to be arnt from books; it requires three fundamentals -viz., a thorough knowledge of harmony and ounter-point, the gift of melody, and executive bility; and without the second the others will not e of much avail. You may, however, find Warren's 'Hints to Young Organists" useful (Cocks and o.).—Ne Sutor.

[33849.]—**Mining Question.**—If, as I understand ou, it is your intention to produce ventilation by neans of the steam jet, the bottom of the shaft is he best place for the steam to issue from the pipes, s a greater amount of ventilation would be thereby ained, than if the steam issued at any other part in he shaft. To protect the pipes from the action of he water in the shaft nothing is better than several oatings of good thick tar, which, on drying, becomes lmost impervious. As the effective power of the et depends on the velocity of the steam at point of ssue the smaller this point is, and the greater num-er there are of them, the better.—T. E. J.

[33852.]—**Centrifugal Pump.**—Of course the tatement quoted is a mistake. It is extraordinary hat it should be found in the work named; but it nust surely have been derived from some process of ompilation. It can scarcely have been the product f the author.—Sigma.

[33853.]—**Horse-shoe Electro-magnet.**—The second method of coiling the wire is the best. In the first method a good deal of the wire is of no use. Care should be taken not to coil too much wire on both reels, because, after a certain number of coatings of wire, the outside, or last ones, have nearly no action on the soft iron, this being at too considerable a distance.—Belgian.

[33853.]—**Horse-shoe Electro-magnet.**—Could not you have tried the experiment? It would only be a few minutes' job. You will find that the magnet will lift most when the wire is concentrated at the ends; but don't wind too many layers on, or the outer ones will have little power. Slip each leg into a piece of wrought-iron tube, and the power will be increased, as the outer coils will then induce magnetism in the tube. For power a Joule's magnet is very good, wound evenly all along. To your other question I can only say: Try.—Ploni Almoni.

[33854.]—**Magnetism.**—Faraday showed that when the magnetic lines of force were passed through or cut by a moving wire a current was induced in the wire. It may be assumed that the telephonic currents are due to the motion of the lines of force across the coil, caused by the vibration (molecular or otherwise) of the diaphragm. As this vibration will cause little or no alteration in the direction of the force at the distant end of the magnet we may conclude that little or no current would result in a coil on that end. It would, however, be very interesting to try the effect of a coil on the distant end, and the transmission of sound by such an arrangement would tend to disprove the assumption that the currents are due to the vibratory motion of lines of magnetic force. The experiment could easily be made on a telephone, the magnet of which was not inclosed in a case. Perhaps some reader who has such an instrument would try it, and report results.—J. Brown, Belfast.

[33855.]—**Thermo-Electric Generator (Clamond's Patent).**—Two of the above were exhibited by the Thermo-Electric Generator Company, in the Loan Collection of Scientific Apparatus at South Kensington in 1876, Nos. 1,294 and 1,301*a*, where there is a long description. It was stated that they were constructed either for electrotyping, plating, gilding, or telegraphy, and that a pile of 100 bars burning 4ft. of gas per hour would deposit an ounce of copper per hour. I was so struck with the account given that I took some trouble to find the company. The address stated was 27, New-street, Cloth Fair, but the company had left, and I vainly tried to find its whereabouts, although kindly assisted by the secretary of the Exhibition. If any other reader has been more fortunate perhaps he will let us know, as the advantages of so neat and handy a producer of electricity are obvious. Meanwhile, when next at South Kensington I will make further inquiries. If the exhibits were not claimed by the exhibitors no doubt they are still at South Kensington. The current obtained is said to be constant and free from polarisation or exhaustion.—R. P. G.

[33857.]—**Skeleton Ferns.**—A tablespoonful of chloride of lime in a liquid state, mixed with a quart of pure spring water. Soak in this for 4 hours, then dry by exposure to light and air. Some will require longer.—F. C. Hawks.

[33857.]—**Skeleton Ferns.**—I think that "Adiantum" will have some difficulty in skeletonising fern fronds, as they generally have such thin veins. Leaves need more care with the chloride of lime process than with the rain-water process. A weak solution of chloride of lime is made, and the leaves are placed in it. If they have stout veins they may be left untouched for about three weeks or a month, and then they must be looked over almost every day. Some leaves take more than a year, while others take only a month or two; but the length of time to leave each leaf in the process has to be learned by experience. The leaves must be taken out when they begin to feel soft, and the epidermis or skin taken off while they are under water with a small brush. When the skeleton has been obtained it must be washed and plunged into a weak solution (about two-pennyworth to a wine-bottleful of water) of chloride of lime, and taken out as soon as they become bleached, or the skeleton will be destroyed. They must then be dried and curled *ad libitum.*—Arthur S. Woodward, Macclesfield.

[33858.]—**Lowering Tone of Bell.**—Affix a lump of beeswax to the outside rim. The larger the lump the deeper the tone.—F. C. Hawks.

[33858.]—**Lowering Tone of Bell.**—Grind or file away at centre of bell for flattening, and at the edges for sharpening.—Cymro.

[33858.]—**Screw Propulsion.**—No. The number of revolutions would be proportionate to the pitch of screw, the size of the ship and her shape, width, depth, &c. If it was a large vessel 100 tons would be a small weight; consequently the propeller would probably be partly out of the water, thereby losing a part of its propelling power by uselessly beating against the air. Again, if it was a small vessel 200 tons would sink it so deeply that, although it would bury the screw well, the extra amount of pushing the vessel would require, because of being so much more in the water, would counteract the extra power got by submerging the screw so deeply. A vessel will go fastest when the screw is just properly submerged when turning, and trimmed a little by the stern.—Ram Chand Biswas.

[33859.]—**Tuning Forks.**—There are A and C tuning forks. They all profess to be "concert pitch," but vary from 509 to 512 or more vibrations in a second for the "C" fork. There are the "Philharmonic," "Exeter Hall," and "Opera House's" concert pitch, besides a proposed standard issued by the Society of Arts, though not generally adopted.—Gimcrack.

[33859.]—**Tuning Forks.**—There is as much as a half-tone difference between tuning forks—that is, common-made ones. A reliable firm would supply the correct pitch, which should be, for concert C, 260 vibrations.—Cymro.

[33859.]—**Tuning Forks.**—No; they are of various pitches. The English concert pitch and highest philharmonic pitch are equally acute, and both differ from the Parisian normal pitch and lowest Philharmonic pitch by nearly a semitone. The Society of Arts' pitch is a trifle under concert pitch, and is therefore, I think, equal to the French concert pitch, that being slightly under ours.—A. Palmer.

[33859.]—**Tuning Forks.**—The C tuning-forks sold are not all of the same pitch, there being at least two kinds. One kind gives 528 vibrations to the second, the so-called concert-pitch, though I very much doubt whether this is not considerably below the pitch of many instruments nowadays, while a tendency to sharpen is still manifested by instrument-makers, much to the injury and annoyance of vocalists. The other kind gives 512 vibrations, which is the number settled upon some years ago for use in vocal classes, and is, I believe, the one generally in use in old notation and sol-fa evening classes at the present time.—C. Lark.

[33863.]—**Apparent Divergence of Sun's Rays.**—"L." has evidently not made an allowance for perspective. If he will take paper and pencil, and draw it out accurately, he will find that, because of the very appreciable width of the sun's disc, the bands in themselves grow wider, but do not diverge from one another. On the contrary, they approach, and the dark space between is narrowed, though their axes remain sensibly parallel. To convince himself of the wonderful effect of perspective on some peculiarly favourable and misty days, he may be able to see that the bands appear to converge again, forming another sunset in the opposite direction.—Accinctus.

[33865.]—**Rowing.**—In sea rowing the rowlocks and oars are rounded, while in river rowing they are square, which makes it more difficult to feather, therefore sea rowers generally do not feather at all, or only half. Sea oars and sculls are generally heavier than those used on rivers, which makes it more difficult to feather. These are the reasons why I find make it more difficult to feather on sea than on river.—Wildfire.

[33865.]—**Rowing.**—"Citrus" makes a mistake in saying the blades of the oars are held vertically in river rowing. One of the first things a novice learns is to turn over his oar well. The reason of this is to prevent the oar sinking in the water during the stroke. If "Citrus" was ever in direct line with a first-class "eight" or "four" he would see the boat rise perceptibly in the water at each stroke. This is caused by all the oars being turned over. This is also the reason why there is always a lashing on the outrigger over the oar. I belonged for some years to a university boat club, and have been coached by a professional trainer, so can speak from experience.—W. A. R.

[33865.]—**Rowing.**—When rowing at sea the oarsman has to contend, as a rule, with rough water, to sit in a boat, the sides of which are much higher out of the water than those of a river-built boat, and to use an ash oar much shorter and heavier than the light, slender, and broad-bladed spruce fir oars used on the river. This combination requires that in making the forward stroke the hands be raised as high as the head, and the pull is rather in a downward direction, so that to bring the blade of the oar perpendicular to the direction of the pull, it has to be slanted forward a little, and an additional slant is often given to insure the keeping of the blade below the surface of the water as well as to cause it to rise to the surface immediately on the commencement of the back stroke. On the back stroke the blade is kept on the slant instead of being feathered horizontally, so that if it should be struck by the crest of a wave it should be thrown up clear of the water. If held horizontally it would be buried in the water and might greatly embarrass the rower. Sometimes the sea is as smooth as glass, and the river may be as rough as a miniature sea. In this latter case, the expert oarsman instinctively shortens his stroke, feathers high, and plunges his oar well into the water. The novice, either by pulling a stroke in the air or allowing the back stroke to meet a lumpy bit of water, loses his balance and perhaps his seat and finds himself with his back in the bottom of the boat and his heels in the air. This is vulgarly called "catching a crab." Light racing gigs, used at sea in smooth water, will, if the crew is well trained, adopt the essentials of the style of river rowing; but seafaring men, from the habit of watching the blade of their oar, can never be got to "keep their eyes in the boat," nor can they get over the twisting and rolling of the back and shoulders acquired from the usual necessity of balancing themselves on a seat so movable as the thwart of a boat that rolls and plunges in the sea. To discuss, however, all the varieties of rowing produced by and suited to the varied circumstances under which boats are propelled would require a treatise rather than a paragraph.—Gimcrack.

[33865.]—**Rowing.**—I offer the following as a suggestion by way of explanation, but the habit is, in my opinion, a lazy and bad one, as if the rowers on one side do it more than the others, the boat gives an uneasy lurch at every stroke, resulting in a waste of energy and loss of speed. Boats intended for the sea are generally higher in the side than river-boats; therefore the loom of the oar is high, and if so high that the direction of pull exerted by the oarsman would tend to lift the blade out of the water, it is more comfortable for him to turn it so that the vertical component of the pressure of the water on the blade is sufficient to counteract this tendency.—J. Brown, Belfast.

[33869.]—**Trespassers.**—Why should the farmer have a better remedy than a man who is assaulted or has his pocket picked? Of course he is at liberty to follow the offender in each case, or to proceed against him if he can discover him in any way and prove the wrong done.—Sigma.

[33879.]—**Photographic.**—The albumen coating may not be considered as so expensive. Take the white of one egg—fresh, and of reasonable size—and add some ounces of water. Shake well till you see that the albumen has well mixed with the water, then add more water, shake again, and so on, till you have a volume of 25 to 30oz. of liquid. Filter then in a funnel, in the bottom of which you have placed a little bit of sponge, well washed in hot water. The solution will filter very clean. A few drops of carbolic acid, say 10, will preserve it from decomposition, and some drops of liq. ammoniæ will secure limpidity. Your plates are supposed to have been soaked in diluted common nitric acid. You take them out of this liquid, and wash them thoroughly under a tap of water. You may rub them with your hands, or, better, with a sponge specially reserved for this purpose. One plate being washed well do not allow it to dry, but pour on it a little of the albumen solution out of a glass, as if you coated with collodion, let it flow over the plate, chasing the water which remained on it; throw all the liquid away after a moment, and pour again a little quantity of solution on the plate. This time the excess should no more be lost, but poured into the filtering funnel, which remains, during all the operations, over the stock bottle. Allow the plate to dry free from dust, and wipe the back well. You can prepare in this manner some dozens of plates in a short time without any hard work. When they are all dried, rub their backs carefully, and even finish with chamois leather to get them thoroughly clean. This will allow you to pack them per doz. without trouble, the coating of one against the back of the following. With one egg you can manage to prepare lots of plates. ½oz. carbolic acid costs about 3d., and will last you some years. There is a saving in spirits, rotten-stone, rubbing materials, and also—elbow grease. On the other hand these plates are always ready for use without previous re-polish. All they require before being coated with collodion is to be dusted with a camel's-hair brush. Caution.—So much as possible the collodion should entirely cover the albumen film, not leaving the corners uncovered, because the albumen is attacked by the nitrate of silver; this causes fogging of the bath when a great number of plates are excited in a short time. A simple edging of the above solution (only 15, or even 10 oz. of water, instead of 30), ¼in. wide, will perhaps answer your purpose, but not so well as an entire coating; but in this case the plate requires to be cleaned and polished in the usual way.—BELGIAN.

[33870.]—**Photographic.**—Do not make your silver bath too "acid," and allow the coated plate to dry rather longer before putting it in the bath. Generally speaking, this will be found to remedy it; if not, write again. Some time back I tried using collodion with one drop of acetic acid to the ounce, and the bath made alkaline with Howard's bicarbonate of soda till there was a slight sediment. This greatly increased the rapidity, and worked well; but I should scarcely like to recommend its trial commercially, because failure in that case means loss as well as trouble. You might try it on an old bath, however, with a little collodion, and if (as I think it will) it answers, let us know.—FINEM RESPICE.

[33879.]—**Photographic.**—Rough the sharp edges of the glass by rubbing another piece of glass over them. No danger of collodion slipping after that.—CYMRO.

[33879.]—**Photographic.**—I have made many trials to find the best means of preventing collodion film from slipping off the glass during the final washing, and have discovered that French chalk, dusted over the glass plate, is the best and simplest remedy. Make a pad by pouring 2 or 3oz. of powdered French chalk into a piece of fine linen, and tying it up into the shape of a ball. By rubbing this gently over the face of the cleaned plate as much chalk will come through the linen as will impart the necessary substratum. Before coating the plate with collodion pass a camel's-hair brush over it to remove any superfluous chalk. The above process takes up little time, and is simple and effective. Doctoring the collodion generally injures the silver bath.—JOHN MCLAREN.

[33880.]—**L. and N. W. Engines.**—The 7ft. 6in. single that you saw was Phosphorus No. 61; John Ramsbottom, is a 6ft. 6in. coupled, No. 1,211. I have never seen an engine named John Hammerton, but there may be one for all that.—WILDFIRE.

[33880.]—**L. and N. W. Engines.**—Although "Tamerlane" has observed some slight difference among the Bloomer engines now, they were originally all similar, and the discrepancies merely arise from modern improvements having been added at different times and in different degrees as they have been rebuilt or repaired. But this circumstance cannot, in my opinion, be considered to take them out of their class. Helvellyn and President have been broken up, as, I think, I mentioned before; so also now has Medea, 623. The name of 61 is Phosphorus, and not Prosperous. John Ramsbottom is No. 1,211, and is like all those numbered 1,211 to 1,220. Pioneer class they are called, an improvement on 1,000 class. There is no John Hammerton.—ITZAEX.

[33880.]—**L. & N.-W. Engines.**—No. 61, 7ft. 6in. single, is Phosphorus. John Ramsbottom is one of Ramsbottom's 6ft. 6in. coupled engines, same as—*e.g.*, Abercrombie, 1,525; Tennyson, 1,747; Sedgwick, 379; which, perhaps, "Tamerlane" may know. About twelve months since I often travelled with J. Ramsbottom, running the 3 p.m. boat express, Holyhead to Crewe, but have not seen her lately; she is one, I think, of the 1,400's. "Tamerlane" may add Vimiera and Gladiator to the names he asked for lately with the L. and N.-W. arms over the driving wheel.—W. J. S.

[33881.]—**Bicycle Fork.**—I have for some months ridden a machine, of which both front and hind forks are formed by splitting hollow taper tubes up the centre, as described by "W. H. B." I bought it of the Surrey Machinist Company, who have patented the invention, and I believe also the tools used to bend the split fork into shape. I am not able to advise "W. H. B." as to what sort of tubing is best, or how to split it up, but can vouch for the strength, rigidity, and lightness of a bicycle constructed in this manner.—J. R.

[33883.]—**Liquid Ammonia direct from Gas Liquor.**—If you have 200 tons to dispose of, make it into sulphate, which will be easier to make and sell. If you have a gas works, and are producing the liquor constantly, fit up a still (an old boiler), and run in your liquor; heat (not boil), and pass the gas into sulphuric acid (B. O. V.), and the salt will crystallise out. I will gladly supply further information.—PLONI ALMONI.

[33886.]—**Removing Gilt Letters from Cloth.**—Try spirits of wine. If they are put on with glaire it is a difficult job. I have removed letters with the above.—JACK OF ALL TRADES.

[33887.]—**Magneto-Electric Bell.**—1. Any good soft iron will do. Put it into a fire, and let the fire go out before you take it out. 2 and 3. If you were not in India I should refer you to back numbers—*Messrs.* Tonkes and Sprague. Begin winding where *you like. When you cross over don't go straight* across, but in the form of the letter S. Then, if the magnet was straightened out, the wire would always run in one direction. 4. The armature to be attracted must be of soft iron, like the magnet. 5. The thinner the wire the more turns you can get; but, unless for long distances, it is not well to be too thin. 6. You may insulate each layer by paraffined paper, or by shellac varnish; but it is not necessary with well-covered wire.—PLONI ALMONI.

[33887.]—**Magneto-Electric Bell.**—1. Good soft iron will do very well, and if you have the slightest doubt concerning its softness after it is forged you can always redden it in a smith's forge, or in any other fire, and allow it afterwards to cool as slowly as possible. To heat the iron in an iron box containing sand is, I think, the method followed by manufacturers, but for your purpose I do not see the necessity of so much care. 2 and 3. It makes no difference. 4. It should be soft iron too. 5. A good way for making the bobbins is to take two small pieces of cardboard, roll them around the part of the iron which you want to cover, and paste the little tubes so made with strong glue. The two circular ends of the bobbins can easily be made with two round pieces of cigar boxes of a diameter of three times, or a little more, that of the iron bar. Bore or saw at the centre of these two discs a hole of the diameter of the iron. Having so treated the three pieces of a bobbin adjust them together on the soft iron, according to your taste. A fretwork saw should be of great value in all this work. The stuff of such bobbins will be as thin as you like. 6. I always used a solution of bitumen in turpentine (used by stovemakers for varnishing) for painting each coating of wire. A general painting with this substance will prevent the iron from rusting, and secure the dryness of the apparatus. I think your non-success must reside either in the weakness of your battery or in the false equilibrium of the trembling part of the bell.—BELGIAN.

[33890.]—**American 8-Day Striking Clock.**—Clock-cleaning is well dealt with in Vol. XIII., p. 142, in four replies to a query. Three brushes, a little Bath brick or very fine emery, rotten-stone rags, and a few bits of wood, some good sperm oil or clock oil, and you may clean all your own and your neighbours' clocks. But I am poaching on "Seconds'" preserves.—PLONI ALMONI.

[33891.]—**German Musical Publication.**—The *Monthly Musical Record*, price 2d., published by Augener and Co., Newgate-street, gives an exhaustive treatise on the works of German masters, and contains a special correspondent's report of musical doings at Vienna and Leipsic, and most of the reviews, which are lengthy, are on works by living German composers. If, however, you wish to read the papers in the German language, the abovementioned firm will doubtless furnish you with a list, and supply you with any you select.—NE SUTOR.

[33892.] — **Varnish for Rollers.** — "Roller Coverer" will find that he could have nothing better than the varnish sold by James Young, chemist, Bolton, for his purpose. It dries quickly, gives a good smooth surface, neither clogs nor cracks, is cheap, and having had it in use myself for a long time can speak with confidence as to its efficiency.—STEPHANTO.

[33894.]—**Real Night.**—By "horizon," in the "Astronomical Notes," the *astronomical*, and not the physical, horizon is meant. As, however, the latter, to the eye of a man 6ft. high, is only depressed 2′ 21″, the two may be considered identical. The least distance of the Sun below the horizon this year, at Greenwich, was on June 21, when he was depressed 15° 2′ 35″ beneath the N point of it at midnight.—THE WRITER OF THE ASTRONOMICAL NOTES.

[33895.]—**Cement.**—If "Excelsior" will dissolve a little isinglass with acetic acid, to the consistency he requires it, he will find it answer his purpose very well. I generally mix it to the consistency of hot glue, and make no more than what I require for the time being, as I find it is much better when new than it is after being kept, and getting hard, and then re-melted. Use as little as possible in making a piecing, and put it on the edges of the leather with a small piece of wood about the size of a match, or a little larger, and made taper at end like a wedge.—STEPHANTO.

[33895.]—**Cement.**—1lb. of guttapercha, 4oz. of indiarubber, 2oz. of pitch, 1oz. of shellac, 2oz. of oil, to be melted together, and applied hot.—F. C. HAWKS.

[33896.]—**Polishing Marble.**—Putty powder or oxide of tin upon a piece of old felt hat will do.—JACK OF ALL TRADES.

[33902.]—**Seeing the Bottom of the Sea.**—There is a very simple instrument for this purpose, called a "water telescope," much used by Swedish and Norwegian fishermen for recovering anchors, &c. Have a brass or tin tube made, conical in form—say, 3in. in diameter at one end, and 6in. or 8in. in diameter at the other end. At the larger end let there be a groove soldered all round, and in this groove fix with putty (mixed with a little red lead and gold size) a stout piece of clear plate glass. If the tube thus fitted be held over the side of a boat, the glass immersed a few inches below the surface of the sea, and the eye applied to the open end, the bottom of the sea can be distinctly seen, if the water be clear, at a depth of 20 or 30 fathoms. In the Mediterranean I have seen rocks and fishes and seaweed at a depth of 60 fathoms by means of this simple instrument.—VANDERDECKEN.

[33909.]—**Moderator Lamp.**—A detailed description of this and other lamps, as well as almost every article of domestic need, will be found in "Domestic Economy," by J. H. Walsh, which may, no doubt, be bought at any second-hand book-stall. To take the spring and piston out: Empty the lamp of all the oil possible, and turn it upside for a day or so. Wind up the piston just the same as if there was oil in the lamp; fasten the key by tying or otherwise, so as to keep the piston up. Get a soldering-bit or a blowpipe, and unsolder the bottom of the lamp cylinder (*i.e.*, the bottom of the bottle), untie your string on the key, and unwind your spring down, when piston and spring will come out of the bottle. Two screws will be found at the neck of the bottle, which fasten the burner and rackwork there. Take these out, and your lamp is all to pieces for cleaning. Try cleansing first by petroleum, if your desire is only to clean the lamp.—R. J. G.

[33919.]—**Size of Battery for Electro-Metallurgy.**—If the querist, "Common Sense," will exercise the quality he makes typical of himself, he will see that he needs a whole treatise to answer his questions. How often is it necessary to say that it is impossible to give cut-and-dried directions in a few lines as a substitute for knowledge to be gained only by proper acquaintance with a subject? Questions 1, 2, and 4 indicate that the querist has not the most preliminary knowledge of the subject, and question 3 is incapable of any answer at all, or else it is open to an indefinite series of answers, all correct. If "Common Sense" will read my treatise on the subject, "Electricity: Its Theory, Sources, and Applications," or any other, and then seek the explanation of any point or points as to which he experiences a difficulty, I shall, as always, be pleased to assist him; but I cannot boil down a science into a dozen lines, as Liebig professes to do with an ox.—SIGMA.

[33923.]—**Circular Cog Wheels.**—I have never seen eccentric cog-wheels running. I have seen heart wheels and oval wheels, and I do not see why the others should not.—JACK OF ALL TRADES.

[33925.]—**Building Societies.**—I do not think building societies keep up the prices of property to a "bubble figure," as they do not buy property, but merely lend a fair proportion of the value of a property to the member who purchases, and so assists such member to buy what he would otherwise be unable to purchase. The proper value of property may be maintained by building societies, but the directors of these societies are mostly hard-headed men of business, who know what they are about, and refuse an advance to a member which would enable him to pay a fancy price for a house. The advantages of these societies are manifold and great, but I will only refer to two. First, they offer a safe channel for the fructification of savings. The money being lent on the security of real property only is quite safe in a well-managed society, and the investor gets more for his money than he would from an ordinary savings bank, while he is able to put his savings by periodically, and in such sums as suit his convenience. Second, the money of the society is in constant use for the purpose of helping those who are desirous of helping themselves, and there is this anomaly that those who borrow the funds are both borrowers and investors at the same time, and while paying for the assistance they receive, and thus benefiting the society to which they belong, they are gradually becoming the owners of property, and laying by for a rainy day. The disadvantages are not so numerous, and are confined to incompetent management and want of knowledge on the part of both directors and borrowers of the exact value of property. Experience proves that it is very seldom that these disadvantages exist to such an extent in any society as to do more than decrease the profits. In conclusion I would like to tell "Jib" and your other readers that it is perhaps best to be a borrower from than an investor in building societies, as in case of the "collapse and grief" (which I do not believe in), the borrower would find himself on the safest side of the financial hedge.—GEO. WRIGHT.

[33927.]—**Money Lenders.**—There is no maximum legal rate of interest on any security. Money-lenders and borrowers enter into a contract and agree beforehand what the rate shall be, and the Government cannot interfere. There are generally two sides to every question, and it is almost invariably the case that where the "unprincipled lender" takes possession of goods under a bill of sale it is because the "unprincipled" borrower has failed to continue his repayments in accordance with the contract he entered into at the time he had the loan. The lender in these cases acts in a strictly legal manner by realising his security, and the borrower has therefore "no legal remedy." If silly people will make foolish bargains why should the law be available to assist them out of a difficulty they have voluntarily incurred? There are money-lenders and money-lenders, and borrowers should be careful in the selection of an office to borrow from, even as they would be in the selection of a security for an investment. As a rule it is safest to avoid those lenders who advance on bills of sale, and it is better to borrow from a society than of an individual, unless the latter be well known locally as a fair-dealing and honourable man. I am secretary of several mutual societies for loaning money to their members, and these societies are constituted similarly to building societies, with the exceptions that they lend on personal security, and the repayments do not extend over a longer period than five years. Any of your readers who are interested should send me their name and address, and I shall be happy to supply them with a copy of our copyright rules.—George Wright, Orwell Bank, Ipswich.

[33943.]—**Gilding Leather.**—Take yellow ochre and white lead and grind with some good old fatty linseed oil very stiff, and then with equal parts of japanner's gold size and paint; then when dry give a coat of gold size and turps, equal parts, and when tacky pounce; dust off when dry, and coat with glaire.—Jack of All Trades.

[33947.]—**Leclanche Battery.**—The cement is pitch, and can be removed by melting over a fire, or flame, or by means of hot irons. It is not necessary to seal them, but it is much better to do so, and also to nearly close up the outer vessel to diminish evaporation.—Sigma.

[33950.]—**Canoe.**—"Pacha" cannot do better than get one of Berthon's canvas canoes, made at Romsey, Hants. He has, after a variety of experiments extending over thirty years, succeeded in obtaining a kind of waterproof canvas for this purpose, and builds his canoes with an inner and outer skin of this material, so that they are divided into air-tight compartments, and are to all intents lifeboats. They are also collapsible, and pack away into a very small compass. They are very durable, and are turned out at much less cost than "Pacha" can possibly make one. If, however, he is bent on doing that, let him get Neison's "Practical Boat-Building," published 170, Strand. He will there find full instructions for building all kinds of boats, canoes, &c.—Vanderdecken.

[33956.]—**Gas Air Engine.**—I should advise "Aëronaut" not to take one up in a balloon. How long does he suppose the balloon would float if he burnt up the gas? The idea is something like that proposed a few years ago of utilising the zinc sheathing of a ship to work a magnetic engine to drive the ship, or even still more like pulling the ship itself to pieces to work its steam-engines.—Sigma.

[33971.]—**Super Heater.**—Get one of Russell's wrought-iron coils, 2in., and place in your flue at end of furnace, and pass your steam through that.—Jack of All Trades.

UNANSWERED QUERIES.

The numbers and titles of queries which remain unanswered for five weeks are inserted in this list, and if still unanswered are repeated four weeks afterwards. We trust our readers will look over the list, and send what information they can for the benefit of their fellow-contributors.

Since our last "Ploni Almoni" has replied to 33174, 33433; "R. P. G.," 33174.

33286. Midland Passenger Carriages, p. 403.
33288. Grammar, 404.
33293. Mustel Organ, 404.
33303. Isle of Wight Railway Engines, 404.
33305. Aniline Test, 404.
33313. Gt. Northern Engines, 404.
33314. Watchmakers in Australia, 404.
33319. Phonograph, 404.
33332. Violin Studies, 404.
33336. Flower Vase, p. 405.
33339. Magneto-electric Machine, 405.
33344. Bagatelle Board, 405.

33539. Breeches Paste, p. 506.
33542. Antique Watch, 506.
33545. Wood and Metal Pipes, 507.
33549. Musical Tones, 507.
33552. Steam in Small Boats, 507.
33559. Speed of L. C. and D. Engines, 507.
33564. Microphone, 507.
33568. The Lord Mayor's Special Express, 507.
33572. Oval-top Trunks, 507.
33577. Looms, 507.
33579. Flying Dutchman, 507.
33583. Shirt-making, 507.
33584. Tartans, 507.

QUERIES.

[33972.]—**Geological.**—I have often noticed in the sandstones of the lower coal measures impressions somewhat like rain prints, only deeper pits, and have found the same impression to go through thick blocks, one of which was 8in. thick. Will any reader kindly inform me of the cause of these impressions?—A Young Geologist.

[33973.]—**Spectroscope.**—To Mr. Lancaster.—Will you kindly inform me how I can, with a dense glass prism, form a spectroscope for a few elementary observations through a £5 telescope—a 2¼in. Wray?—G. Brown.

[33974.]—**Green Paint.**—I should be very much pleased if any of "ours" would give me instructions how to prepare a dark bronze-green paint for a street door, with proportions?—A Perplexed One.

[33975.]—**British Association.**—It is reported that at the recent meeting at Dublin Dr. John Evans spoke of two speciment of teeth-bearing birds from the London clay. I know of one specimen of odontopteryx in the British Museum, and am anxious to obtain information relative to the other example spoken of by Dr. Evans. Perhaps some one will oblige.—W. Hobbs.

[33976.]—**Boat Building.**—Will any one inform me how to make a small ship's boat on the half-board system? How keel and ribs are fixed, &c., how grooves are cut in the keel, and the strakes fitted on. A sketch would oblige.—Jack.

[33977.]—**Joining Indiarubber Tubing.**—Will any one inform me what cement or solution I should use for making indiarubber joints, say a tube to a ball, and should the cement be different for black rubber and for vulcanite?—A Constant Reader.

[33978.]—**Bells Ringing the Same Tone.**—Having lately removed into a new house where there are 21 bells which all ring the same note or nearly so, so that it is impossible to distinguish one from another, can any of "ours" tell me whether I can have anything done to them so as to alter their tone?—Hosnikos.

[33979.]—**Circular Eccentric Cog-Wheels.**—Can any English mechanic give an instance of above being used? I have plugged the holes of two 60-teeth lathe-wheels and put a screw through each at key way, and I find they will revolve together. Eccentric wheels are sometimes geared into elliptical, elliptical into elliptical, eccentric-elliptical into eccentric-elliptical.—E. R. Dale, Glanville's Wootton.

[33980.]—**Brine.**—Is this found in any considerable quantity, and could it be obtained in any other parts of England than Cheshire, Staffordshire, and Worcestershire? Is any obtainable on the east coast or in Scotland? I refer to the brine from which salt is made. Some geological friend will perhaps answer.—S. L. T.

[33981.]—**Magnifying Telescopic Image.**—Can the image formed by a telescope be again magnified, and if not, why not? When we look at a distant object, rays doubtless proceed from every part of that object to our eye, though for obvious reasons they are not apparent to us until magnifying power is brought to bear. Now this is the case with the magnified image produced by a telescope, though on a larger scale. Why, then, cannot the rays which make up this image be again magnified, and so bring to view parts of the object viewed which were before invisible?—Idris.

[33982.]—**Caterpillar.**—Can any of our readers tell me the name of a very large caterpillar that I found the other day? It is about 4½in. in length, and nearly one inch in diameter; the general colour is yellow, with two rows of diamond-shaped patches down the back of a greenish-blue colour, and a lot of little black dots over all.—H. King.

[33983.]—**Athletics.**—Would some reader kindly inform me what training would be necessary for running 100 yards, 200 yards, and quarter-mile races? My hours of business, as near as possible, are as follows:—I have to be at the office before 9 a.m. one week, and the next at 7 a.m., and so every alternate week. When I go at 7 I have an hour for breakfast, from 8 to 9. I have an hour for dinner at noon, and generally finish work by 5 p.m.—Clerk.

[33984.]—**Armour.**—The armoury at the Tower of London, where there is a large collection of arms and armour, is now open free to the public on Mondays and Saturdays from 10 to 4 o'clock, catalogue 2d. Will any reader inform us how the fluted and ribbed wrought-iron and steel armour was made, if welded together, and what dies, moulds, and tools are used in the manufacture of it, also how the small rings, of which some of the armour is composed, like network, were made and fitted? Is there any work published on the subject?—Trevelyan.

[33985.]—**Cement for Broken Stone.**—Could any of your numerous readers give me the receipt of a cement for broken stone to hold in very damp situation? Shellac won't stand the damp. If a dryer could be had for Venice turpentine would it do? It must be a fluid, cold or hot, to be of any use? I noticed it stated that common glue could be rendered insoluble by adding bichromate of potash; if this is a fact, and if it can be applied in the usual way and set after put together I think it would suit the purpose.—M. C. J.

[33986.]—**Speculum Grinding and Silvering.**—To Mr. W. J. Lancaster.—Would this gentleman be kind enough to give some information (as I think he promised) on this subject, as I have looked through all the numbers of the present volume and cannot find anything to suit my wants? I also think that there are several amateurs who would gladly avail themselves of simple instructions on silver speculum grinding, &c. For my part I should like to try a 6in. or 9in. Cassegrain (spherical figure), though I have few appliances and can neither afford to buy a telescope nor a lathe. I have an old foot-treadle sewing machine which I could use for a turning power by taking off all unnecessary appendages, and perhaps Mr. W. J. L. will show me how to utilise it. I should also want to know about the tools, glass, and grinding apparatus, in fact, how to finish both mirrors ready for mounting. If there be any cheap publication that would give me all these details I should be glad to know its title, price, and where it is to be purchased. From the above it will be seen that cost is a serious consideration to me. I should also like to know the powers available on reflector. Does the same law hold good, as with refractor—i.e., 100 to the inch or not?—Fras. W. B.

[33987.]—**Photography.**—Can any of our readers, who have tried the gelatino-bromide process, help me with my difficulties? On developing the plate the image is of a deep orange colour in the lights, and a pale yellowish-green in the shadows. The orange changes to more of a ruby when dry. On trying to print from a negative I found it was not anything like dense enough. I then tried to intensify with pyro and silver, but only made the whole plate fog. The formula for the emulsion I took from one in the "Year Book of Photography for 1878," by Mr. King. I also tried one or two others, but succeeded no better. I have tried various exposures. The pyrogallic acid I am using is rather old, but is still quite white. I am using the alkaline developer with liquid ammonia.—E. C. R.

[33988.]—**Speed of Trains.**—The following question appeared in one of our local papers—viz.: If the distance from York to Newcastle be 80 miles, the length of two trains 88 yards each, one of them, a goods train, starts from York for Newcastle at 8 a.m., the other, an express, starts on the same journey at 8.30 a.m.; the time taken by the latter in passing the former is 18 seconds. Required their distance from York when they pass, and the time at which each train is due at Newcastle. The answer given by several correspondents, and apparently approved of by the editor, was, "They are each 60 miles from York when they pass, and the express train is due at Newcastle at 9.50 a.m., the goods train at 10 a.m." Now, if each train be 60 miles from the starting point, it can hardly be said that one has passed the other any more than that one horse passed the other when they are level at the winning post. I also contend it is a mistake to suppose that one train commences to pass the other before it has overtaken it, and, to put the case as briefly as possible, I submit that the speed of the goods train was 176 yards in 18 seconds, or 20 miles an hour, the express 264 yards in 18 seconds, or 30 miles an hour. At 9.30 the former had run 30 miles in 1½ hours, at 9.30 the latter had run 30 miles in one hour; they were, therefore, level, and at 9h. 30m. 18sec. the express passed the slow train, being then 30 miles 264 yards from York, and arrived at Newcastle at 11.10 a.m. The goods train was passed at 9h. 30m. 18sec., was then 30 miles 176 yards from York, and arrived at Newcastle at 12 o'clock. As very strong and diverse opinions have been expressed on this subject I will feel extremely obliged if you can favour me with your view of the case, and insert it in your notes and queries.—Kernel.

[33989.]—**L. and N.W. Engines.**—"Itaaox" says there are now 65 "Bloomers." I believe there were 74 originally. Can he tell me what numbers have been "scrapped" besides 613, 624, 890, and 1,007, and what the names and dates of 613 and 624 were? Also the same of 853, 856, 888, 892, and 1,006. Another correspondent stated that the numbers or names of "Trentham," 894, and "Torch," 895, had been altered at some period. Is that so? Is "Clyde," 833, like 830? What are the numbers and dates of "Latona" and "Delhi," and is the date put anywhere on the L.N.W. goods engines? What are the dates of "Miranda" and "Rocket?" Are there any more of the class, and are they really different to the "L. of the L." class? Where do they run, and what engines work the Harborne, Stourbridge, and Ashby branches? Are the 2,240 class used? Can "Itaaox" tell me anything about a little four-coupled (leading and driving wheels) inside cylinder, saddle-tank engine, No. 1,168? It belongs to Willesden. Is not like No. 48, &c. There are four four-wheeled coupled tank engines also at Euston, used for shunting Nos. 1,292, 1,362, 1,439, and 1,444. Are they rebuilt engines? Can any one give the chief dimensions of the "goods" engines, Nos. 74, 781, 1,178, and 2,195?—Murano.

[33990.]—**Midland Engines.**—Is it really true that the numbers of some have been altered? Are the five Swansea tank engines new, and who built them, and where will they work? Why were they not numbered 1,340, or 1,377 upwards, instead of changing the old numbers? What traffic are the bogie tank engines now building intended for? Are they like No. 15? Are the new "goods" engines—Nos. 1,357 to 1,376—of Mr. Johnson's standard design (6 coupled 4ft. 10in.)? How many "single" engines still remain, and where do they work? Have the coupled 7ft. engines built at Derby a bogie or two pair of wheels leading? Can "C. E. S.," to whom I owe thanks for previous answers, give me the numbers and dates of the "23 engines," similar to 890, and built at Derby, that he mentions on page 160, Vol. XXVI.? Also the same of the ten engines like No. 1,070, and the ten like 134? What are Nos. 1,100 to 1,109 and 210 to 229 like, and who built them?—Murano.

[33991.]—**Soldering Brass Wire.**—I want to make some chains of brass wire (No. 13), links about ½in. long, which I mean to solder with hard solder. How am I to prepare to hold those links for soldering, and what description of solder must I use? Is a blow-pipe the best, and what kind?—E. B. Fennessy.

[33992.]—**P. O. Electrical Apparatus.**—Would any of our readers inform me how the batteries at the telegraph offices are constructed, and whose batteries are commonly used?—Progresso.

[33993.]—**Bleaching and Weaving.**—Could any of my fellow-readers oblige me with the following information? The authors and publishers' names of books on the above, and which they could recommend as good.—Spring-coil.

[33994.]—**Lubricating.**—Will any of my fellow-readers of the Mechanic kindly say what is used in preparing tallow for lubricating steam-engines, as I find the prepared article does better than genuine tallow?—Jas. Adams.

[33995.]—**Cement for Cast Iron Cisterns of Large Dimensions.**—Will any of "ours" practically acquainted with fixing above-named kindly give their experience as to the best kind of cement to stand test of expansion, &c., in exposed situation? The cistern is made up of a number of flanged plates bolted together.—F. J. Nelluc.

[33996.]—**Locomotive Regulators.**—Can any of your correspondents tell me the respective advantages of a regulator placed in the smoke-box, and one in the steam-dome of a locomotive? Also what are the constituents of artificial or patent metal used in bearings, &c.? Novocastrian.

[33997.]—**Horses' Corns.**—Is there any way to remove a corn on a horse's foot, which causes him to stumble sometimes? It is under the horny part between the frog and the rim of the shoe.—S. P. W.

[33998.]—**Slide-Rest Castings, 4½in.**—Will some brother-reader give hints how to fit the above up? I can use a file and have a steel straight-edge. I want to make a good job of them. I have the last ten volumes of Mechanic. If it has been described before please refer me to same.—Lathey.

[33999.]—**Flat-Bottomed Boat.**—Is there any correspondent who would give me some information how to build a boat (flat-bottomed) with paddles, to be about 14ft. long, giving material and probable cost? And how to make a pair of patent floats as cheap as possible, only required for about three months of summer at shore?—Amateur Carpenter.

[34000.]—**Animal Intelligence.**—In Mr. Romanes' lecture on the above, on p. 595, he says: "I am satisfied with my work if I have made it clear to you that the question whether human intelligence differs from animal intelligence in kind or in degree hinges entirely on the question whether the faculty of speech has been of an origin natural or supernatural." The abstract of the lecture given has not made it clear to me. I understand that Mr. R. considers animal intelligence to differ in degree, not in kind, from ours; but does he think the origin of speech natural or supernatural?—Brickwall.

[34001.]—**Phonograph.**—To Mr. Shelford Bidwell.—Following your instructions as closely as possible I have constructed a phonograph, but it does not act. I believe the fault lies in the diaphragms. I could not get thin charcoal iron. I have used a tinned Tagger plate. Ferrotype plate I found blistered the varnish directly heat was applied. I made my point from a small drill, and the point not sharp enough to prick my finger; only a fine point. The diaphragm and flange both being 4in. in diameter, I made holes in both for screws to pass into woodwork; second point much sharper but rather soft. I used parchment for diaphragm. Again, I could only get thin tinfoil. Will Mr. Bidwell say where the thick he recommends can be obtained; also where thin charcoal iron can be got? What gauge does he recommend?—T. P. W.

[34002.]—**Magnetic Engine.**—I have seen it stated in many of the papers (the ENGLISH MECHANIC amongst others) that an American has invented a flying machine in which the motive power is supplied by a ¼-horse magnetic engine. Putting aside for the moment the question of cost, will "Sigma" or Mr. Lancaster kindly tell us whether they consider the construction of such a magnetic engine possible, and, if so, how they would set about making one if they had to undertake such a job, with approximate size of magnets, battery power, &c.—ARSENTUOUS.

[34003.]—**G. N. R. Engine.**—According to the *Illustrated London News* the G. N. R. Company sent to the Darlington Exhibition an express engine capable of running at a speed of 70 miles an hour with 24 coaches on. Could any one give the dimensions of this engine and say where it is to be seen?—WILLESDEN.

[34004.]—**Scotch Mail Engines.**—What are the principal dimensions of the engines which run the limited Scotch mails between Carlisle and Edinburgh and Glasgow, and to whom do they belong?—WILLESDEN.

[34005.]—**L. and S.W. R. Engines.**—What engines run the 2.10 p.m. fast express from Waterloo? What is the size of driving-wheels of the new express bogie engines? Have the L. and S. W. any single express engines?—WILLESDEN.

[34006.]—**M. S. and L. R. Engines.**—What is the size of driving-wheels and cylinders of the bogie express engines?—WILLESDEN.

[34007.]—**L. B. and S. C. R. Engines.**—What is the size of driving-wheels and cylinders of Grosvenor (No. 151) and Westminster?—WILLESDEN.

[34008..]—**Asbestos Washers.**—Can any one tell me the cheapest and best way of cutting washers out of "Asbestos millboard." If machinery is requisite, a description of the same would oblige—RINGS.

[34009.]—**Scales on Two-foot Rule.**—What do the following denote:—1. A scale extending from one end to near the middle, marked E, 35 divisions, occupying about 10 inches, each numbered division divided into two? 2. On the other leg, extending to near the middle, 48 divisions equal nearly 10 inches; each numbered division is halved, marked M. On another rule divisions nearly same are marked 8 square instead of E, and line instead of M.—PLONI ALMONI.

[34010.]—**Photographic.**—As requested by "Finem Respice," I report how I got on in my attempt to make two ounces of gelatine emulsion. Proceeding exactly as instructed I found my first difficulty in dissolving the gelatine (used Mawson's through not receiving what I had ordered), only succeeding after frequent additions had been made to the warm water basin. When dissolved, which was in from 15 to 20 minutes, I mixed carefully and well, all went right until it came to pouring off the methylated spirit, when instead of a "leathery mass" it was a creamy solution. After standing another half hour it was much more like what I expected to see at first, although not entirely so. Pouring off, washing, &c., having been done, I dissolved again, and, still keeping the flask warm, I coated about 20 plates. The emulsion did not flow easily, and was very frothy, covering most of the plates with small air bubbles. The plates were then left for three days, when I found them firmly fastened to the levelled glass on which I had placed them to dry. Considerable force was required to get them off. Exposed as for a wet plate they developed steadily, but were too dense in some parts (distance, &c.) before all detail was out in the shadows. When dry the colour of film was in some cases orange, in others olive green. I have never worked a process which gave such exquisite detail, and despite my failure I am convinced of the value of this emulsion. Wishing to try again, I should be glad if "Finem Respice" will explain how I may avoid these things happening again, and also give a few more instructions about development. I should also like to know how the plates will keep before and after exposure, and what a strong solution of ammonia means. I used ammonia 1 part and water 2 parts. In the mean time I will procure Nelson's gelatine and "try again."—ZINCO.

[34011.]—**Photography.**—Having one of Stanley's £5 10s. sets of photographic apparatus, will one of our able friends kindly help me by instructions in higher processes than contained in "Photography made Easy," with a view to obtaining the best possible results? Wishing also to take views, &c., at a distance from home, will the dry plate process—so kindly explained by "Finem Respice" (reply 33521, page 506)—be too advanced for a novice? And how are the plates carried about and transferred?—G. B. S.

[34012.]—**κ Sagittæ.**—May I inquire if a star marked κ Sagittæ on one globe of 1816 and another of 1845 (the apex of a triangle, south of γ and δ) is the same as 13 Sagittæ mentioned in Webb's "Celestial Objects" as an orange star?—VAUGHAN CORNISH.

[34013.]—**α Cephei.**—Will some of your astronomical correspondents tell me if this star is known variable? The mags. are very discordant. I should like to know the mags. according to Piazzi, Argelander, and Heis.—VAUGHAN CORNISH, Debenham, Suffolk.

[34014.]—**H.M.S. Thunderer.**—Will some one inform me what is the diameter and height from deck of the turrets of H.M.S. Thunderer? Also what is the object in having a long kind of tube or funnel leading from deck to side of hurricane deck? I am making a model of her from some photos I have, and have got the principal dimensions except the diameter and height of turrets. Any other information that would help me in making the model will be welcome. Is it possible to get a deck plan of her?—W. S. T.

[34015.]—**Paste.**—I suppose that no inquiry has been more frequently responded to than that of "how to make paste that will keep." Judging from my experience, however, any sufficient answer that there may be has yet to be published. I have tried the addition of each of the substances that I have seen recommended, such as alum, oil of cloves, &c., but not one of them answers the purpose. Gum is not so suitable for large surfaces as paste, and it gets mouldy in the bottle. The paste that I have found both the least liable to speedy putrescence and the most stickable, and which is brownish in colour, is sold at a certain shop for sale of shoemaker's implements in Rochester-row, where I was told that a powder of which it was made could be had, enabling one to make the paste oneself. The next best was to be got at a simple shop in Pimlico. The latter is more like what is ordinarily called shoemaker's paste, and has this advantage, that, if too thick, it can be diluted with water. But then, I think, it acquires the objectionable properties of ordinary paste. What one wants, with materials at hand, and wherever one is, is to be able quickly, oneself, to make unputrescible, as well as stickable, paste, or some sufficient and cheap substitute for it, and, I may add, if the paste contained an ingredient whereby the pasted papers would be distasteful to mice there would be some loss of valuable documents prevented for such people as—AN OLD LITERARY MAN.

[34016.]—**Open Pan.**—Will any of our kind correspondents inform me whether there is any way of heating to the boiling point 1,700 gallons of water than by having a steam-pipe down to the bottom of the pan and blowing the steam in the liquid in the old and common way? I have a 12-horse steam boiler, upright fire-box inside, and I have heard of a method of having a steam-coil with both ends of the coil attached to the boiler at different levels, and thus the steam or hot water circulates through the coil in the open pan backwards and forwards from boiler to pan continually. Can this be done economically, and how?—OPEN PAN.

[34017.]—**Sewing Machine.**—I have a hand-shuttle sewing machine (don't know name or maker) which will work very well on soft material, as cloth or calico, but when required to operate upon such stiff hard stuff as buff blinds it seems impossible to get the upper tension tight enough to pull the under thread up into its place. If it is very tight the thread continually breaks. Can this be cured, and if so, how? What is the best position for the eye of the needle, with reference to the point of the shuttle, and how much play should the latter have in its carrier? The shuttle moves in a horizontal, curved path.—J. E. FLOYD.

[34018.]—**Paralysis.**—To DOUGLAS SCOFFERN.—What is the usual (or the best) treatment for paralysis of the eye and eyelid? General health excellent; age 45; sanguine temperament; occupation sedentary. Symptoms: Eye inclined outwards, eyelid closed, no power to raise it, preceded by neuralgic pains in forehead, pain now gone; case recent.—CYMRO.

[34019.]—**L. and N. W. R. Engines.**—Are there any 6ft. 9in. coupled on the L. and N.W. R.? "W. J. S." says in letter 14433, p. 315, Prince Leopold, Snowdon, Lowther, Princess Beatrice (6ft. 9in. coupled). Is not this a mistake for 6ft. coupled, as I always thought that these engines were 6ft. coupled?—WILDFIRE.

[34020.]—**Nitric and Sulphuric Acids.**—Wishing to ascertain whether a small sample of acid was nitric or sulphuric, I let a drop fall on some powdered potassic chlorate and loaf sugar. As no immediate effect followed I concluded that the acid was nitric. But in the course of about half a minute I was surprised to notice chemical action taking place, and in a few moments the powder took fire, much as it would have done in the case of sulphuric acid having been used. I have never heard of nitric acid causing this combustion, but it may be known to some of your readers. I should be glad if, in that case, they will mention their experiences.—A. B. HARDING, Forest-hill.

[34021.]—**Phonograph.**—I have made one of these wonderful instruments according to the very complete and full instructions given by Mr. Shelford Bidwell on p. 157, and it speaks very distinctly, far exceeding my expectations. I have made it in every respect exactly to instructions, and I feel sure if others would do the same there would be fewer complaints of failures. I have a little difficulty in adjusting my points, and should like to know how Mr. Bidwell adjusts his "in a few seconds in the dark."—CHESTERTON.

[34022.]—**Physically Unfit.**—Will any of "ours" kindly inform a joiner as to what other trade or calling he could turn his attention to with a view to a reasonable subsistence? The doctor tells him he must avoid throwing or twisting the body about, which a joiner is frequently in the habit of doing at his bench, and advises him to find some lighter occupation. I may state here that my complaint has to do with the chest—have been under an operation—and now wear a tube in the left side of my back, which prevents me from moving about. As my joiner's trade is the best thing I am acquainted with, I am somewhat at a loss to know what I could turn my hand to with any chance of success, for any great exertion is now out of the question. Any suggestions or information would be very acceptable.—PINE WOOD.

[34023.]—**Acetic Acid.**—The formula for acetic acid given in our elementary books is $C_2H_4O_2$, and in a book that I have the formula $C_4H_3O_3$ is given as shown in the following reactions:—$8\ Fe + C_{12}H_5NO_4 + 8HO + 12\ C_4H_3O_3 = 4\,(Fe_2O_3 \cdot 3C_4H_3O_3) + C_{12}H_7N + 6H$.—CHEMICAL STUDENT.

[34024.]—**Extracts from Grain.**—Would any reader inform me the simplest method of obtaining extracts from malt or other grain?—J. CHANDOS.

[34025.]—**Goldfinches.**—Can any reader inform me how I may detect the difference between the young male and female bird of the goldfinch species?—EUTERPE.

[34026.]—**Gas Lighting by Electricity.**—About a year ago a public lecturer named Professor Haggerty was lecturing in Bolton on scientific subjects. Amongst other novelties he had an upright gas-stand, and near the top there were two discs; by turning on the gas and giving the loose disc half a turn an electric spark was got at the gas burner, which lighted the gas. Can any of "ours" inform me what the substance is which causes the electric spark? Also how is the apparatus constructed? Some time back I called on Mottershead and Co., of Manchester, who advertise in your columns, and they told me they had sold out, also that it was an American patent which had run out, and they had no chance of getting any more. It sold retail at about five shillings. Any information on the above subject will be thankfully received by—AGRICOLA.

[34027.]—**L.N.W.R. Engines.**—What is the height of centre line of boiler from rails in "Precursor" class? What is the weight on each pair of wheels of "Precedent" class? Why are the "Bloomer" engines so called?—WILLESDEN.

[34028.]—**Fitting Brake on Premier Bicycle.**—Will any correspondent learned in bicycle matters kindly inform me whether it is possible to fit a brake on the front wheel of a "Premier" bicycle, and if so if it could be done in a town where there are good workshops and foundry? There is a brake on the back wheel, but I do not find that sufficient for going down the steep hills we have here.—ALPHA BETA.

[34029.]—**Seeing under Water.**—The reason it is impossible to see clearly under water is that the water and the substance of the eye being of about the same density, parallel rays converge behind the retina. Hence some convex lens might possibly correct this. Would any optical correspondent give the dimensions of such a lens, of course assuming the dimensions, &c., of an average eye, as given in any textbook? Also how close such a lens would have to be put to the eye to secure distinct vision.—H. J. A.

[34030.]—**The Pianista at the Paris Exhibition.**—There is one instrument in the Exhibition I should like to see described, and that is an instrument by which any air may be played, by any one who does not know music, on the piano or a harmonium. It is exhibited by Jerome Thibouville-Larny, 68 and 70, Rue Reaumur, and is termed a "pianista." It is placed in front of an ordinary piano, and the keys, of which there are about four octaves, strike the keys of the piano as the fingers would. The music to be played is on sheets of perforated cardboard. The perforations are longitudinal, and of various lengths, according to the length in point of time of the notes. The cardboard passes from one end of the machine to the other under two rollers, turned by hand; the second roller is surrounded with raised rings, which correspond with the lines of the perforations. The assistant who was playing the instrument did not possess a sufficient knowledge of English, nor I of French, to enable me to ascertain precisely the means by which the keys were actuated, and the mechanism was inclosed; but from what I could see it appeared to me that the action was produced by pneumatic bellows set in action by studs which were in some way acted on by the rings round the second roller when the perforations passed under the rings on that roller. The assistant stated that the action was not electric, but pneumatic. The automatic system of playing by perforated paper or cardboard is not, I believe, new. Patents in connection with electric action having been some years ago taken out, one wonders why it has never been followed out. Although there is an expression stop, the instrument, as may naturally be expected from its being automatic, appears to be deficient in that respect. The price is £32, and the price of each air or piece is about [illegible]—E. T. B.

CHESS.

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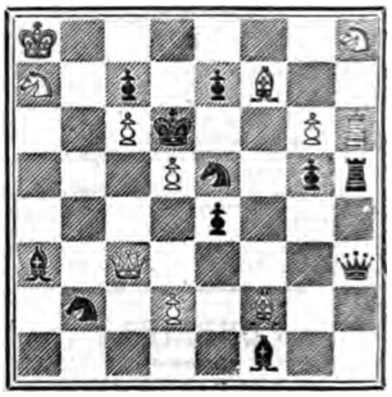
ALL Communications intended for this department must be addressed to J. PIERCE, Copthill House, Bedford.

PROBLEM CCCCXLI.

BY J. A. W. HUNTER AND H. F. L. MEYER (dedicated to R. J. HUNTER, Esq.)

Black.



White.

White to play and mate in two moves.

SOLUTION TO 439.

White.	*Black.*
1. R to K B 4.	1. Anything.
2. B to K R 4.	2. Anything.
3. R, Kt or P mates accordingly.	

NOTICES TO CORRESPONDENTS.

E. F. JOHN.—There is no mate your way if 1. $\overline{\text{K R to Kt sq}}$; for if, as you say, 2. $\frac{\text{Kt takes P (ch)}}{\text{R takes Kt}}$; and there is no mate.

A. C. PEARSON, F. C. COLLINS, AND J. G. FINCH.—Problems received with thanks.

E. TURKINGTON.—How can there be mate next move if 2. $\overline{\text{R to K sq}}$?

J. G. F.—The three problems previously sent were all marked for insertion

JUN 26 1941